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Survey for Greenland Halibut in NAFO Divisions 1C-1D, 2006

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Abstract

In 1997 Greenland initiated a survey series covering NAFO Divisions 1CD at depths between 400 and 1 500 m. The survey is designed as a Stratified Random Bottom Trawl Survey aimed mainly at Greenland halibut and roundnose grenadier. The paper gives biomass and abundance estimates and length frequencies for Greenland halibut, roundnose and roughhead grenadier, and deep sea redfish together with age and maturity data for Greenland halibut. The biomass of Greenland halibut was estimated as 77 010 tons in 2006 compared to 80 900 tons in 2005 and hence remained stable at a high level. The biomass of roundnose grenadier remained at a very low level and was estimated as 658 tons only.

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. The survey traditionally covers NAFO Div. 1CD, but in 2001 the survey area was expanded to include Div. 1A (to 74°N) and Div. 1B and in 2004 the northern part of the Baffin Bay (73°N-77°N) was surveyed, too.

Materials and Methods

The survey in 2006 covered Div. 1CD at depths between 400 and 1500 m and took place during 11/10-22/10.

Stratification

The survey covered NAFO Div. 1C-1D between the 3-nm line and the 200-nm line or the midline to Canada at depths between 400 and 1 500 m. The survey area was stratified in NAFO divisions and subdivided in 6 depth strata 401-600, 601-800, 801-1 000, 1 001-1 200, 1 201-1 400 and 1 401-1 500 m. The depth stratification was based on Greenland Geological Survey's 10 m depth contour maps, Canadian maps and depth soundings made during previous surveys. The area of each stratum was measured using "MapInfo Version 4.0" (Table 3).

The survey was planned as a Stratified Random Bottom Trawl Survey with in total 70 hauls. Each stratum was allocated at least two hauls. The remaining hauls were allocated in order to minimize the variance in the estimation of the biomass of Greenland halibut. *i.e.* strata with great variation in the catches of Greenland halibut in the previous years surveys have got relatively more hauls than strata with little variation in the catches. In 2004 a new

method of choosing stations was introduced. The method combines the use of a minimum between-stations-distance rule (buffer zone) with a random allocation scheme (Kingsley et al. 2004).

Vessel and gear

The survey was conducted by the 722 GRT trawler PAAMIUT, as in previous years, 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 Injector weighing 2 700 kg. The Injector otter doors replaced the Perfect doors that have been used until 2003. The average net height was 20 cm higher with the new doors compared to the old, but the difference was not statistically significant (95% level) and it was concluded that the net performance has not changed by the introduction of new doors. 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 + 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, or in a few cases based on GPS observations (mean of records made every 5 min. during the haul). Trawling took place day and night.

Near-bottom temperatures were measured, by 0.1^{o}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 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 always comprised of at least 200 specimens.

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

In strata with one haul only SD was estimated as: SD= biomass or abundance.

Otoliths for age determination of Greenland halibut (n = 566) 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.

Results and Discussion

In total 61 successful hauls were made, giving a mean coverage of the surveyed area on 843 km^2 per haul. The number of tows was reduced compared to the 70 planned mainly due to bad weather, however, all strata were covered. Haul by haul information on catches, depth, temperature etc. is given in Table 1 and the distribution of hauls by strata is given in Table 3.

In total 93 species or groups of species were recorded (Appendix 1).

Greenland halibut (*Reinhardtius hippoglossoides*)

Greenland halibut was caught in all hauls (Fig. 1, Table 1) and the biomass was estimated at 77 010 tons (S.E. 6259.6) (Table 3) which is a slight decrease from 80 865 tons (S.E. 8 365.7) in 2005 (Table 2). The biomass estimates showed little variation by stratum compared to 2005 except for a, however statistically insignificant (95%level), decrease from 22 796.1 tons to 14 356.1 tons in depth stratum 1201-1400 m in Div. 1D. The estimate

from 2006 is not statistically different (95% level) from the estimates from 1997-2004. (Jørgensen, 2006; 2005; 2004; 2003; 2002; 2001; 2000; 1999 and 1998b). The weighted mean catch per tow also showed an insignificant decrease from 1.55 tons/km^2 to 1.47 tons\km^2 and was in 2006 a little above average for the time series (Fig 2.).

The abundance in Div. 1CD was estimated at 70.715 *10^6 (S.E 5.622*10^6) (Table 3) which is a slight decrease compared to 73.001*10^6 (S.E. 7.319*10^6) in 2005. The distribution of the abundance by stratum showed little variation compared to 2005.

Estimated abundance by age in Div. 1CD is given in Table 5.

The length ranged from 15 cm to 101 cm (excluding a few larvae on 8-9 cm). The overall length distribution (weighted by stratum area) was totally dominated by a mode at 47-50 cm where the mode was at 48 cm in 2004 and 2005 (Fig. 3). Generally the length distributions in the different depth strata were dominated by a single mode and fish size increased with depth and from north to south at the same depth (Fig. 4) as seen in previous surveys (Jørgensen, 1997b).

The age ranged from 1 to 17 years. Generally the age increased by depth but the age composition was dominated by ages 5-7 in all strata (Fig. 5). The overall age distribution (weighted by stratum area) in Div. 1CD was monomodal with a mode around age 6 while the mode was at age 7 in 2005 (Fig. 6). Mean weight - and length at age is given in Table 6.

Females stated maturing at age 8 and 100% maturity was reached at age 13 (Table 7).

Roundnose grenadier (*Coryphaenoides rupestris*)

Roundnose grenadier was caught in most of the survey area but the catches were very low (Table 1, Fig. 7). The biomass has been very low for more than a decade (Table 8) and far below the level seen in the late 80'. The biomass estimated from the 2006 survey was the second lowest in the time series: 658.6 tons (S.E. 192.2).

Most of the biomass was found in Div 1C, 801-1000 m and Div. 1D, 1001-1400 m (Table 9).

The abundance in Div. 1C-1D was estimated at 10.843*10^6 (S.E. 4.3*10^6) which is the second lowest observed and a slight decrease compared to 2006 (Table 10). The highest densities were found in Div. 1C 601-1000 m where about 3/4 of the total abundance was located.

Pre anal fin length ranged from 2 to cm 18 cm. The grenadiers were generally small and the overall length distribution (weighted by stratum area) was totally dominated by a mode at 6 cm where the mode has been at 5 cm as in previous years (Fig. 8).

Roughhead grenadier (*Macrourus berglax*)

Roughead grenadier was caught in all hauls except in three shallow (< 510 m) hauls in Div. 1D. The catches were generally low (Table 1, Fig. 9). The biomass of roughhead grenadier was estimated at 5148. 2 tons (S.E. 621.2), which is at the same level as in 2005 and around average for the time series (1997-2005) (Table 11).

The highest densities were found between at depths > 6001 m in Div. 1D and but the largest biomass was found in Div. 1C 601-800 m (Table 12).

The total abundance was estimated at 11.838*10^6 (S.E. 1.093*10^6) (Table 13), which is at slight decrease compared to 2005 (Table 11).

Pre anal fin length ranged from 4 to 36 cm and the over all length distribution was dominated by a mode at 15 cm with minor modes at 7, 10, 12 and 21 cm (Fig. 10).

Deep-sea redfish (*Sebastes mentella*)

Deep-sea redfish + *Sebastes* sp. was caught in 24 of the 61 valid hauls, but the catches were very low, <10 kg, except three hauls on 16.2, 44.2 and 44.6 kg, respectively (Table 1). The biomass was estimated at 2 188.4 tons (S.E. 700.7) which is slight decrease compared to 2005 and below the average for the time series 1997-2005) (Table 14) Almost all the biomass was found in Div. 1C 401-600 m as in most other years (Table 15).

The abundance was estimated at $18.20*10^6$ (S.E. $8.4010*^6$) which is the second highest estimate in the time series. (Table 14). Almost all the abundance was found at depths < 600 m, most in Div. 1C 401-600 m.

The length ranged from 6 to 41 cm with a clear mod at 21 cm and a minor mode at 15 cm. (Fig. 11).

Temperature

The bottom temperature ranged from 2.2 to 4.7 °C and the mean temperature was generally decreasing by depth (Table 17).

The mean temperatures decreased slightly (1.0 to 0.2 °C) in the two shallower depth strata while the temperature was unchanged in the deep strata compared to 2005.

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Table.1. Catch weight and - numbers (not standardized to kg/km^2) of Greenland halibut, roundnose and roughhead grenadier and *Sebastes mentella + S. sp.* by haul. Depth in m, swept area in km^2 and bottom temperature in °C. 11 hauls have been excluded as invalid.

