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Survey for Greenland Halibut in NAFO Divisions 1C-1D, 2007

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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 74 357 tons in 2007, which is at same level as in 2004-2006 and hence remained stable at a high level. The biomass of roundnose grenadier is still at a very low level and was estimated as 838 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) (Div. 1A) was surveyed, too.

Materials and Methods

The survey in 2007 covered Div. 1CD at depths between 400 and 1500 m and took place during 19/9-8/10. The survey included a tagging experiment in the southern part of the Baffin Bay (Div. 0A and 1A) during 25/9-5/10.

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 selecting 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 Seastar 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.

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 = 331) 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.

Tagging experiment

Greenland halibut were tagged with floy-tags during 25/9-5/10 2007 in the southern Baffin Bay area in order to investigate the relationship between Greenland halibut in Baffin Bay and Davis Strait. A little less than half of the tagged fish had $SrCl_2$ injected in the stomach cavity. $SrCl_2$ is incorporated in the otoliths and it should hence be possible to investigate growth of otoliths.

Results and Discussion

In total 50 successful hauls were made. The number of tows was reduced compared to the 70 planned mainly due to bad weather. Depth stratum 600-800 m in Div. 1D (1940 km^2) was not covered and there was only 1 haul in depth stratum 401-600 m in Div. 1C . 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 80 species or groups of species were recorded (Appendix 1).

Greenland halibut (*Reinhardtius hippoglossoides*)

Greenland halibut was caught in all hauls except one (Fig. 1, Table 1) and the biomass was estimated at 74 357 tons compared to 77 010 tons (Table 3) in 2006 (Table 2). The Stratum 1D 600-8000 m that was not covered in 2007 had a biomass on about 1 600 tons in 2006. The biomass estimates showed little variation by stratum compared to 2006 besides a tendency to a slight decrease in biomass in Div. 1C and a slight increase in Div. 1D. The estimate from 2007 is not statistically different (95% level) from the estimates from 1997-2004. (Jørgensen, 2007, 2006; 2005; 2004; 2003; 2002; 2001; 2000; 1999 and 1998b). The weighted mean catch per tow also showed slight increase from 1.47 tons/km^2 in 2006 to 1.48 tons/km^2 in 2007 and was a little above average for the time series (Fig 2.).

The abundance in Div. 1CD was estimated at $67.427*10^6$ compared to $70.715*10^6$ in 2006 (Table 3). The abundance has hence been decreasing (statistically insignificant 95% level) form $74.859*10^6$ in 2004. The stratum 1D 600-800 m not covered in 2007 had an abundance on $1.713*10^6$ The distribution of the abundance by stratum showed little variation compared to 2006 besides a decrease in abundance in Div. 1C and a slight increase in Div. 1D.

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

The length ranged from 18 cm to 105 cm (excluding a few larvae on 8 cm). The overall length distribution (weighted by stratum area) was totally dominated by a mode at 47- 49 as in the previous years (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 2 to 20 years. Generally the age increased by depth but the age composition was dominated by ages 6-8 in all strata except in Div. 1C 601-800 m (Fig. 5). The overall age distribution (weighted by stratum area) in Div. 1CD was monomodal with a mode around age 7 as in 2005 while the mode was at age 6 in 2006 (Fig. 6). Mean weight - and length at age is given in Table 6. The ageing data should, however, be treated with caution especially for ages > 8. There are hence no females age 9, 11 and 13, while there are 17-23 from ages 8, 10, 12 and 14.

Females stated maturing at age 8 and 100% maturity was reached at age 14 (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 in the 2007 survey was estimated as 838 tons, which is only slightly above the lowest on record - 633 tons in 2004..

Most of the biomass was found in Div 1C, 801-1000 m and Div. 1D, 801-1500 m (Table 9).

The abundance in Div. 1C-1D was estimated at $13.162*10^6$ which is the highest seen since 2002, but still at a very low level compared to the 90'ies (table 7) and especially the 80'ies (Jørgensen 1998a). The highest densities were found in Div. 1C 801-1000 m where more than ½ of total abundance was located.

Pre anal fin length ranged from 2 to cm 18 cm. The grenadiers were generally small and the over all length distribution (weighted by stratum area) was totally dominated by a mode at 6 cm as in 2006 (Fig. 8).

Roughhead grenadier (*Macrourus berglax*)

Roughead grenadier was caught in all hauls except two. The catches were, however, generally low (Table 1, Fig. 9). The biomass was estimated at 3467.6 tons compared to 5148. 2 tons in 2006 and the lowest observed since 1997 (Table 11).

The highest densities were found between at depths > 601 m in Div. 1D and but the largest biomass was found in Div. 1C 601-800 m (Table 12) as in 2006. The decrease in biomass was mainly seen in Div. 1C.

The total abundance was estimated at $8.185*10^6$ (Table 13) compared to $11.838*10^6$ in 2006 and lowest observed since 1997 (Table 11).

Pre anal fin length ranged from 4 to 36 cm and the over all length distribution was dominated by a mode at 18 cm with minor modes at 6, 10, 12 ,15 and 24 cm (Fig. 10).

Deep-sea redfish (*Sebastes mentella*)

Deep-sea redfish + *Sebastes* sp. was caught in 23 of the 50 valid hauls, but the catches were very low, <10 kg, except one haul on 16.7 kg (Table 1). The biomass was estimated at 574.2 tons which is about ¼ what has been estimated in most of the previous year. The decrease in biomass was seen in almost all strata, especially in Div. 1C 401-600, where the biomass decreased from 1503 tons in 2006 to 142 tons in 2007. There were, however, only 2 and 1 haul in that stratum. In 2006 and 2007 (Table 14) Almost all the biomass was found in Div. 1C 401-800 m as in most other years (Table 15).

The abundance decreased from $18.20*10^6$ in 2006 to $3.0041*10^6$ in 2007 (Table 16). The decrease is however not statistically significant. The 2007 estimate is the lowest in the time series. (Table 14). Almost all the abundance was found at depths < 800 m in Div. 1C.

The length ranged from 5 to 40 cm with a number of minor modes. There is no trace of the very clear mode at 21 cm seen in 2006 (Fig. 11).

Temperature

The bottom temperature ranged from 3.6 to 4.9 and were generally higher compared to 2006 where temperatures ranged from 2.2 to 4.7 °C. The mean temperature was generally decreasing by depth (Table 17).

The mean temperatures increased in all strata by 0.4 to 1.6 °C except in Div. 1C 401-600 m where the increase was on 0.1 °C only. The mean temperatures are generally the highest observed in the time series which dates back to 1997.