					Grl. halibut		Roundnose gre.		Roughhead gre.		*S. mentella*	
St. No	Depth	S. Area	Div.	Temp.	Weight	Number	Weight	Number	Weight	Number	Weight	Number
2	845.0	0.0801	1C	4.2	198.5	208	2.0	56	7.5	29	0.3	2
3	824.0	0.0736	1C	4.5	57.2	69	0.7	15	2.7	13	0.0	0
4	473.5	0.0643	1C	5.0	9.9	11	0.0	0	1.1	4	16.2	97
7	804.0	0.0802	1C	4.2	54.4	65	1.6	36	8.0	27	0.0	0
8	729.5	0.0851	1C	3.1	55.6	70	0.1	1	8.0	27	1.5	7
9	559.0	0.0689	1C	4.7	2.1	4	0.0	0	1.4	4	44.2	434
10	653.0	0.0781	1C	2.4	30.6	55	0.0	0	3.1	8	1.0	9
11	635.5	0.0747	1C	2.2	18.2	32	0.0	0	8.5	24	2.2	20
12	691.5	0.0795	1C	2.6	43.5	60	0.0	1	4.3	21	1.7	11
13	792.0	0.0780	1C	4.0	39.7	45	0.1	2	11.6	34	0.5	2
14	846.0	0.0776	1C	3.9	112.6	104	0.4	14	5.6	16	0.0	0
15	782.5	0.0832	1D	4.0	99.9	107	0.9	14	5.5	19	0.2	1
16	777.0	0.0784	1C	4.0	78.1	86	1.4	28	8.4	13	0.1	1
17	816.0	0.0743	1C	4.0	223.7	226	0.3	7	11.1	36	0.9	2
18	838.5	0.0699	1C	3.8	48.9	50	1.2	21	5.7	12	0.3	1
19	974.5	0.0763	1C	4.1	292.8	290	3.2	66	3.1	8	0.0	0
20	1050.5	0.0760	1C	3.9	316.6	262	0.8	19	6.7	13	0.3	1
21	868.5	0.0819	1C	4.1	98.7	106	2.7	63	1.5	4	0.0	0
22	1058.5	0.0635	1C	3.7	56.0	51	0.9	15	2.3	7	0.0	0
23	954.5	0.0316	1C	4.2	103.8	90	8.8	207	5.9	8	0.0	0
26	1136.0	0.0715	1D	3.8	280.8	250	1.0	16	2.8	9	0.4	1
27	941.5	0.0720	1D	4.0	95.9	83	0.2	5	2.4	8	0.0	0
28	1051.5	0.0713	1D	3.8	175.0	142	0.5	4	1.5	7	0.0	0
29	1023.0	0.0777	1D	3.7	151.2	118	0.0	0	2.4	9	0.0	0
30	874.5	0.0478	1D	4.0	29.9	28	0.2	5	4.2	8	0.0	0
31	741.5	0.0355	1D	3.8	14.1	17	0.2	4	12.1	17	6.4	17
32	1065.0	0.0749	1D	3.8	131.5	118	0.1	3	1.1	4	0.3	1
33	1108.5	0.0730	1D	3.7	156.6	126	0.1	1	5.7	14	0.0	1
34	1167.0	0.0840	1D	3.7	343.6	315	0.9	6	4.1	11	0.0	0
35	1362.5	0.0779	1D	3.6	181.0	166	0.7	7	6.0	15	0.0	0
36	1485.5	0.0748	1D	3.5	86.8	70	0.7	3	6.3	11	0.0	0
37	1456.5	0.0759	1D	.	155.7	116	4.2	16	7.8	11	0.0	0
38	1335.0	0.0763	1D	.	114.1	80	3.3	7	5.0	15	0.0	0
39	1290.5	0.0790	1D	.	502.8	466	0.8	6	4.7	9	0.0	0
40	1430.5	0.0756	1D	.	366.0	294	1.9	13	17.0	20	0.4	2
41	1431.0	0.0716	1D	.	146.2	107	0.1	1	13.0	17	0.0	0
42	1323.5	0.0357	1D	3.3	188.9	170	0.8	3	6.7	12	0.0	0
43	1191.0	0.0713	1D	3.4	324.3	223	4.5	24	14.3	25	0.0	0
44	1271.0	0.0663	1D	3.5	145.9	94	0.9	2	9.4	17	0.0	0
45	1285.0	0.0716	1D	3.6	80.4	61	0.9	2	4.1	10	0.6	1
46	1369.0	0.0633	1D	3.6	290.3	209	1.0	3	20.5	43	0.0	0
47	1137.0	0.0673	1D	3.8	186.8	147	0.0	1	5.4	16	0.0	0
49	1420.5	0.0706	1D	3.6	130.7	92	0.1	1	10.6	24	0.0	0
50	1288.5	0.0734	1D	3.7	226.2	175	1.5	8	8.4	23	0.0	0
52	1211.5	0.0386	1D	3.7	110.2	92	1.2	14	1.6	6	0.2	1
55	1169.5	0.0346	1D	3.7	49.8	43	0.5	14	21.0	29	0.0	0
56	1213.0	1.1284	1D	3.9	89.6	71	2.0	10	7.4	12	0.3	1
59	1375.5	0.0607	1D	.	75.7	53	2.1	6	5.6	11	0.0	0
60	1295.0	0.0547	1D	.	6.9	7	0.0	0	0.2	1	0.0	0
61	1224.5	0.0368	1D	.	52.5	40	0.5	9	10.8	19	0.0	0
62	1238.5	0.0621	1D	3.3	15.8	14	0.3	2	10.4	18	0.0	0
63	1421.5	0.0517	1D	3.6	15.7	11	0.0	0	1.3	3	0.0	0

64	1169.5	0.0388	1D	3.6	48.9	31	0.6	14	6.8	11	0.0	0
65	1179.5	0.0743	1D	3.6	104.8	78	0.7	4	10.6	16	0.0	0
66	1167.0	0.0769	1D	3.8	275.1	249	0.0	0	14.0	19	0.0	0
67	899.5	0.0400	1D	4.1	114.1	114	0.5	7	1.6	6	0.0	0
68	1128.0	0.0731	1D	3.9	86.4	70	0.3	4	2.8	7	0.0	0
69	958.5	0.0643	1D	4.1	130.4	115	0.2	5	5.0	16	0.0	0
70	402.0	0.0636	1D	4.3	1.9	2	0.4	2	0.0	0	7.4	44
71	408.0	0.0712	1D	4.4	15.1	39	0.0	0	0.0	0	44.6	584.74
72	509.5	0.0420	1D	4.4	25.0	20	0.5	1	0.0	0	2.0	10

Table 2. Biomass (tons) and abundance in Div. 1CD and mean catch per tow standardized to km^2 (tons) with S.E.

Year	Biomass	S.E.	Mean	S.E.	Abundance ($*10^6$)	S.E.
1997	56 260.2	4 399.6	1.07	0.08	53.613	4.118
1998	70 473.5	8 391.7	1.34	0.16	67.677	7.687
1999	64 398.0	6 912.1	1.27	0.14	61.366	6.265
2000	59 092.4	5 543.3	1.28	0.11	61.710	5.976
2001	77 554.0	13 013.6	1.57	0.26	80.814	14.221
2002	71 932.4	5 613.9	1.56	0.12	71.510	6.223
2003	68 717.2	6 411.9	1.39	0.13	72 556	7.764
2004	75 869.4	5 186.3	1.48	0.1	74.859	5.445
2005	80 865.4	8 365.7	1.54	0.16	73.001	7.317
2006	77 010.3	62 59.6	1.47	0.12	70.715	5.622

Table 3. Biomass (tons) of Greenland halibut by Division and depth stratum, 2006.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Biomass	SE
1C	401-600	3366	2	0.0922	310.3	205.6
	601-800	16120	6	0.5564	8969.7	1687.7
	801-1000	6066	9	1.9352	11738.8	2486.2
	1001-1200	611	2	2.5238	1542.1	1003.3
1D	401-600	903	3	0.2788	251.7	150.3
	601-800	1940	2	0.7996	1551.3	779.4
	801-1000	3874	4	1.7087	6619.4	1847.6
	1001-1200	10140	13	2.5013	25363.0	3308.2
	1201-1400	6195	14	2.3174	14356.1	3225.3
	1401-1500	3091	6	2.0407	6307.8	1927.3
All				1.4723	77010.3	6259.6

Table 4. Abundance of Greenland halibut by Division and depth stratum, 2006.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Abundace	SE
1C	401-600	3366	2	114.5	385414.7	190113.3
	601-800	16120	6	730.5	11775843.2	1496091.3
	801-1000	6066	9	1931.2	11714508.1	2314476.3
	1001-1200	611	2	2125.3	1298529.4	807837.2
1D	401-600	903	3	351.7	317597.8	145825.0
	601-800	1940	2	883.0	1712990.0	783295.7
	801-1000	3874	4	1594.4	6176771.5	1881913.5
	1001-1200	10140	13	2051.0	20797312.4	2883482.9
	1201-1400	6195	14	1896.6	11749185.6	2894459.2
	1401-1500	3091	6	1560.2	4822523.1	1565516.5
All				1352.6	70750675.7	5621695.6

Table 5. Estimated abundance by age from Div. 1C-1D from the surveys in 1997-2006. The Age-length key from 1998 is applied on the 1999 data.

AGE	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0	0	0	78826	15585	71512	833452	314358	200672	132147
2	536130	609093	184098	109496	281013	214536	3187890	255511	201882	641030
3	1704893	3722237	920490	479059	511722	285367	1468105	274564	569831	524114
4	3023773	4662948	4172888	3074341	4835796	2361529	2417001	4465950	1749900	2959669
5	9961295	14760362	11291344	15090231	20601616	11779876	12348567	14877198	12218823	13324592
6	15370847	19057854	15893794	16838191	26595603	26697300	21816458	30067732	19867351	20210890
7	13558728	14083592	19759852	14711646	17922784	18561065	18499540	14298142	21303055	15509156
8	5436358	5766084	4786548	5026106	4674899	6201987	6534966	6252194	12674030	13224793
9	1200931	1515966	859124	3214208	2550178	1857799	2403542	1724259	385774	731747
10	948950	1211419	920490	1040152	780082	1340261	1244102	944766	1881136	1342871
11	584382	764751	613660	717770	705656	905723	581491	392534	158664	362986
12	466433	527881	675026	350292	369836	166242	224915	230820	1044342	958082
13	187646	351921	429562	318336	345397	257412	264203	158687	36861	122337
14	96503	155657	429562	122157	195607	143024	207745	163836	410090	459693
15	262704	236870	184098	230208	225277	263139	67270	218713	85460	114617
16	187646	115051	61366	128242	91540	178780	206590	71775	13547	102977
17	64336	128586	61366	95352	80275	107268	72546	96352	118365	28973
18	16084	0	61366	57045	22628	35756	41219	6650	35465	0
19	0	0	0	27474	32325	83431	58531	37874	45452	0
20	0	0	0	0	8081	0	22258			
21						0	7419			
SUM	53607639	67670271	61304634	61709132	80845900	71512007	72507812	74851915	73000702	70750676

Table 6. Mean weight and mean length-at-age of Greenland halibut, 1997-2006.

	1997		1998		1999		2000		2001		2002		2003		2004		2005		2006	
AGE	weight	length	weight	length	weight	length	weight	length	weight	length	weight	length	weight	length	weight	length	weight	length	weight	length
1							25	13.5	28	14.4	20	16.0							18	13.3
2	23	15.3	38	18.7	64	21.0	75	21.0	85	21.0	60	21.7	85	23.0			69	21.5	71	21.1
3	58	19.8	176	28.5	206	27.4	146	26.3	173	26.7	200	29.6	192	29.4			169	28.5	180	28.6
4	137	26.1	348	35.3	342	34.4	329	33.6	366	34.2	341	35.5	355	35.7	487	39.1	382	36.6	397	36.8
5	272	32.8	551	40.9	571	40.3	528	39.5	574	39.7	487	39.9	522	40.2	646	42.8	550	41.3	594	41.8
6	444	38.0	854	46.8	793	45.6	764	44.5	849	44.9	747	45.6	763	45.4	917	47.5	831	46.7	867	47.0
7	737	43.9	1218	51.9	1196	51.4	1074	49.8	1159	49.9	1132	51.7	1116	51.2	1293	52.5	1137	51.6	1142	51.4
8	1070	49.9	1572	56.8	1665	57.9	1376	53.7	1541	54.8	1370	55.6	1419	55.9	1638	56.5	1569	56.5	1531	56.1
9	1454	55.6	2075	60.6	2057	61.1	1631	56.8	1844	58.0	1844	60.7	1861	59.8	1942	60.2	1754	58.8	2189	61.2
10	2043	61.2	2293	63.1	2441	64.1	2077	61.5	2259	61.8	2037	62.5	2115	62.6	2191	62.3	2301	63.8	2502	64.2
11	2815	66.7	2867	66.5	2812	66.9	2503	63.9	3316	65.0	2508	66.0	2668	66.8	2924	67.8	2878	68.0	3588	70.9
12	3828	72.6	3453	69.9	4000	72.9	3014	67.5	3450	68.7	3011	69.7	3190	70.4	3237	68.2	3464	71.2	3450	70.2
13	4840	77.3	4538	74.7	5679	79.5	3612	70.4	3866	71.3	3558	71.6	3178	70.6	3683	72.4	4617	77.0	4951	77.5
14	6679	84.0	5112	77.6	7613	86.7	3893	72.8	5257	77.8	4650	78.5	3845	75.5	3889	71.1	5305	79.1	5324	79.0
15	7711	87.8	7141	85.1	8477	91.2	5409	78.3	6324	81.9	5149	79.0	4340	76.0	4740	74.8	6468	86.0	7029	86.1
16	9166	94.6	8385	88.9	9925	88.5	6873	85.5	7203	86.0	6786	84.8	5747	81.3			13320	100.0	8415	89.3
17	10797	97.8	10684	95.4			8492	91.8	8954	92.4	8520	90.3	6200	84.0	6498	82.0			9588	95.0
18					12500	99.0	8590	92.3	8760	93.0	9385	93.0			893	93.0	9570	97.0		
19			12850	99.0			9645	91.5	11500	102.0	8553	90.3			10220	93.0	14150	101.0		
20									14400	105.0										

Table 7. Maturity-at-age in percent, females, Div. 1C-1D, 2006.

age	Immature	Maturing	N
1	100.0	0.0	2
2	100.0	0.0	12
3	100.0	0.0	14
4	100.0	0.0	26
5	94.1	5.9	34
6	93.8	6.3	32
7	90.9	9.1	22
8	57.1	42.9	35
9	0.0	100.0	3
10	37.5	62.5	24
11	30.8	69.2	13
12	18.6	81.4	43
13	0.0	100.0	9
14	5.6	94.4	36
15	0.0	100.0	10
16	0.0	100.0	10
17	0.0	100.0	2

Table 8. Biomass (tons) and abundance of roundnose grenadier with S.E. by year.