Tagging of Greenland halibut

In total 8257 Greenland halibut were tagged with floy-tags 383 were tagged in the inshore area Vaigatet, 6063 at two positions west of Disko Island (Div. 1A) and 1811 off Canada in the southern part of Div. 0A. (Fig. 12) About 3200 were injected with $SrCl_2$. By the end of February 2008, 6 whole fish with $SrCl_2$ and about 50 tags with valid information on recapture position have been returned.

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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.

					Grl. halibut		Roundnose gre.		Roughhead gre.		*S. mentella*	
St. No	Depth	S. Area	Div.	Temp.	Weight	Number	Weight	Number	Weight	Number	Weight	Number
1	1161.5	0.0818	1D	.	277.2	193.7	2.8	57	4.8	8	0.0	0
2	1121.5	0.0851	1D	4.2	159.1	153	1.1	9	10.1	22	0.0	0
3	1118.0	0.0583	1D	4.2	117.2	106	0.5	11	6.4	14	0.0	0
4	1256.0	0.0565	1D	4.5	72.5	40	0.4	2	3.6	12	0.0	0
5	1420.0	0.0743	1D	4.3	111.3	77	1.4	6	11.0	22	0.0	0
6	1450.5	0.0577	1D	3.9	111.4	78	4.9	15	3.5	8	0.0	0
8	1357.5	0.0800	1D	3.6	90.8	60	1.4	9	10.0	22	0.3	1
9	1139.5	0.0760	1D	4.0	103.4	81	0.2	1	6.0	24	0.0	0
10	1078.5	0.0855	1D	3.9	196.4	156	1.5	12	8.0	15	0.0	0
11	1215.5	0.0788	1D	4.2	274.7	236	0.5	2	7.1	16	0.0	0
12	1189.0	0.0768	1D	4.2	283.3	252	0.9	9	9.1	17	0.0	0
13	1304.0	0.0437	1D	4.0	182.3	175	0.9	4	7.2	12	0.0	0
14	1335.5	0.0395	1D	4.1	155.9	128	1.6	5	4.9	13	0.3	1
15	1460.5	0.0778	1D	4.2	138.2	112	3.5	12	8.7	18	0.0	0
16	1362.0	0.0787	1D	4.0	106.9	94	0.4	1	6.6	14	0.0	0
17	1453.0	0.0742	1D	3.8	130.6	109	2.3	15	12.8	21	0.0	0
18	1467.5	0.0760	1D	4.0	222.8	210	4.6	32	4.0	12	0.0	0
19	1359.0	0.1867	1D	4.0	149.6	127	0.2	3	3.8	4	0.0	0
20	1263.5	0.1266	1D	4.0	211.5	199	0.3	3	13.5	25	0.1	1
21	1168.0	0.0778	1D	4.0	152.3	160	2.0	21	2.4	7	0.2	1
22	1131.0	0.0836	1D	4.0	117.3	114	0.5	2	7.6	22	0.0	1
23	934.0	0.0564	1D	4.3	31.4	28	0.3	5	2.6	5	0.0	0
24	791.5	0.0438	1C	4.4	7.8	10	0.0	0	1.4	1	0.0	0
25	833.0	0.0809	1C	4.3	39.1	41	0.2	5	4.9	8	0.4	1
26	817.5	0.0405	1C	4.1	20.1	21	0.3	3	2.9	12	0.5	2
27	780.5	0.0811	1C	4.3	42.7	43	0.0	0	4.0	12	0.5	2
28	829.0	0.0904	1C	4.2	26.7	32	0.3	9	1.8	6	0.6	2
29	921.0	0.1588	1C	4.3	105.3	96	0.2	4	2.2	4	0.0	0
33	890.0	0.0768	1D	4.2	120.4	132	0.6	12	8.7	8	0.2	1
34	954.0	0.0824	1D	4.3	152.8	144	0.3	6	1.8	7	1.2	2
35	1120.5	0.0827	1D	4.3	243.9	210	0.0	1	6.2	11	0.2	1
36	1217.0	0.0765	1D	4.2	363.1	282	1.6	3	5.5	17	0.0	0
37	1164.5	0.0436	1D	4.2	472.2	409	0.0	0	7.0	15	0.0	0
39	1102.0	0.0501	1C	3.6	189.8	183	0.8	16	1.5	3	0.0	0
41	931.5	0.0400	1C	3.9	260.3	257	12.3	272.7	4.9	8	0.2	1
114	726.0	0.0865	1C	4.8	22.8	29	0.0	0	10.0	28	0.2	1
115	825.0	0.0872	1C	4.8	52.8	58	4.5	26	0.0	0	0.4	3
116	839.0	0.0784	1C	4.8	64.3	71	10.3	250	2.0	9	0.0	0
117	896.5	0.0792	1C	4.8	70.8	77	2.1	50	3.7	12	0.4	1
118	866.5	0.0594	1C	4.9	185.3	203	1.2	29	5.8	13	0.0	0
119	487.0	0.0538	1C	4.9	0.0	0	0.0	0	0.3	1	2.3	17
120	970.0	0.0689	1C	4.9	167.5	176	3.0	52	2.4	8	0.7	3
121	729.0	0.0316	1C	4.9	4.2	5	0.1	3	1.3	5	1.3	5
123	1137.5	0.0847	1D	4.9	113.8	104	0.3	10	6.0	17	0.0	0
124	882.0	0.0450	1D	4.8	155.6	149	4.9	97	4.1	11	0.1	1
125	859.0	0.0830	1D	4.8	144.7	154	3.0	78	15.9	23	6.9	17
126	439.5	0.0314	1D	4.8	2.5	3	0.0	0	1.4	2	1.4	11
127	1081.0	0.0896	1C	4.8	183.8	153	0.4	8	5.3	13	0.0	0
128	1191.0	0.1644	1D	4.8	242.8	165	0.1	4	1.8	4	0.0	0
129	425.5	0.0853	1D	4.9	39.3	56	0.6	1	0.0	0	16.7	115

Table 2. Biomass (tons) and abundance of Greenland halibut 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
2007	74356.8	9455.4	1.48	0.19	67.427	8.492

Table 3. Biomass (tons) of Greenland halibut by Division and depth stratum, 2007.