Year	Biomass	S.E.	Abundance ($*10^6$)	S.E. ($10*^6$)
1997	5 686.5	926.4	32.44	7.06
1998	7 263.3	2 530.2	75.24	27.36
1999	2 771.8	445.5	29.10	8.96
2000	5 593.7	2 616.8	99.52	67.31
2001	1 577.2	516.4	24.70	8.80
2002	1 593.1	462.7	18.61	8.91
2003	774.2	144.0	6.90	1.27
2004	633.0	98.2	10.56	2.53
2005	733.0	116.0	12.18	3.75
2006	658.6	192.2	10.83	4.28

Table 9. Biomass (tons) of roundnose grenadier by Division and depth stratum, 2006.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Biomass	SE
1C	401-600	3366	2	0.0000	0.0	0.0
	601-800	16120	6	0.0032	51.9	46.2
	801-1000	6066	9	0.0484	293.4	176.8
	1001-1200	611	2	0.0122	7.4	1.2
1D	401-600	903	3	0.0062	5.6	3.1
	601-800	1940	2	0.0075	14.6	6.1
	801-1000	3874	4	0.0059	22.9	9.5
	1001-1200	10140	13	0.0110	111.3	46.7
	1201-1400	6195	14	0.0168	103.8	20.6
	1401-1500	3091	6	0.0154	47.7	27.7
All				0.0126	658.6	192.2

Table 10. Abundance of roundnose grenadier by Division and depth stratum, 2006.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Abundace	SE
1C	401-600	3366	2	0.0	0.0	0.0
	601-800	16120	6	67.8	1093148.9	934189.0
	801-1000	6066	9	1122.5	6809230.1	4147710.1
	1001-1200	611	2	243.1	148536.5	4215.3
1D	401-600	903	3	18.4	16622.7	8547.3
	601-800	1940	2	140.6	272684.2	53932.6
	801-1000	3874	4	106.7	413375.2	92989.0
	1001-1200	10140	13	125.4	1271453.9	420806.0
	1201-1400	6195	14	93.1	576808.5	163145.9
	1401-1500	3091	6	75.1	232243.6	115748.8
All				207.1	10834103.5	4278428.0

Table 11. Biomass and abundance of roughhead grenadier by year in Div. 1CD,. with S.E.

Year	Biomass	S.E.	Abundance ($*10^6$)	S.E. ($*10^6$)
1997	2 258.6	250.1	4.60	0.45
1998	4 314.1	377.9	11.62	1.01
1999	5 166.2	854.1	14.07	2.04
2000	7 178.1	2 226.5	20.28	7.18
2001	4 576.6	456.3	13.87	1.55
2002	7 907.6	823.6	19.62	1.76
2003	5 657.5	700.8	15.37	2.57
2004	4 314.3	452.6	11.16	1.32
2005	5 602.6	419.5	14.00	1.31
2006	5 148.2	621.2	11.84	1.09

Table 12. Biomass (tons) of roughhead grenadier by Division and depth stratum, 2006.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Biomass	SE
1C	401-600	3366	2	0.0180	60.7	5.2
	601-800	16120	6	0.0927	1495.1	262.4
	801-1000	6066	9	0.0864	523.9	109.7
	1001-1200	611	2	0.0621	38.0	15.7
1D	401-600	903	3	0.0000	0.0	0.0
	601-800	1940	2	0.2027	393.2	265.8
	801-1000	3874	4	0.0593	229.8	51.9
	1001-1200	10140	13	0.1273	1291.1	443.8
	1201-1400	6195	14	0.1165	721.6	161.9
	1401-1500	3091	6	0.1277	394.8	90.5
All				0.0984	5148.2	621.2

Table 13. Abundance of roughhead grenadier by Division and depth stratum, 2006.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Abundace	SE
1C	401-600	3366	2	60.1	202292.2	6990.7
	601-800	16120	6	267.8	4316509.6	785842.1
	801-1000	6066	9	238.2	1445213.1	275876.8
	1001-1200	611	2	140.6	85932.1	18582.2
1D	401-600	903	3	0.0	0.0	0.0
	601-800	1940	2	353.9	686480.0	243214.3
	801-1000	3874	4	169.3	655830.5	112157.7
	1001-1200	10140	13	229.5	2327476.5	567641.9
	1201-1400	6195	14	242.8	1504394.8	300793.4
	1401-1500	3091	6	198.6	613974.2	127655.1
All				226.3	11838103.0	1093056.4

Table 14. Biomass and abundance of *Sebastes mentella* + *Sebastes* sp. by year in Div. 1CD with S.E.

Year	Biomass	S.E.	Abundance $*10^6$	S.E.$*10^6$
1997	2 464.3	787.1	14.69	5.50
1998	2 408.1	503.9	18.83	4.50
1999	2 484.9	1 007.7	12.93	4.09
2000[1)]				
2001	2 063.4	873.5	16.34	6.47
2002[1)]				
2003	1 493.4	684.5	7.13	3.08
2004	2 329.1	1 986.8	13.34	11.31
2005	2 546.2	1 683.3	7.28	3.16
2006	2 188.4	700.7	18.20	8.40

1). Poor coverage of relevant depths.

Table 15. Biomass (tons) of *Sebastes mentella* + *Sebastes* sp. by Division and depth stratum, 2006.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Biomass	SE
1C	401-600	3366	2	0.4465	1502.9	655.2
	601-800	16120	6	0.0148	238.8	67.7
	801-1000	6066	9	0.0022	13.6	8.1
	1001-1200	611	2	0.0018	1.1	1.1
1D	401-600	903	3	0.2636	238.0	164.9
	601-800	1940	2	0.0915	177.5	172.6
	801-1000	3874	4	0.0000	0.0	0.0
	1001-1200	10140	13	0.0008	8.0	5.4
	1201-1400	6195	14	0.0009	5.8	4.2
	1401-1500	3091	6	0.0009	2.9	2.9
All				0.0418	2188.4	700.7

Table 16. Abundance of *Sebastes mentella* + *Sebastes* sp. by Division and depth stratum, 2006.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Abundace	SE
1C	401-600	3366	2	3901.6	13132658.2	8057547.7
	601-800	16120	6	107.0	1724880.0	610376.4
	801-1000	6066	9	7.4	44628.2	23346.8
	1001-1200	611	2	6.6	4019.8	4019.8
1D	401-600	903	3	3048.4	2752721.2	2336048.0
	601-800	1940	2	245.6	476512.0	453182.3
	801-1000	3874	4	0.0	0.0	0.0
	1001-1200	10140	13	3.2	32018.0	16878.8
	1201-1400	6195	14	2.9	18044.0	12567.3
	1401-1500	3091	6	4.4	13625.7	13625.7
All				347.9	18199107.0	8423794.8

Table 17. 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	4.8	.13	2	3.0	.33	6	4.1	.07	9	3.8	.09	2						
1D	4.4	.04	3	3.9	.10	2	4.1	.04	4	3.7	.03	13	3.6	.07	9	3.6	.03	3

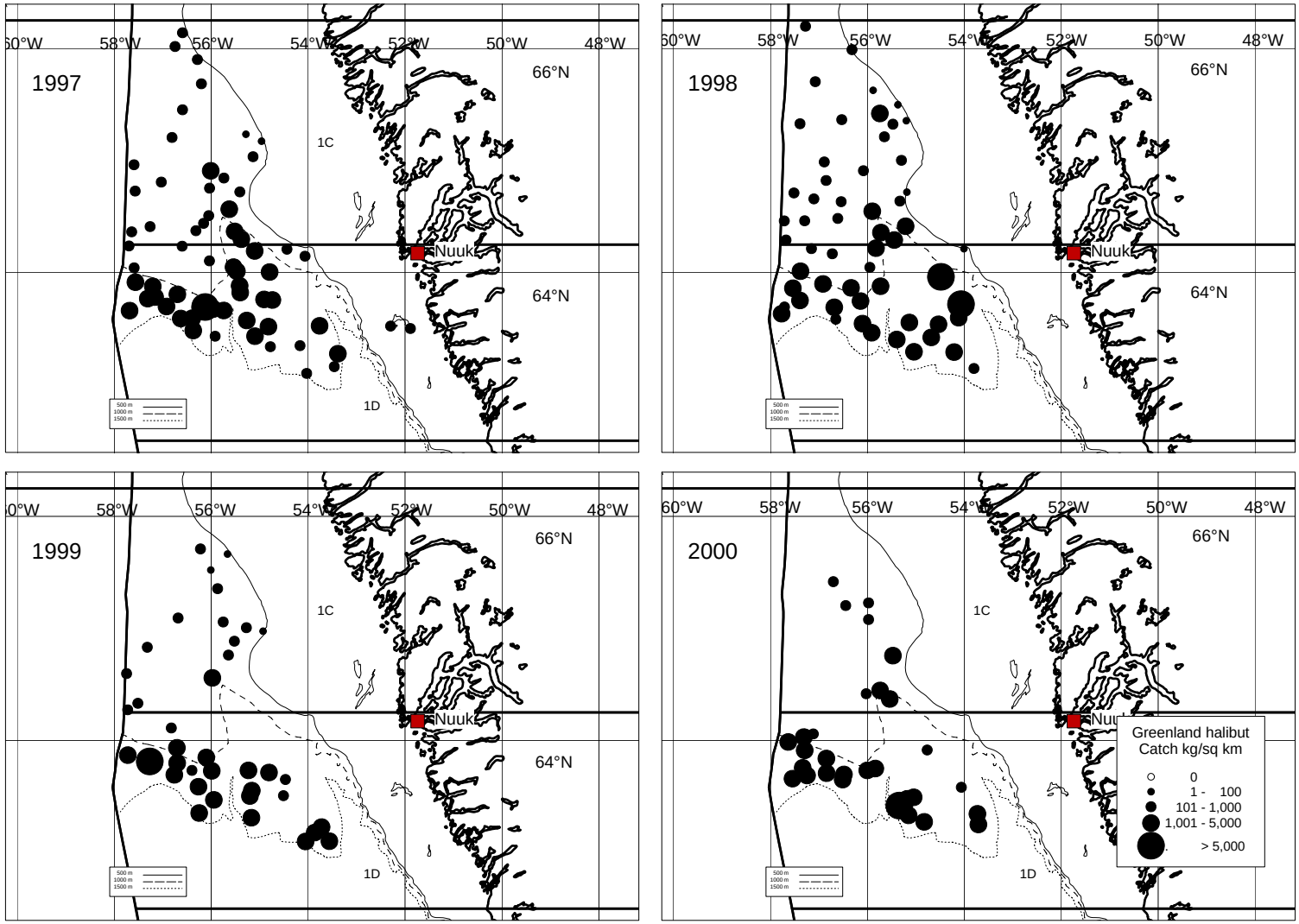


Fig. 1 Distribution of catches of Greenland halibut during 1997-2000 in kg km^{-2}.

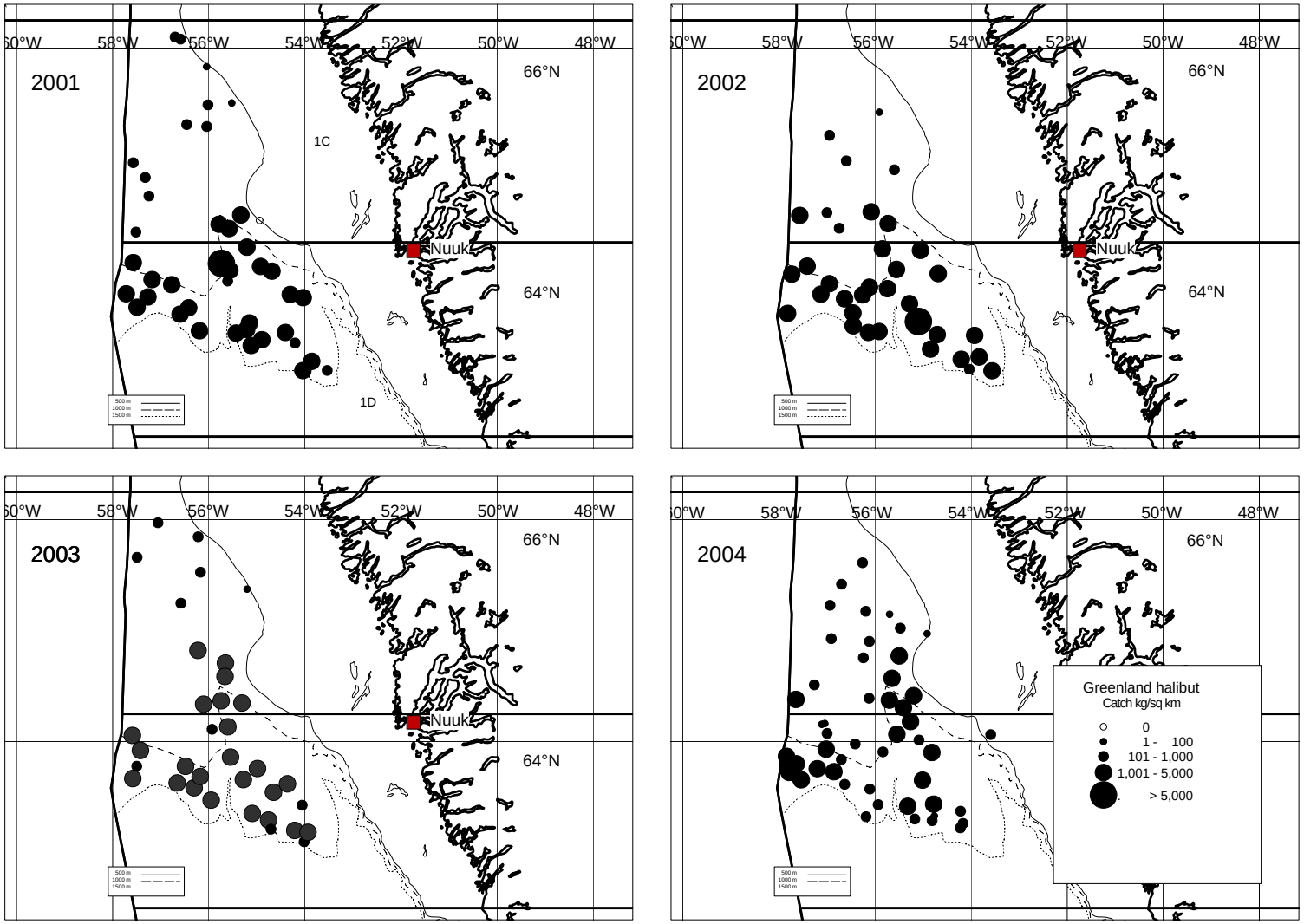


Fig. 1 (cont). Distribution of catches of Greenland halibut in 2001 - 2004 in kg km^{-2}

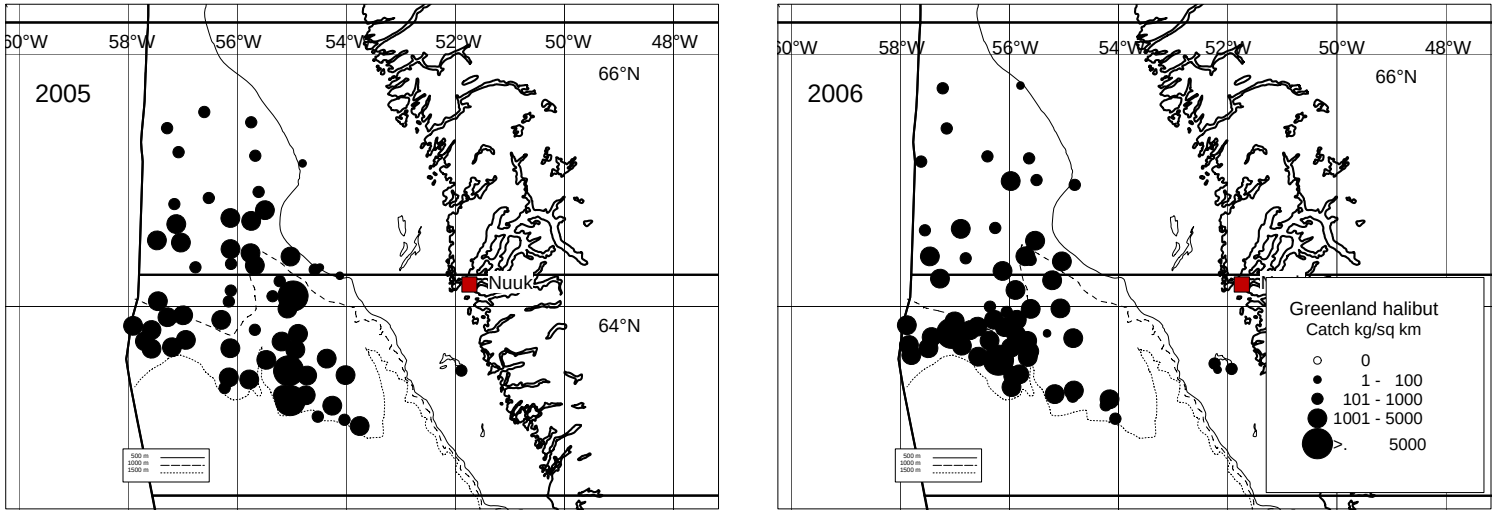


Fig. 1 (cont). Distribution of catches of Greenland halibut in 2005 - 2006 in kg km^{-2}

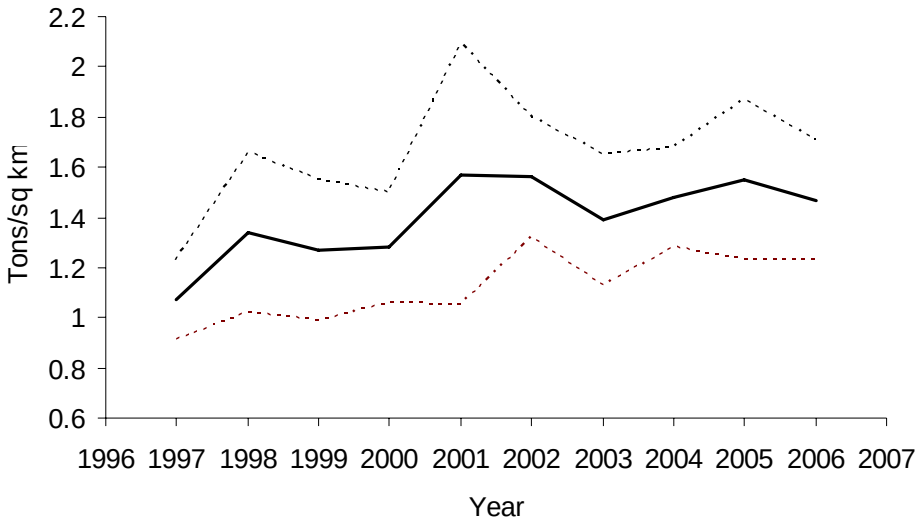


Fig. 2. Mean catch of Greenland halibut per sq. km (tons) standardized by stratum area with 2* +/ S.E.

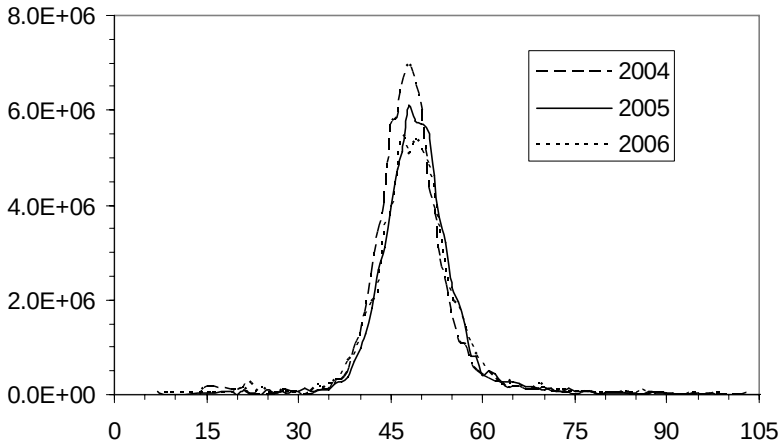


Fig. 3. Over all length distribution of Greenland halibut in numbers (weighted by stratum area) by year.