Div.	Depth (m)	Area	Hauls	Mean	Biomass	SE
1C	401-600	3366	1	0.0000	0.0	.
	601-800	16120	4	0.2751	4434.7	1423.5
	801-1000	6066	10	1.6309	9893.1	3736.4
	1001-1200	611	2	2.9193	1783.7	529.9
1D	401-600	903	2	0.2702	244.0	172.1
	601-800	1940				
	801-1000	3874	5	1.8361	7112.9	1808.2
	1001-1200	10140	12	2.8809	29211.9	7683.7
	1201-1400	6195	9	2.5116	15559.6	3195.5
	1401-1500	3091	5	1.9790	6117.0	766.8
All				1.4763	74356.8	9455.4

Table 4. Abundance of Greenland halibut by Division and depth stratum, 2007.

Division	Depth (m)	Area	Hauls	Mean sq/km	Abundance	SE
1C	401-600	3366	1	0.0	0.0	.
	601-800	16120	4	313.1	5046373.2	1307063.6
	801-1000	6066	10	1692.0	10263737.4	3729210.7
	1001-1200	611	2	2680.0	1637478.6	593798.2
1D	401-600	903	2	376.1	339614.2	253325.3
	601-800	1940				
	801-1000	3874	5	1826.2	7074620.2	1732545.5
	1001-1200	10140	12	2476.9	25116017.6	6645342.6
	1201-1400	6195	9	2093.1	12966479.5	2841071.5
	1401-1500	3091	5	1611.9	4982509.1	921212.1
All				1338.7	67426829.9	8492043.9

Table 5. Estimated abundance by age from Div. 1C-1D from the surveys in 1997-2007. The Age-length key from 1998 is applied on the 1999 data.

AGE	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	0	0	0	78826	15585	71512	833452	314358	200672	132147	0
2	536130	609093	184098	109496	281013	214536	3187890	255511	201882	641030	99520
3	1704893	3722237	920490	479059	511722	285367	1468105	274564	569831	524114	268062
4	3023773	4662948	4172888	3074341	4835796	2361529	2417001	4465950	1749900	2959669	802718
5	9961295	14760362	11291344	15090231	20601616	11779876	12348567	14877198	12218823	13324592	12509462
6	15370847	19057854	15893794	16838191	26595603	26697300	21816458	30067732	19867351	20210890	18237159
7	13558728	14083592	19759852	14711646	17922784	18561065	18499540	14298142	21303055	15509156	19469186
8	5436358	5766084	4786548	5026106	4674899	6201987	6534966	6252194	12674030	13224793	11815872
9	1200931	1515966	859124	3214208	2550178	1857799	2403542	1724259	385774	731747	360855
10	948950	1211419	920490	1040152	780082	1340261	1244102	944766	1881136	1342871	1960085
11	584382	764751	613660	717770	705656	905723	581491	392534	158664	362986	0
12	466433	527881	675026	350292	369836	166242	224915	230820	1044342	958082	1030110
13	187646	351921	429562	318336	345397	257412	264203	158687	36861	122337	26403
14	96503	155657	429562	122157	195607	143024	207745	163836	410090	459693	502253
15	262704	236870	184098	230208	225277	263139	67270	218713	85460	114617	27483
16	187646	115051	61366	128242	91540	178780	206590	71775	13547	102977	182091
17	64336	128586	61366	95352	80275	107268	72546	96352	118365	28973	49422
18	16084	0	61366	57045	22628	35756	41219	6650	35465	0	26001
19	0	0	0	27474	32325	83431	58531	37874	45452	0	0
20	0	0	0	0	8081	0	22258				46549
21						0	7419				
SUM	53607639	67670271	61304634	61709132	80845900	71512007	72507812	74851915	73000702	70750676	67413231

Table 6. Mean weight and mean length-at-age of Greenland halibut, 1997-2007.

	1997		1998		1999		2000		2001		2002		2003		2004		2005		2006		2007	
AGE	weight	length	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	70	22.0
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	181.7	28.7
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	352.6	35.9
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	565.8	41.6
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	859.6	47.2
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	1072	51.1
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	1541	56.6
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	1635	57.5
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	2123	62.4
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	3049	68.6
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	3300	70.0
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	4548	76.4
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	6443	85.5
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	8402	90.8
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	9565	92.5
18					12500	99.0	8590	92.3	8760	93.0	9385	93.0			893	93.0	9570	97.0			9200	95.0
19			12850	99.0			9645	91.5	11500	102.0	8553	90.3			10220	93.0	14150	101.0				
20									14400	105.0											12330	102.0

Table 7. Maturity-at-age in percent, females, Div. 1C-1D, 2007. 1 immature, 2 maturing.

Age	Maturity		n
	1	2	
2	100 .		1
3	100 .		1
4	100 .		4
5	100 .		10
6	81.82	18.18	11
7	100 .		12
8	47.62	52.38	21
9			
10	41.18	58.82	17
11			
12	30.43	69.57	23
13			
14	4.35	95.65	23
15 .		100	2
16 .		100	9
17 .		100	2
18 .		100	1
19			
20 .		100	1

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
2007	838.0	206.4	13.16	4.50

Table 9. Biomass (tons) of roundnose grenadier by Division and depth stratum, 2007.

Div.	Depth (m)	Area	Hauls	Mean	Biomass	SE
1C	401-600	3366	1	0.0000	0.0	.
	601-800	16120	4	0.0004	6.4	6.4
	801-1000	6066	10	0.0595	361.0	183.4
	1001-1200	611	2	0.0101	6.1	3.4
1D	401-600	903	2	0.0033	3.0	3.0
	601-800	1940				
	801-1000	3874	5	0.0324	125.6	77.1
	1001-1200	10140	12	0.0104	105.3	32.1
	1201-1400	6195	9	0.0133	82.4	25.5
	1401-1500	3091	5	0.0479	148.2	35.4
All				0.0166	838.0	206.4

Table 10. Abundance of roundnose grenadier by Division and depth stratum, 2007.

Div.	Deoth (m)	Area	Hauls	Mean	Abundace	SE
1C	401-600	3366	1	0.0	0.0	.
	601-800	16120	4	23.7	382770.5	382770.5
	801-1000	6066	10	1049.5	7534551.0	4162185.0
	1001-1200	611	2	204.3	124827.9	70256.4
1D	401-600	903	2	5.9	5294.1	5294.1
	601-800	1940				
	801-1000	3874	5	682.9	2645580.5	1559834.8
	1001-1200	10140	12	142.6	1445484.2	565563.6
	1201-1400	6195	9	53.7	332641.3	91098.8
	1401-1500	3091	5	223.6	691250.7	177597.0
All				261.3	13162400.2	4502004.9

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
2007	3 467.6	374.6	8.18	1.08

Table 12. Biomass (tons) of roughhead grenadier by Division and depth stratum, 2007.

Div.	Depth (m)	Area	Hauls	Mean	Biomass	SE
1C	401-600	3366	1	0.0056	18.8	.
	601-800	16120	4	0.0599	966.1	306.8
	801-1000	6066	10	0.0490	297.3	74.2
	1001-1200	611	2	0.0439	26.8	9.0
1D	401-600	903	2	0.0216	19.5	19.5
	601-800	1940				
	801-1000	3874	5	0.0927	359.0	114.3
	1001-1200	10140	12	0.0847	858.7	119.2
	1201-1400	6195	9	0.0943	584.0	85.9
	1401-1500	3091	5	0.1091	337.4	72.2
All				0.0688	3467.6	374.6

Table 13. Abundance of roughhead grenadier by Division and depth stratum, 2007.

Div.	Depth (m)	Area	Hauls	Mean	Abundace	SE
1C	401-600	3366	1	18.6	62602.3	.
	601-800	16120	4	163.2	2630729.5	994738.1
	801-1000	6066	10	128.8	781410.3	174273.6
	1001-1200	611	2	102.5	62628.5	26050.2
1D	401-600	903	2	31.9	28763.0	28763.0
	601-800	1940				
	801-1000	3874	5	159.9	619382.7	161397.6
	1001-1200	10140	12	197.0	1997773.2	281831.5
	1201-1400	6195	9	212.6	1317193.2	178225.2
	1401-1500	3091	5	221.4	684304.6	98621.1
All				162.5	8184787.5	1082713.5

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
2007[1)]	574.2	230.0	3.00	1.31

1). Poor coverage of relevant depths.

Table 15. Biomass (tons) of *Sebastes mentella* + *Sebastes* sp. by Division and depth stratum, 2007.

Div.	Depth (m)	Area	Hauls	Mean	Biomass	SE
1C	401-600	3366	1	0.0421	141.8	.
	601-800	16120	4	0.0124	200.3	155.8
	801-1000	6066	10	0.0050	30.5	8.4
	1001-1200	611	2	0.0000	0.0	0.0
1D	401-600	903	2	0.1204	108.7	68.4
	601-800	1940				
	801-1000	3874	5	0.0207	80.3	61.2
	1001-1200	10140	12	0.0004	4.3	2.9
	1201-1400	6195	9	0.0014	8.4	5.3
	1401-1500	3091	5	0.0000	0.0	0.0
All				0.0114	574.2	230.0

Table 16. Abundance of *Sebastes mentella* + *Sebastes* sp. by Division and depth stratum, 2007.

Div.	Depth (m)	Area	Hauls	Mean	Abundace	SE
1C	401-600	3366	1	316.2	1064240.0	.
	601-800	16120	4	48.6	783960.1	594854.4
	801-1000	6066	10	20.0	121022.5	34854.8
	1001-1200	611	2	0.0	0.0	0.0
1D	401-600	903	2	849.4	767018.2	450625.4
	601-800	1940				
	801-1000	3874	5	52.9	204780.3	148065.2
	1001-1200	10140	12	3.1	31183.9	16296.2
	1201-1400	6195	9	5.1	31488.3	18305.1
	1401-1500	3091	5	0.0	0.0	0.0
All				59.6	3003693.0	1308915.0

Table 17. Mean temperature, S.E and number of observations by NAFO Division and depth stratum. OK 2007

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	4.9	.	1	4.6	.14	4	4.5	.12	10	4.2	.59	2						
1D	4.9	.05	2				4.5	.13	5	4.3	.09	11	4.1	.08	9	4.0	.09	5