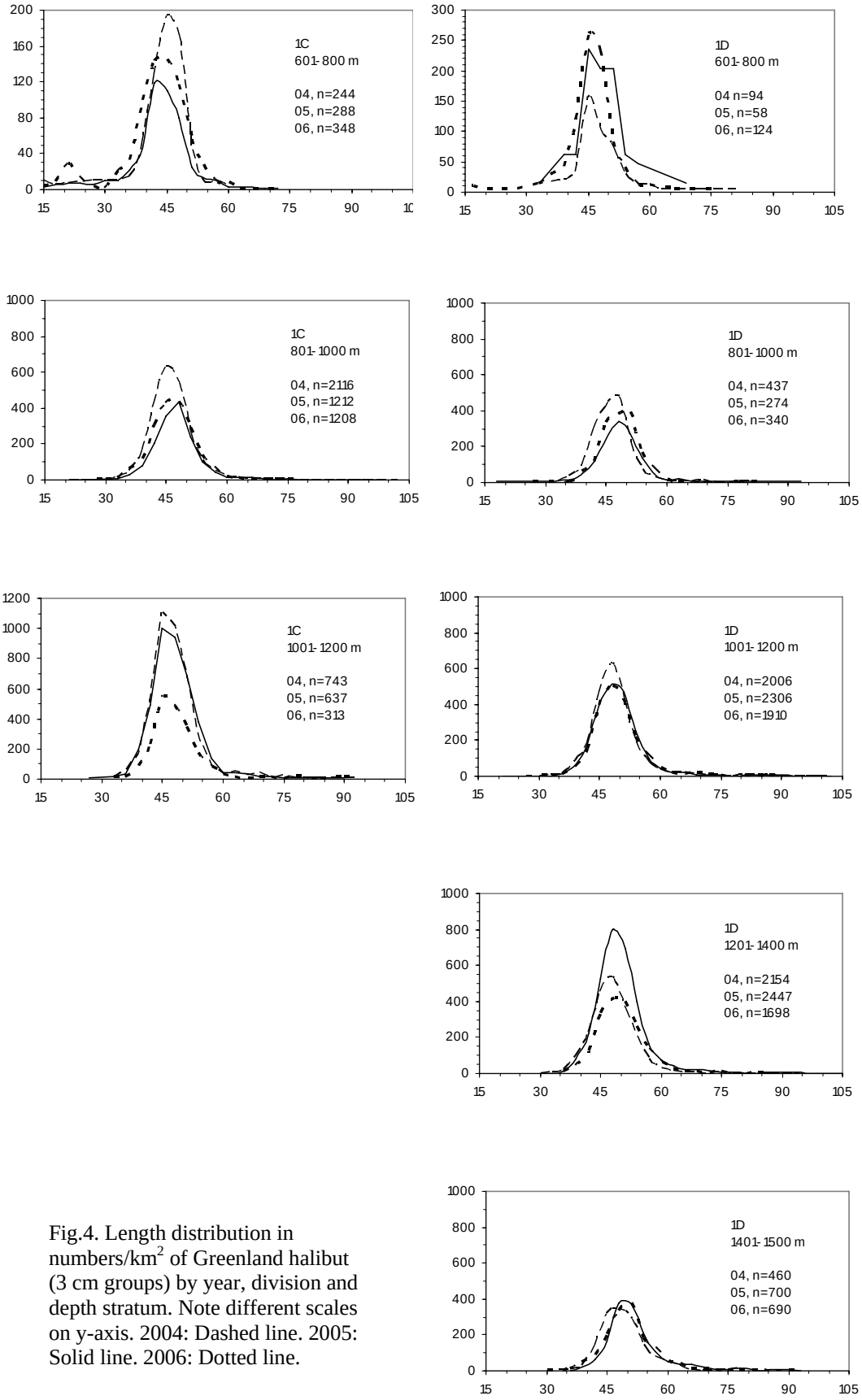
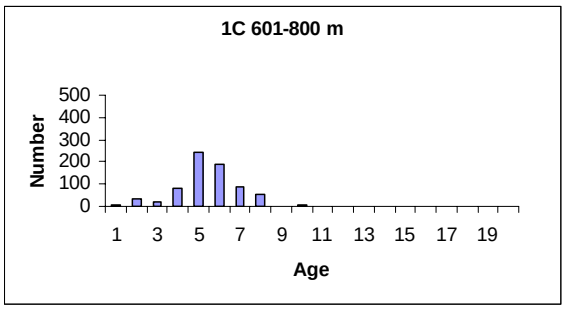
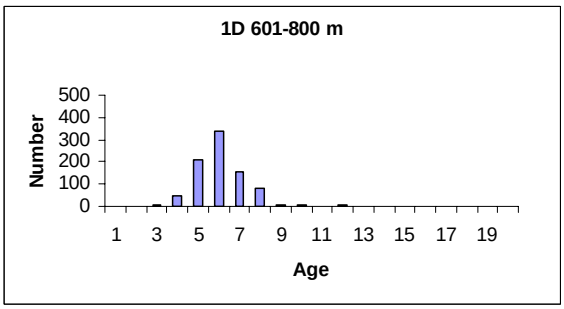
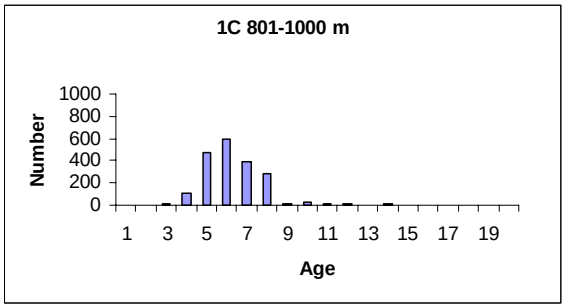
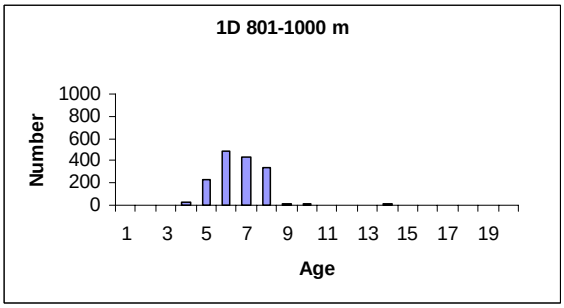


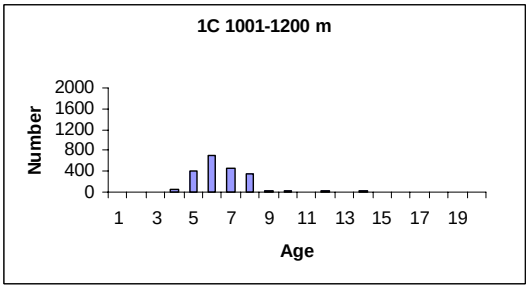
Fig.4. Length distribution in numbers/km^2 of Greenland halibut (3 cm groups) by year, division and depth stratum. Note different scales on y-axis. 2004: Dashed line. 2005: Solid line. 2006: Dotted line.

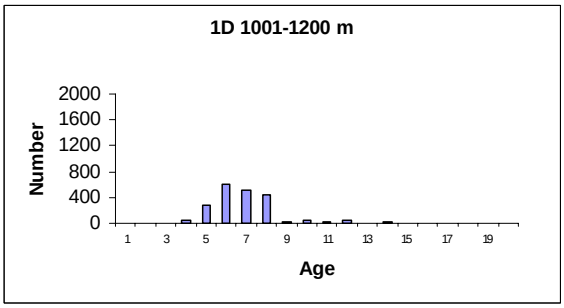


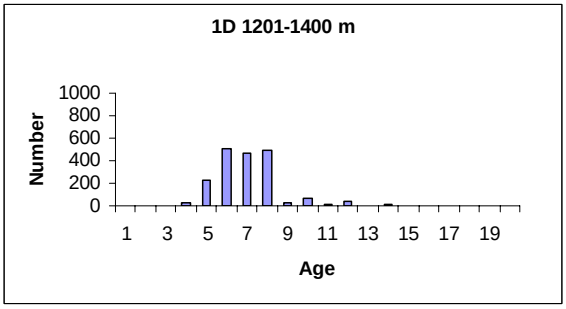












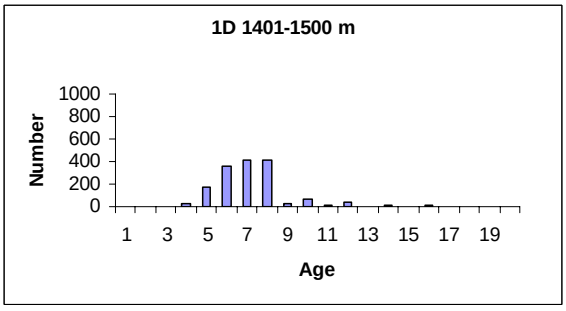


Fig. 5. Age distribution (number km^{-2}) by NAFO Division and depth stratum. Note different scales on y-axis.

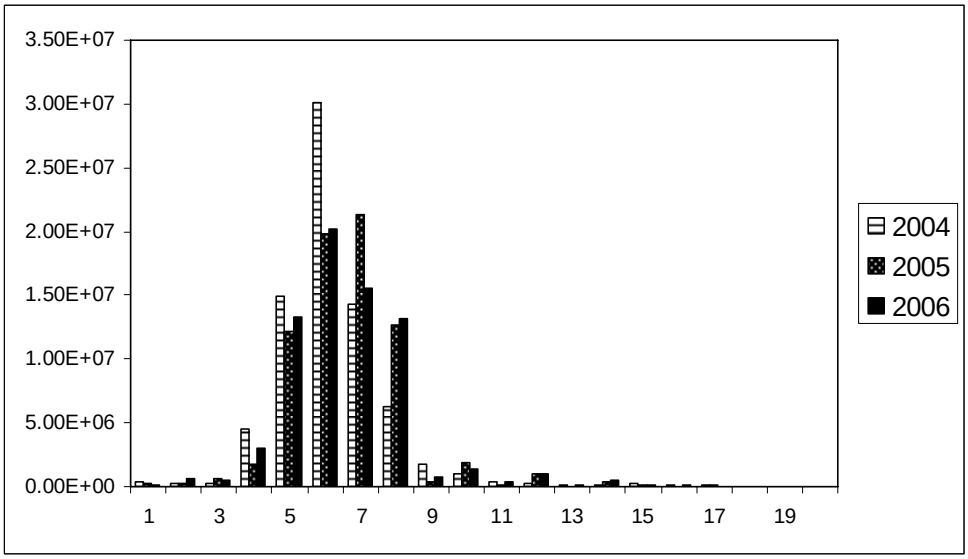


Fig. 6. Total age distribution in numbers (weighted by stratum area) of Greenland halibut in 2004-2006.