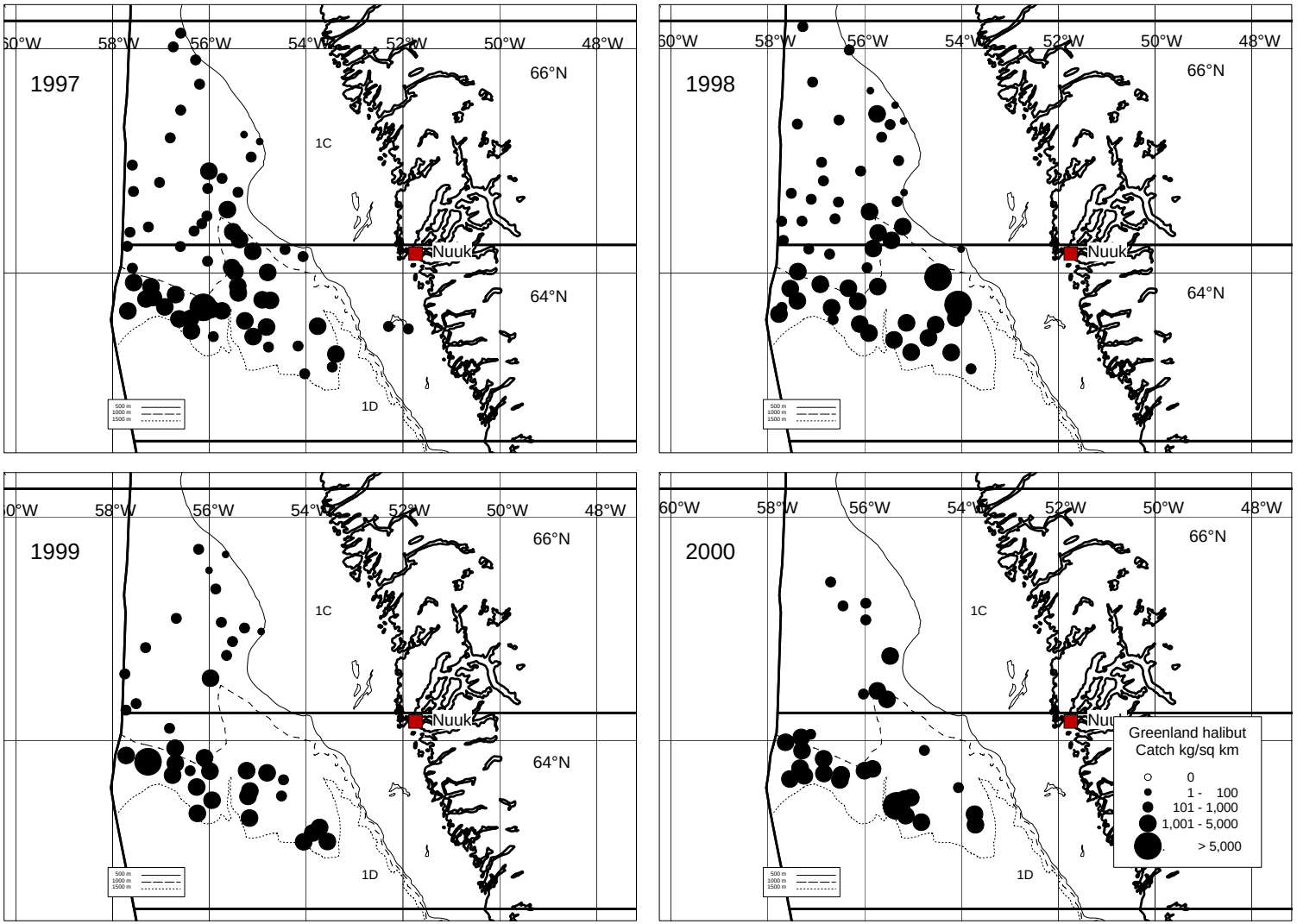


Fig. 1 Distribution of catches of Greenland halibut during 1997-2000 in kg km^{-2}.

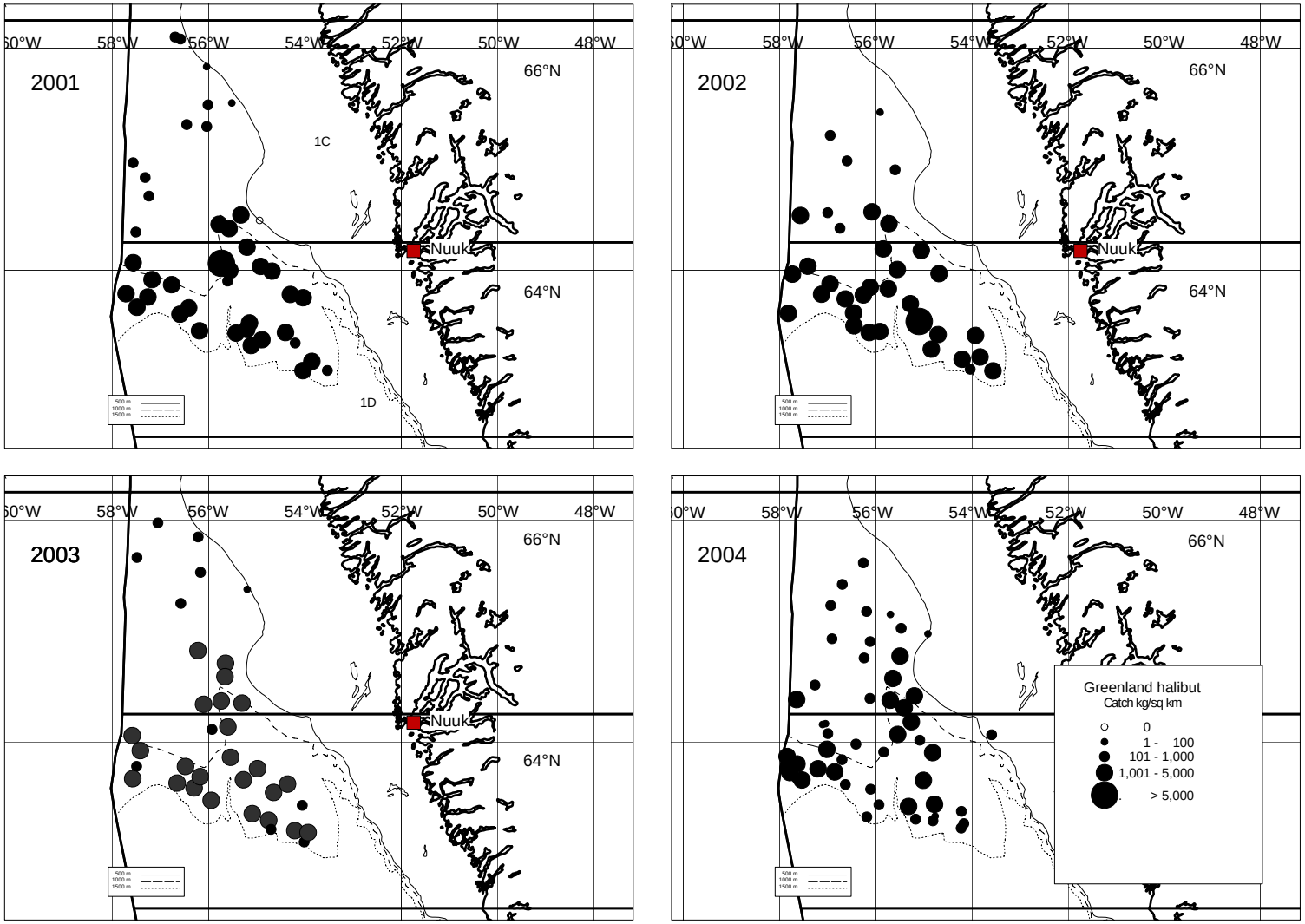


Fig. 1 (cont). Distribution of catches of Greenland halibut in 2001 - 2004 in kg km^{-2}