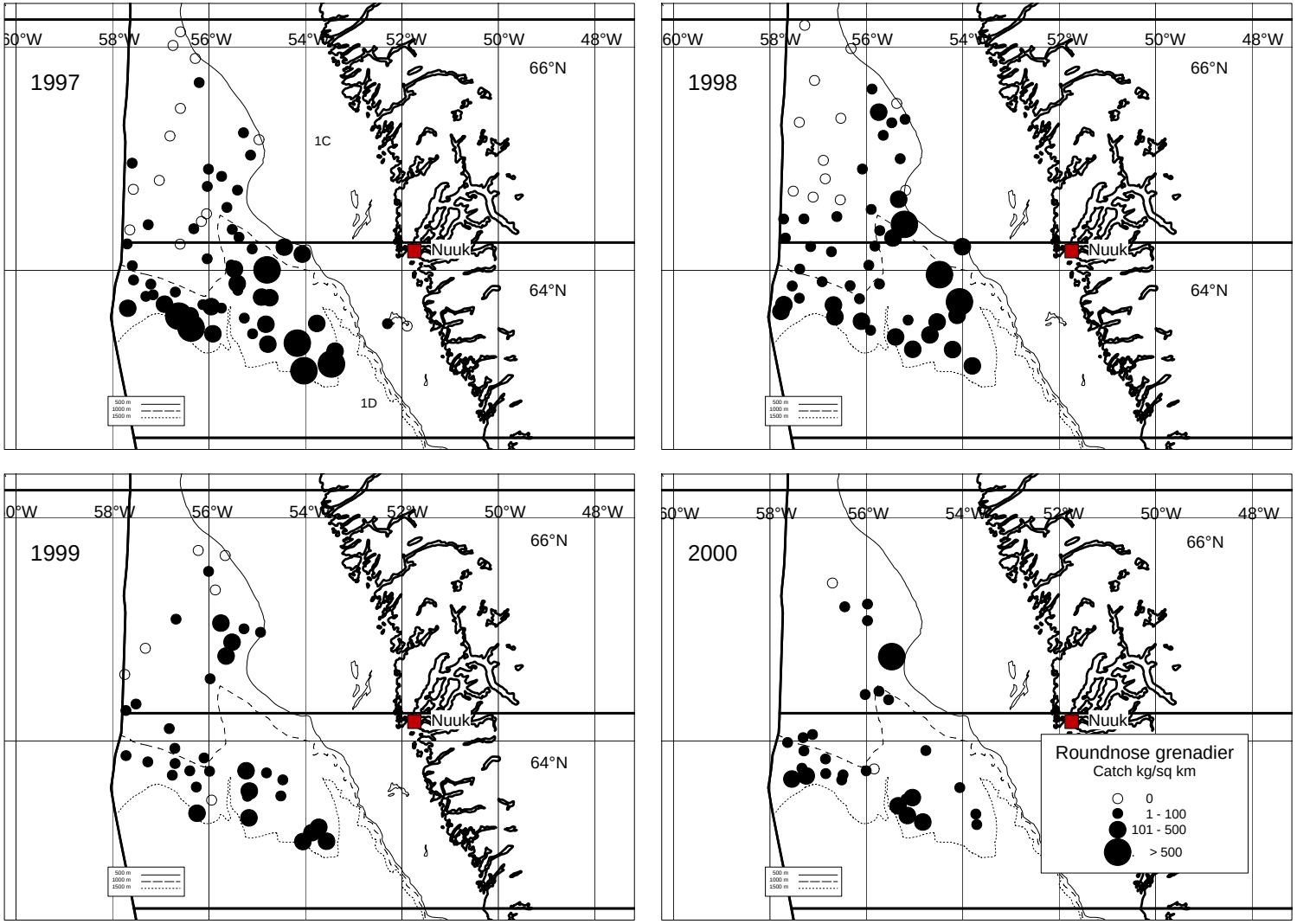


Fig. 7. Distribution of catches of roundnose grenadier in 1997-2000 in kg km^{-2}.

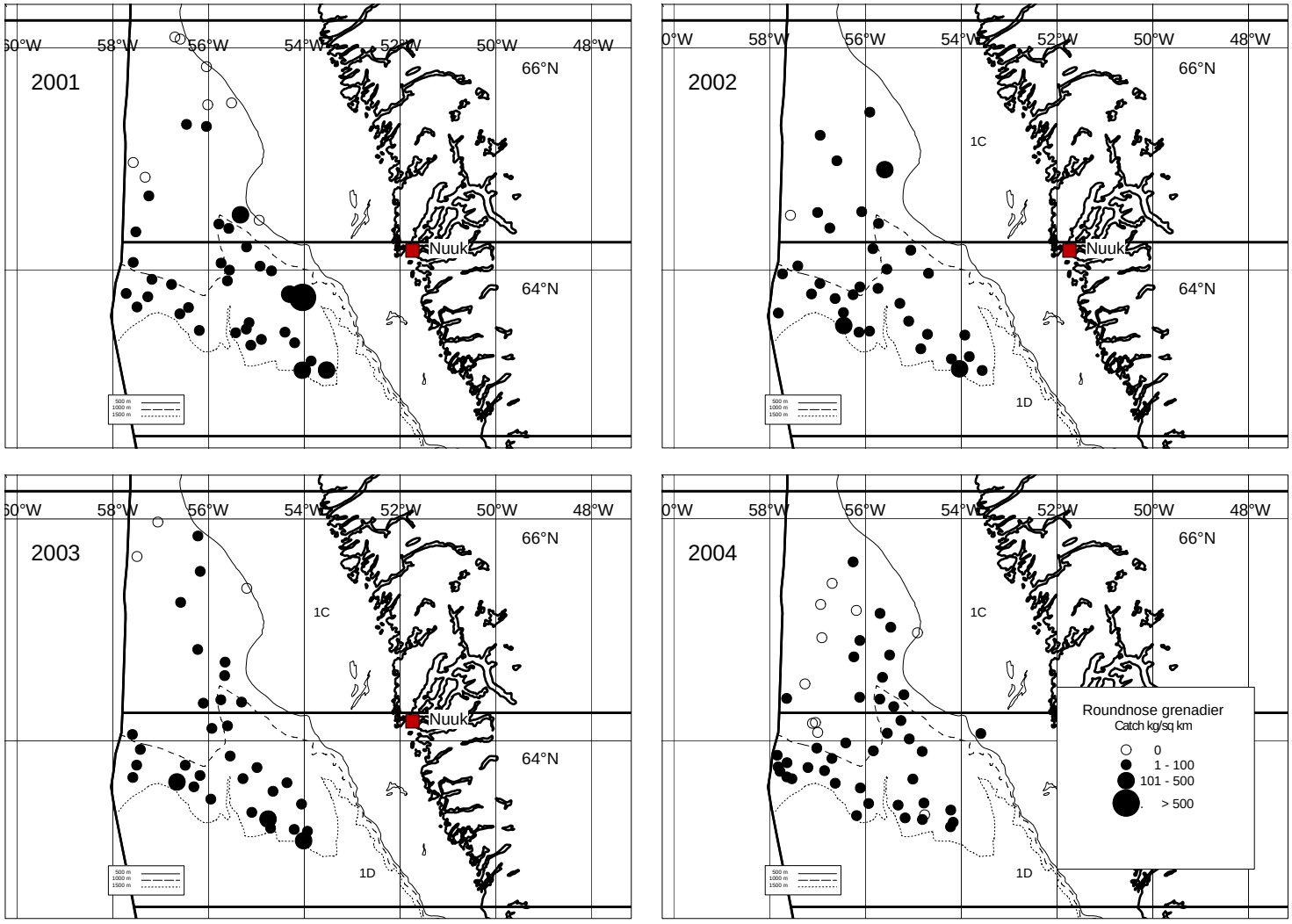


Fig. 7 cont. Distribution of catches of roundnose grenadier during 2001-2004.

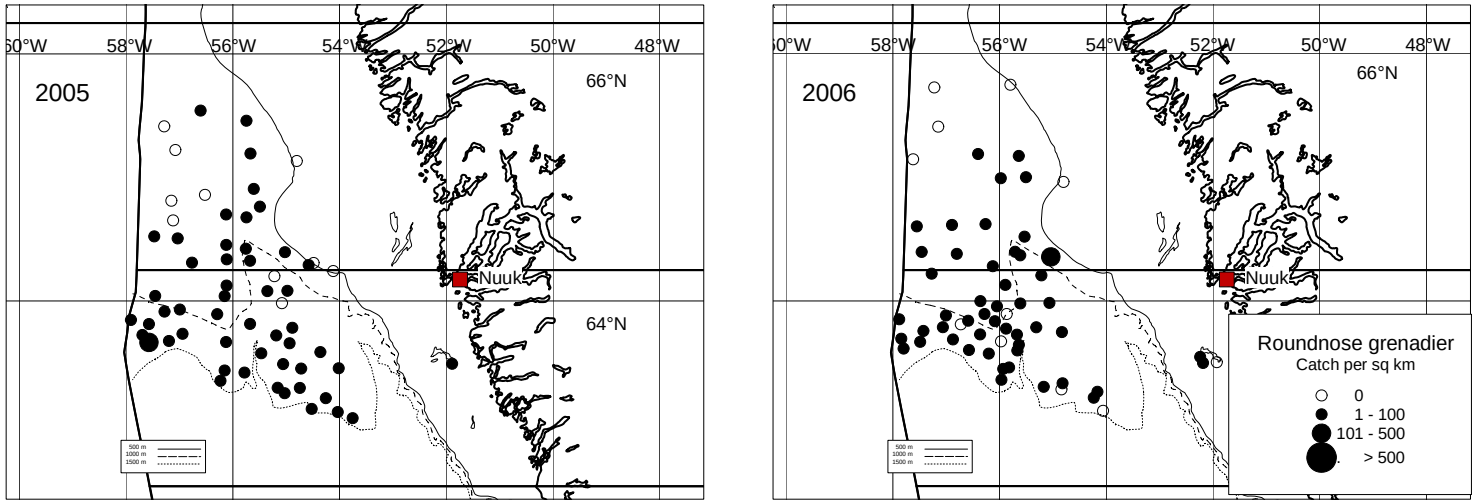


Fig. 7 cont. Distribution of catches of roundnose grenadier during 2005-2006.

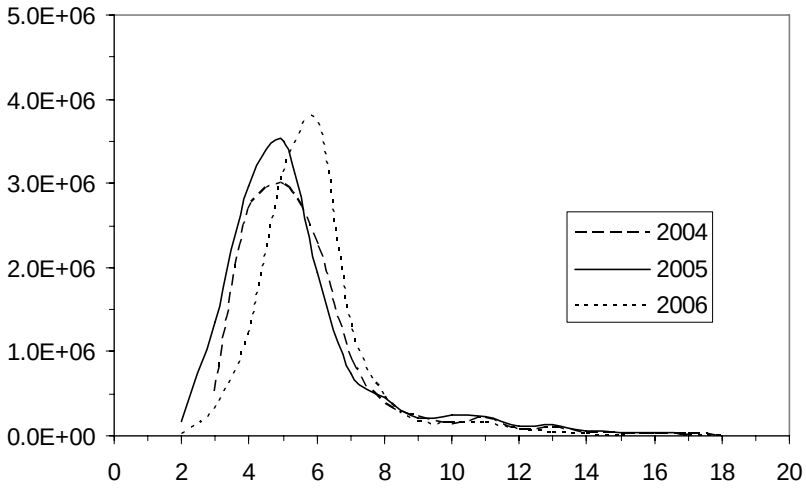


Fig. 8. Overall length distribution of roundnose grenadier (pre anal fin length) in numbers (weighted by stratum area) by year.