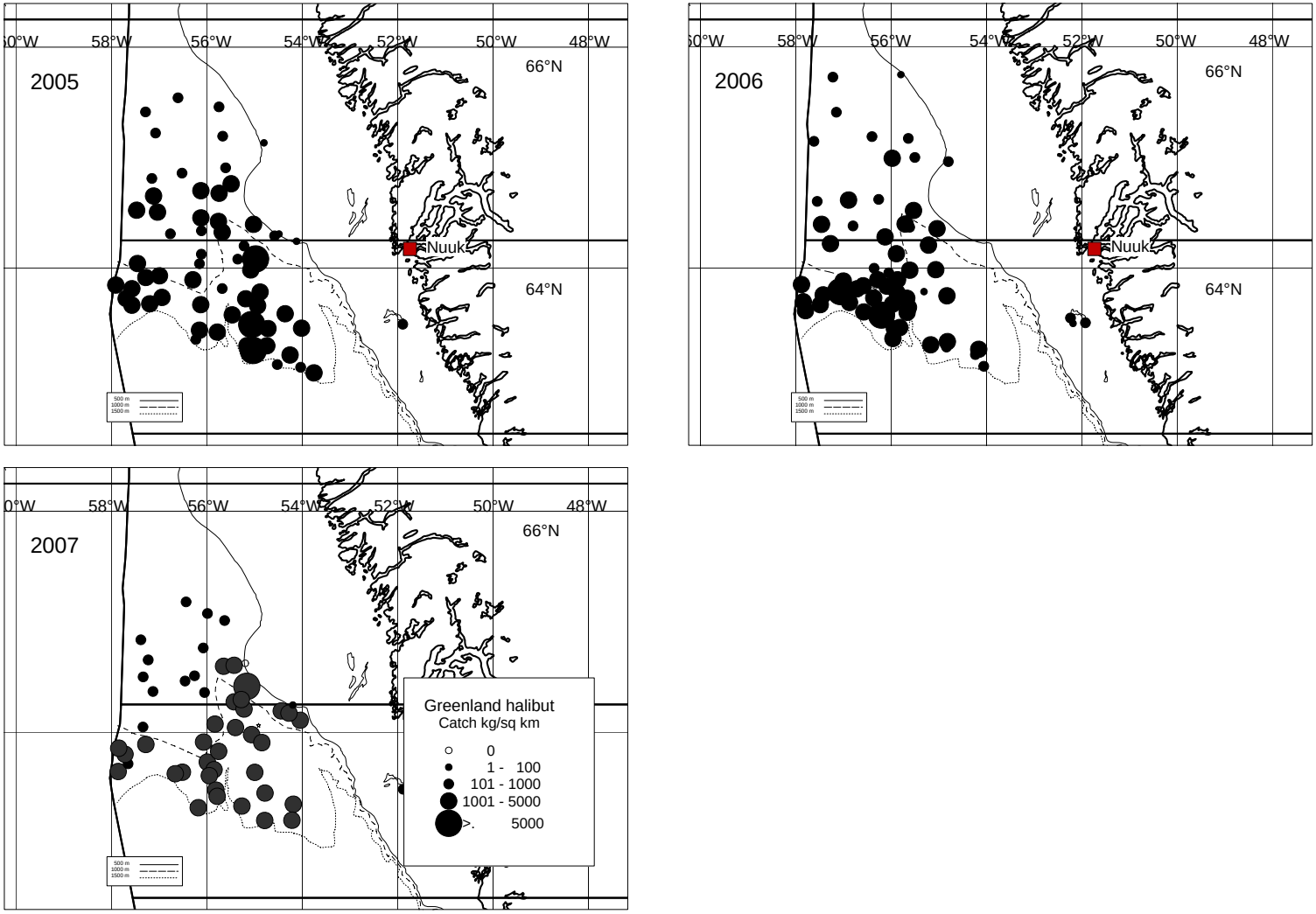


Fig. 1 (cont). Distribution of catches of Greenland halibut in 2005 - 2007 in kg km^{-2}

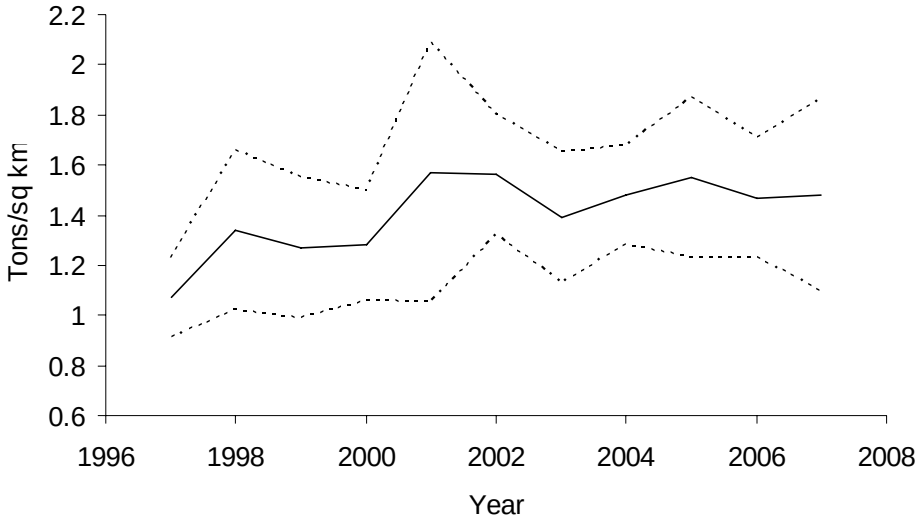


Fig. 2. Mean catch of Greenland halibut per sq. km (tons) standardized by stratum area with 2* +/ S.E.

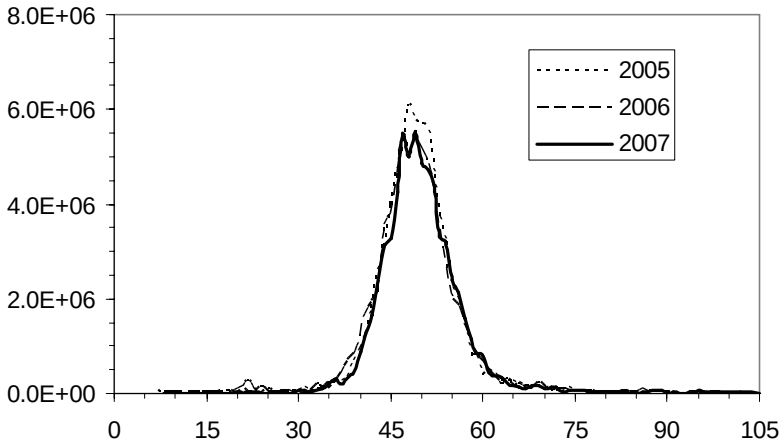


Fig. 3. Over all length distribution of Greenland halibut in numbers (weighted by stratum area) by year.

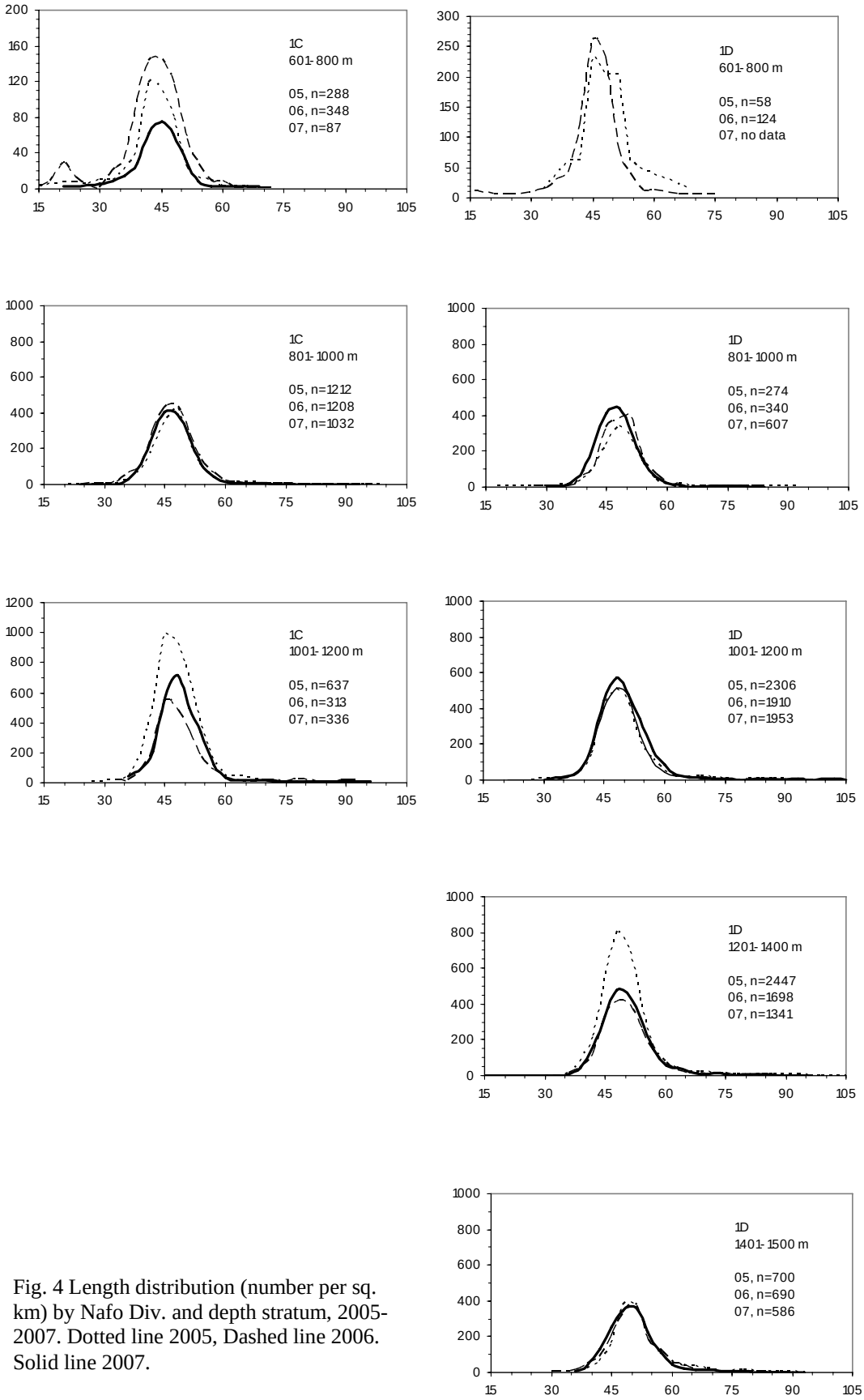
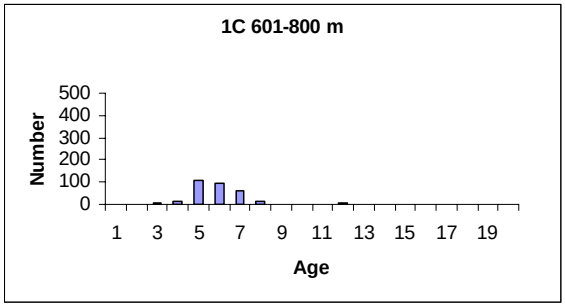
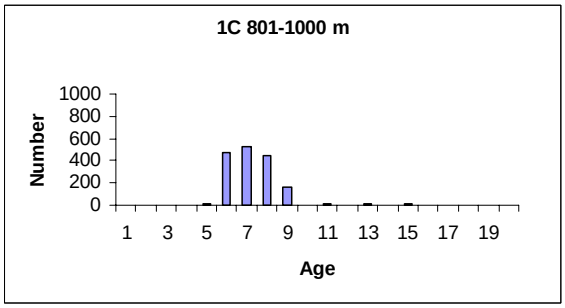
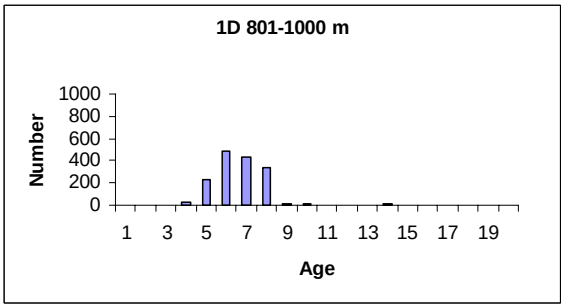
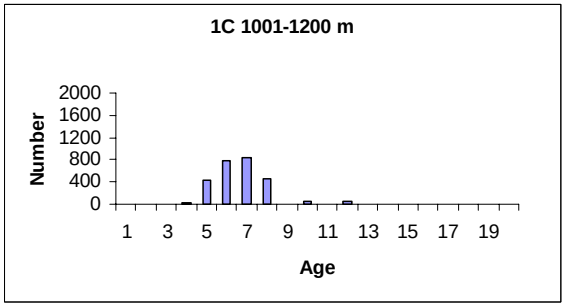


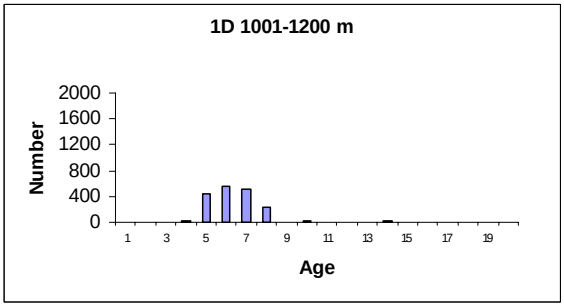
Fig. 4 Length distribution (number per sq. km) by Nafo Div. and depth stratum, 2005-2007. Dotted line 2005, Dashed line 2006. Solid line 2007.