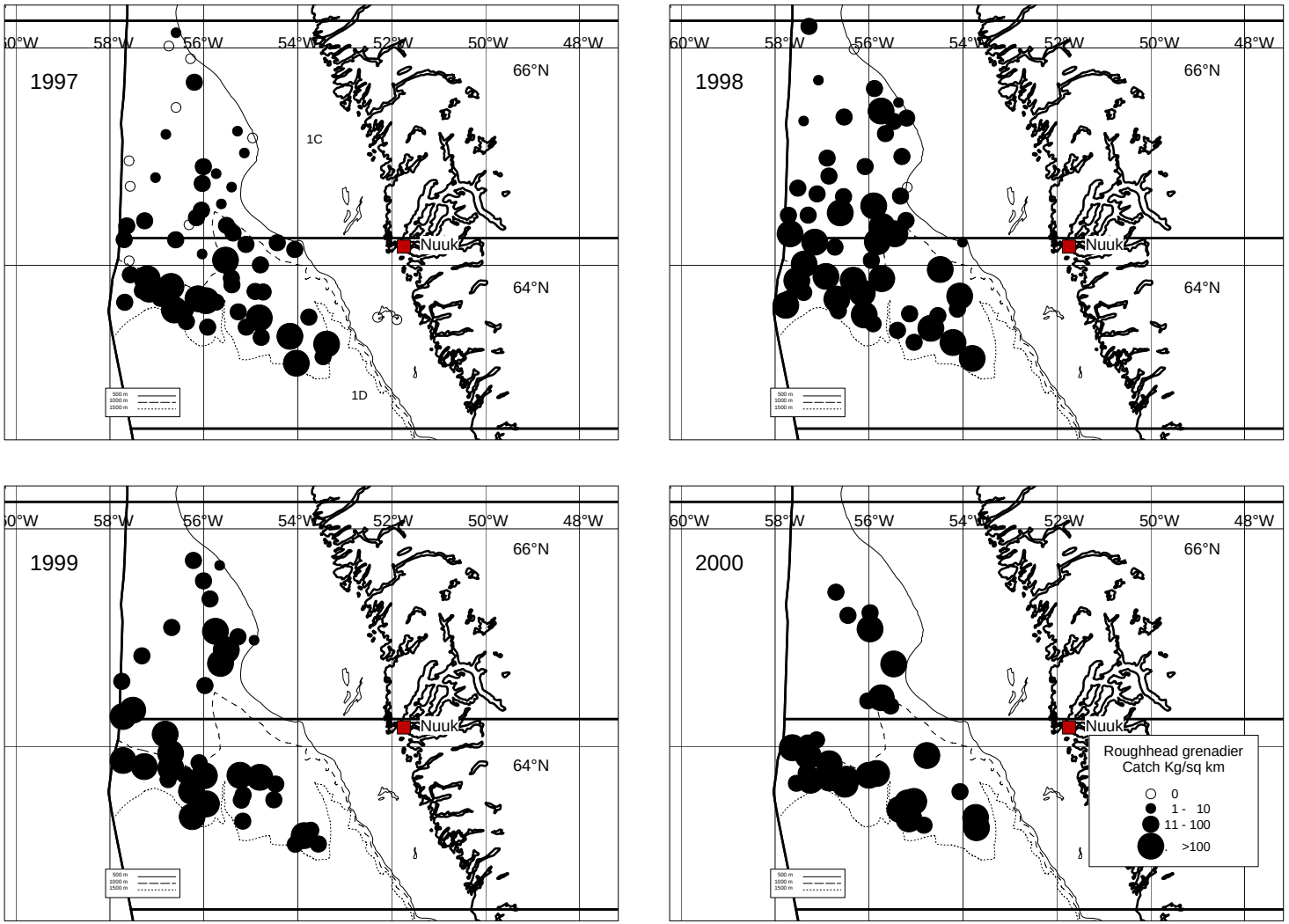


Fig. 9. Distribution of catches of roughhead grenadier in 1997-2000 in kg km^{-2}.

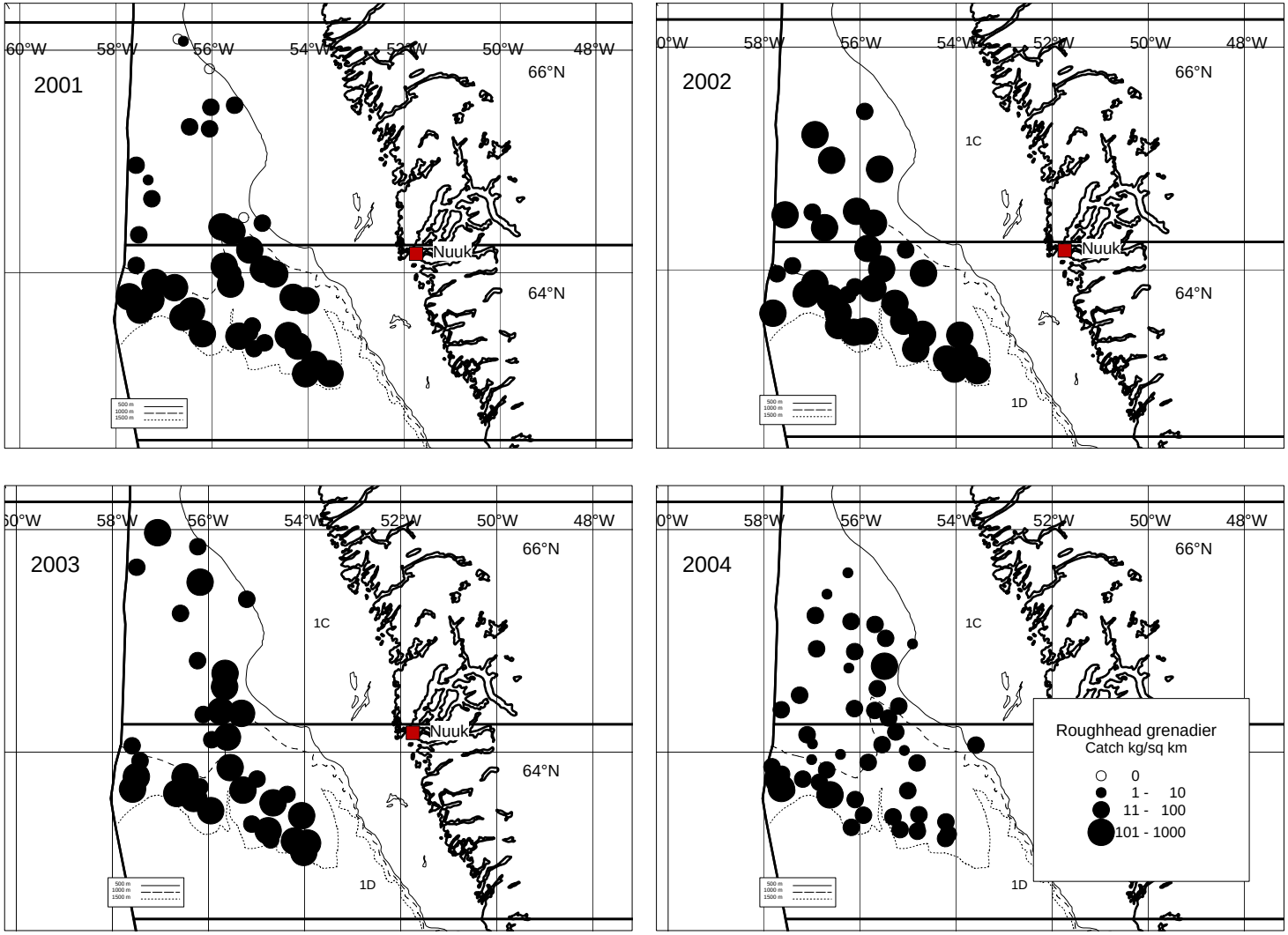


Fig. 9 cont.. Distribution of catches of roughhead grenadier during 2001-2004

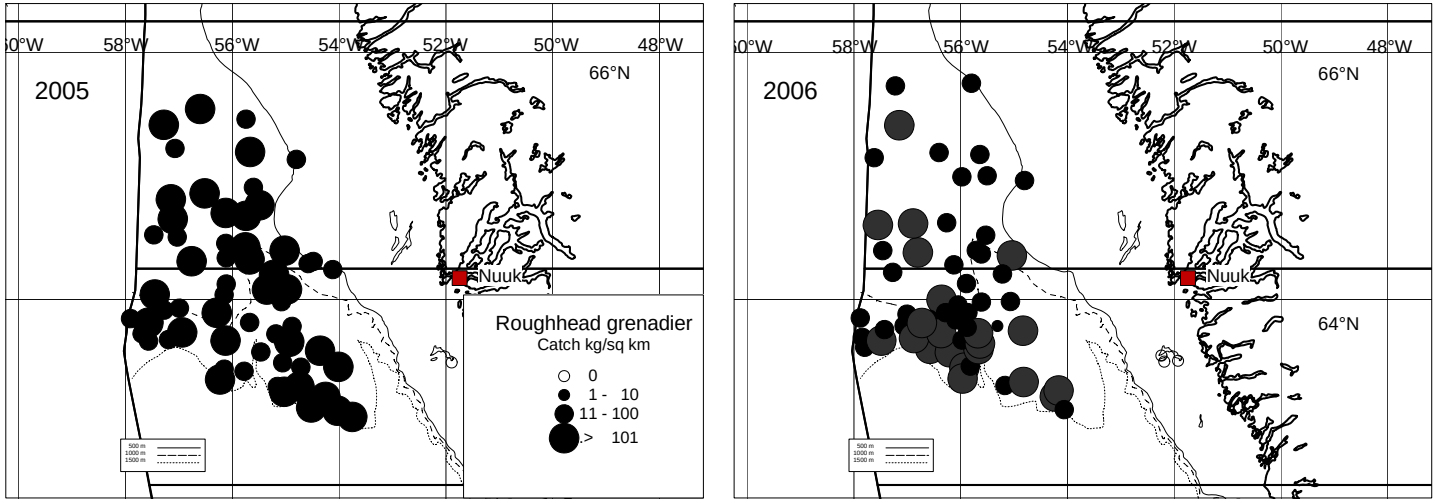


Fig. 9 cont.. Distribution of catches of roughhead grenadier during 2005-2006

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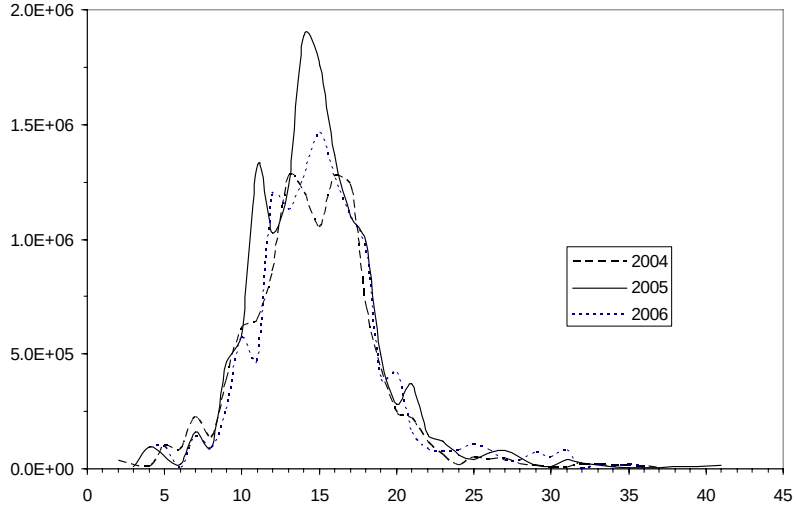

Fig. 10. Overall length distribution (pre anal fin length) of roughhead grenadier in numbers (weighted by stratum area) by year.

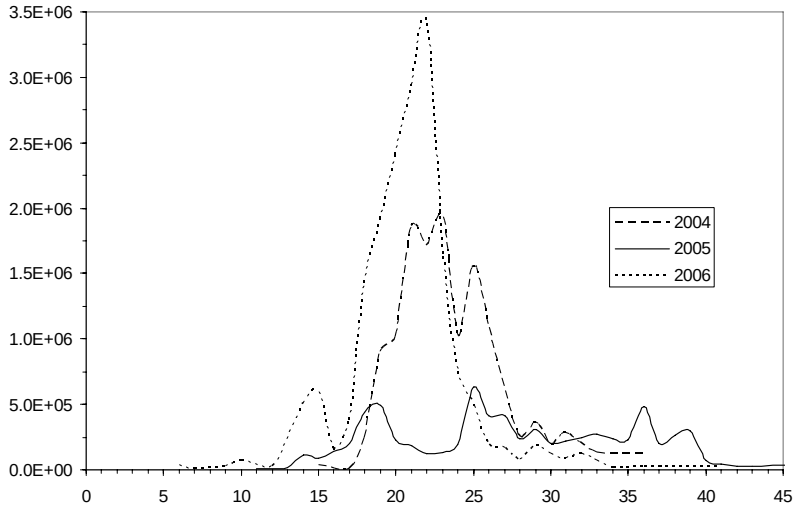

Fig. 11. Overall length distribution (pre anal fin length) of deep *Sebastes mentella* + *Sebastes* sp. in numbers (weighted by stratum area) by year.

Appendix 1. List of species and groups of species recorded in Div. 1C-D in 2006 with observed maximum catch weight (kg), maximum number per tow, minimum and maximum depth(m), minimum and maximum bottom temperature (°C) and most northern observation, respectively (Weight <50 g given as 0.0 kg).

Obs	art	species	maxwgt	maxno	mindepth	maxdepth	mintemp	maxtemp	maxpos
1		Not yet determined	0.0	1	838.5	838.5	3.8	3.8	64.6210
2	ALA	Alepocephalus agassizzi	1.3	1	1023.0	1456.5	3.7	3.7	63.8937
3	ALB	Alepocephalus bairdii	0.2	1	824.0	824.0	4.5	4.5	65.0013
4	AMD	Ammodytes dubius	0.0	2	408.0	408.0	4.4	4.4	63.5039
5	CAD	Anarhichas denticulatus	24.3	2	559.0	1271.0	3.4	4.7	65.7498
6	CAA	Anarhichas lupus	0.2	2	402.0	402.0	4.3	4.3	63.4979
7	CAS	Anarhichas minor	7.9	3	402.0	402.0	4.3	4.3	63.4979
8	ANC	Anopologaster cornuta	0.2	1	1108.5	1290.5	3.3	3.7	63.8815
9	ANT	Antimora rostrata	19.2	51	777.0	1485.5	3.3	4.5	65.1727
10	ARZ	Arctozenius rissoi	0.3	9	402.0	1169.5	3.7	4.4	63.8348
11	BAM	Bajacalifornia megalops	0.2	1	1285.0	1285.0	3.6	3.6	63.4610
12	BAT	Bathylagus euryops	5.3	97	691.5	1485.5	2.6	4.5	65.1887
13	BBA	Bathypolypus baridii	0.2	2	509.5	1023.0	3.1	4.5	65.1887
14	BSE	Bathypolypus sp.	1.0	1	792.0	1369.0	3.3	4.0	64.6034
15	BSP	Bathyraja spinicauda	5.3	1	1167.0	1167.0	3.8	3.8	63.8104
16	BEG	Benthosema glaciale	0.1	67	402.0	1485.5	2.2	5.0	65.7498
17	BOA	Borostomias antarctica	0.7	10	777.0	1485.5	3.3	4.2	65.1727
18	CAG	Caristidae	0.3	1	1369.0	1421.5	3.6	3.6	63.5994
19	CFB	Centroscyllium fabricii	7.1	13	824.0	1288.5	3.3	4.5	65.0013
20	CHO	Ceratias holboelli	0.9	1	691.5	691.5	2.6	2.6	65.1471
21	CHA	Chauliodus sloani	0.2	4	691.5	1485.5	2.6	4.2	65.1727
22	CAU	Chaulophryne jordani	0.1	1	1249.0	1249.0	3.7	3.7	63.9079
23	CHN	Chiasmodon niger	0.4	7	782.5	1485.5	3.3	4.1	64.6210
24	CRQ	Chionocetes opilio	2.4	4	408.0	509.5	4.3	4.4	63.5473
25	CIM	Cirroteuthis mulleri	5.4	2	1050.5	1485.5	3.3	3.9	64.3985
26	CBB	Coryphaenoides brevibarbis	0.2	6	1362.5	1485.5	3.5	3.6	63.6942
27	CGR	Coryphaenoides guntheri	1.9	25	777.0	1485.5	3.3	4.2	64.6034
28	RNG	Coryphaenoides rupestris	8.8	207	402.0	1485.5	2.6	4.5	65.1887
29	COM	Cottunculus microps	0.8	3	635.5	1136.0	2.2	4.2	65.4099
30	COS	Cottunculus sadko	0.3	1	804.0	804.0	4.2	4.2	65.1727
31	COT	Cottunculus thomsonii	1.6	2	804.0	1290.5	3.7	4.2	65.1727
32	LUM	Cyclopterus lumpus	2.7	1	408.0	1167.0	2.2	4.4	65.4099
33	CYB	Cyclothone braueri	0.0	2	1050.5	1050.5	3.9	3.9	64.3985
34	CLM	Cyclothone microdon	0.0	36	635.5	1485.5	2.2	4.2	65.4099
35	EUR	Eurypharynx pelecanoides	0.1	1	1167.0	1323.5	3.3	3.8	63.8104
36	COD	Gadus morhua	31.8	66	402.0	509.5	4.3	4.4	63.5473
37	ONA	Gaidropsarus argentatus	0.3	3	559.0	1167.0	2.2	4.7	65.7498
38	ONN	Gaidropsaurus ensis	2.1	4	509.5	1485.5	2.2	4.3	65.7284
39	WIT	Glyptocephalus cynoglossus	0.6	1	402.0	974.5	3.9	4.3	64.5198
40	GST	Gonatus steenstrupi	0.2	3	941.5	1362.5	3.6	4.1	64.5198
41	GOB	Gonostoma bathyphilum	0.1	2	792.0	1323.5	3.3	4.0	64.6034
42	PLA	Hippoglossoides platessoides	25.4	181	402.0	1323.5	3.3	5.0	65.7498
43	HOA	Holtbyrnia anomala	0.3	4	1065.0	1421.5	3.3	3.8	63.8394
44	HMC	Holtbyrnia macrops	0.1	1	777.0	1167.0	3.8	4.0	64.3811
45	HAT	Hoplostethus atlanticus	0.0	1	816.0	816.0	4.0	4.0	64.6146
46	HAF	Hydrolagus affinis	17.6	2	1420.5	1431.0	3.6	3.6	63.6441
47	LMC	Lampanyctus macdonaldi	4.3	250	473.5	1485.5	2.2	5.0	65.4099
48	LAS	Lampedena speguligera	0.0	1	804.0	804.0	4.2	4.2	65.1727
49	LEP	Lepedion eques	0.4	3	473.5	991.0	4.1	5.0	64.9634
50	EUD	Leptagonus decagonus	0.0	1	408.0	408.0	4.4	4.4	63.5039
51	LIF	Liparis fabricii	0.1	1	635.5	653.0	2.2	2.4	65.7284
52	KCT	Lithodes maja	0.1	1	991.0	991.0	4.2	4.2	64.1388
53	LYN	Lycodes eudipleurostictus	0.1	1	691.5	691.5	2.6	2.6	65.1471

54	LFR	Lycodes frigidus	0.4	1	1169.5	1169.5	.	.	63.8051
55	LSQ	Lycodes squamiventer	0.1	1	635.5	635.5	2.2	2.2	65.4099
56	LYT	Lycodes terranova	0.2	1	974.5	1285.0	3.6	4.1	64.5198
57	LYV	Lycodes vahli	2.6	30	402.0	509.5	4.3	4.4	63.5473
58	RHG	Macrourus berglax	21.0	43	473.5	1485.5	2.2	5.0	65.7498
59	MAA	Magnisudis atlantica	0.1	1	846.0	1065.0	3.8	3.9	64.3959
60	MAL	Malacosteus niger	0.1	1	1238.5	1375.5	3.3	3.3	63.3050
61	MMI	Maulisa microlepis	0.1	1	1023.0	1238.5	3.3	3.7	63.8937
62	MYP	Myctophum punctatum	0.7	76	408.0	1369.0	3.6	4.4	63.9842
63	MYX	Myxine glutinosa	0.1	1	1023.0	1023.0	3.7	3.7	63.8937
64	NEG	Neolithodes grimaldi	3.2	1	958.5	1362.5	3.3	4.1	64.5198
65	NZA	Nezumia aequalis	0.7	5	804.0	1456.5	3.7	4.2	65.1727
66	NOT	Notacanthus chemnitzii	5.4	7	691.5	1456.5	2.6	4.2	65.1471
67	NOK	Notoscopelus kroeyri	1.0	53	408.0	473.5	4.4	5.0	64.9634
68	OND	Oneirodes sp.	0.0	1	1137.0	1137.0	3.8	3.8	63.6724
69	ONE	Oneiroides eschrichti	0.5	1	1290.5	1369.0	3.6	3.6	63.7870
70	OPI	Ophisthoteuthis sp.	1.6	1	1169.5	1169.5	3.6	3.6	63.2638
71	PAC	Paraliparis copei	0.0	1	1335.0	1369.0	3.6	3.6	63.7573
72	PAG	Paraliparis garmani	0.0	3	691.5	900.5	2.6	4.2	65.1887
73	POL	Polyacanthonotus rissoanus	0.3	1	1335.0	1431.0	3.6	3.6	63.7573
74	POM	Poromitra megalops	0.0	1	1420.5	1420.5	3.6	3.6	63.6441
75	RBT	Raja bathyphila	8.6	1	1137.0	1431.0	3.6	3.9	63.7860
76	RFL	Raja fyllae	1.9	3	635.5	1213.0	2.2	4.2	65.4099
77	RLT	Raja lintea	2.0	1	1335.0	1335.0	.	.	63.7573
78	RRD	Raja radiata	7.0	16	402.0	509.5	4.3	4.4	63.5473
79	RSP	Raja spinacidermis	13.6	1	1065.0	1065.0	3.8	3.8	63.8394
80	GHL	Reinhardtius hippoglossoides	502.8	466	402.0	1485.5	2.2	5.0	65.7498
81	RME	Rossia megaptera	0.0	1	792.0	792.0	4.0	4.0	64.6034
82	ROM	Roulina maderensis	0.0	1	1058.5	1058.5	3.7	3.7	64.3691
83	SCO	Scopelosarus lepidus	2.2	18	782.5	1485.5	3.3	4.5	65.1727
84	REG	Sebastes marinus	12.7	116	402.0	974.5	3.8	4.7	65.7498
85	REB	Sebastes mentella	44.2	434	402.0	1430.5	2.4	5.0	65.7498
86	RED	Sebastes sp.	44.6	585	408.0	1430.5	2.2	5.0	65.4099
87	SER	Serrivomer beani	0.5	5	804.0	1485.5	3.3	4.2	65.1727
88	GSK	Somniosus microcephalus	8.9	1	1238.5	1238.5	3.3	3.3	63.2159
89	STO	Stomias boa	0.2	16	402.0	1485.5	2.2	4.7	65.7498
90	SYN	Synapobranchus kaupi	1.9	14	509.5	1485.5	2.4	4.3	65.7284
91	TRA	Trachyrynchus murrayi	0.8	3	874.5	1288.5	3.7	4.2	64.1388
92	TRM	Triglops murray	0.0	1	473.5	473.5	5.0	5.0	64.9634
93	XEC	Xenodermichthys copei	0.0	1	816.0	1362.5	3.6	4.0	64.6146