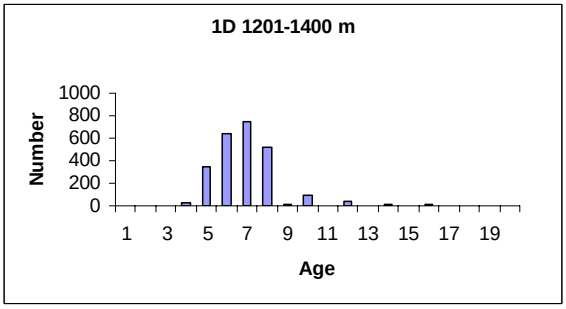












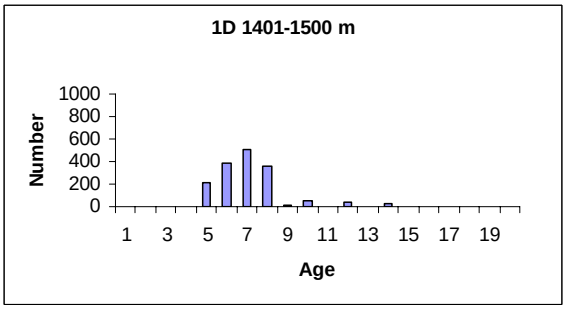


Fig. 5. Age distribution (number by age per sq. km) by Nafo Div. and depth stratum

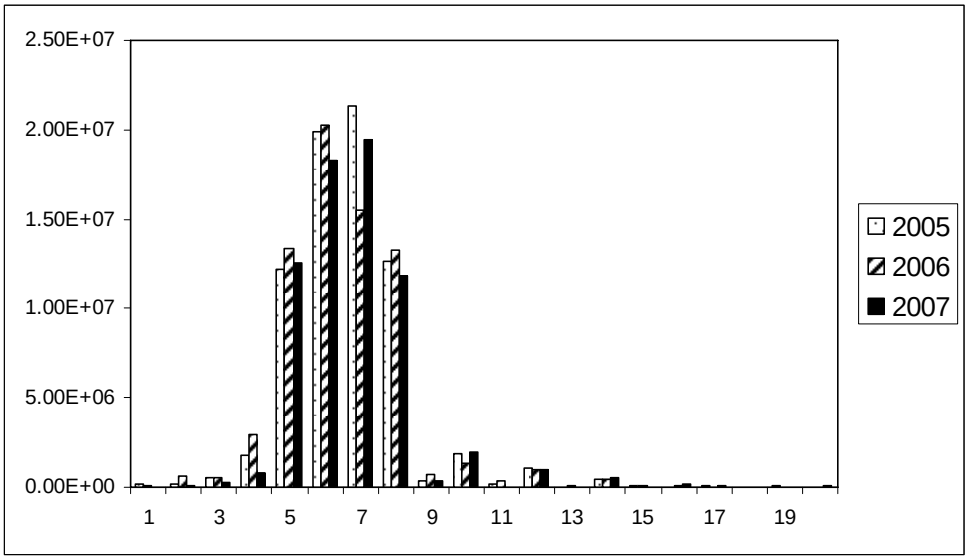


Fig. 6. Total age distribution in numbers (weighted by stratum area) of Greenland halibut in 2005-2007.

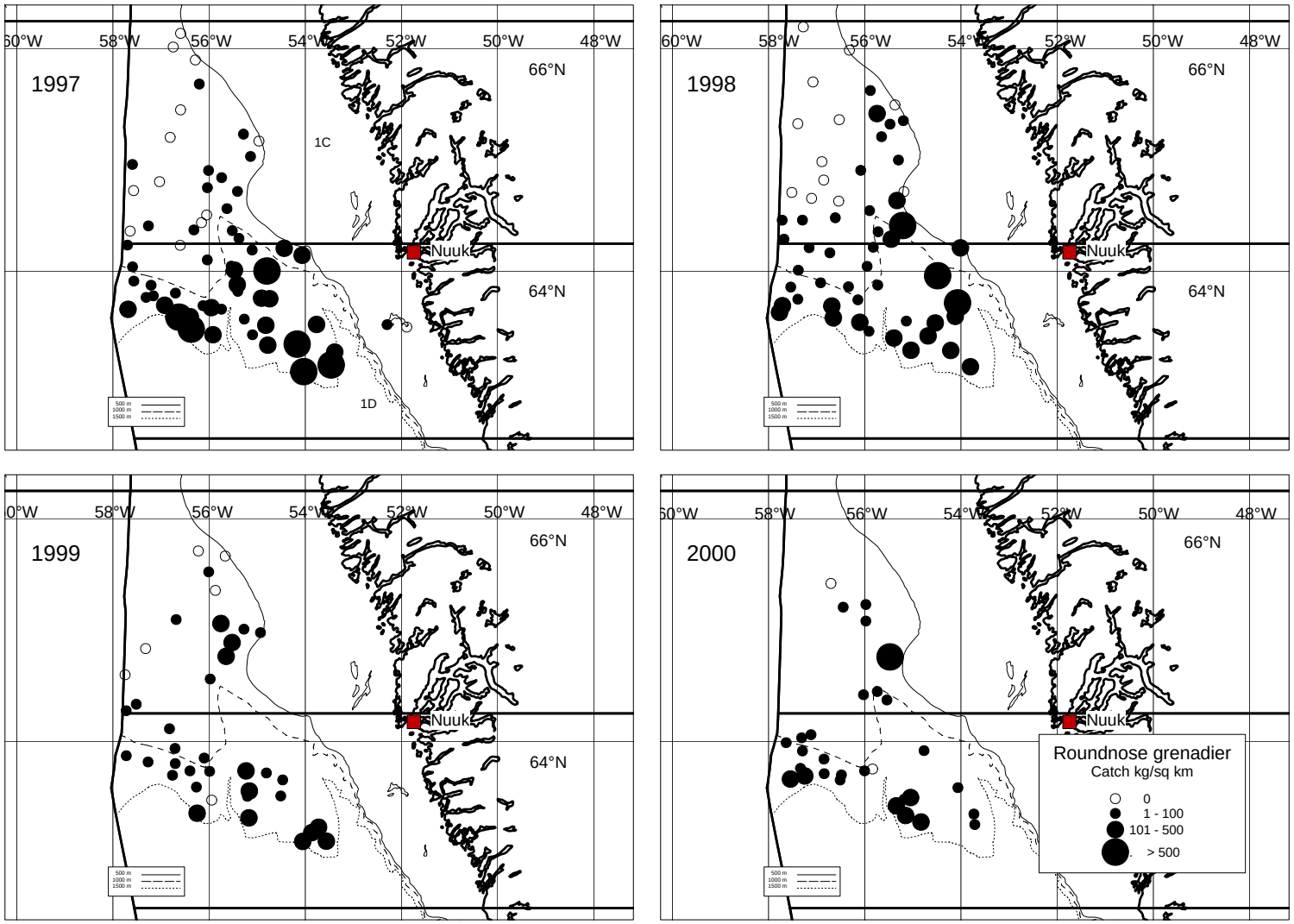


Fig. 7. Distribution of catches of roundnose grenadier in 1997-2000 in kg km^{-2}.

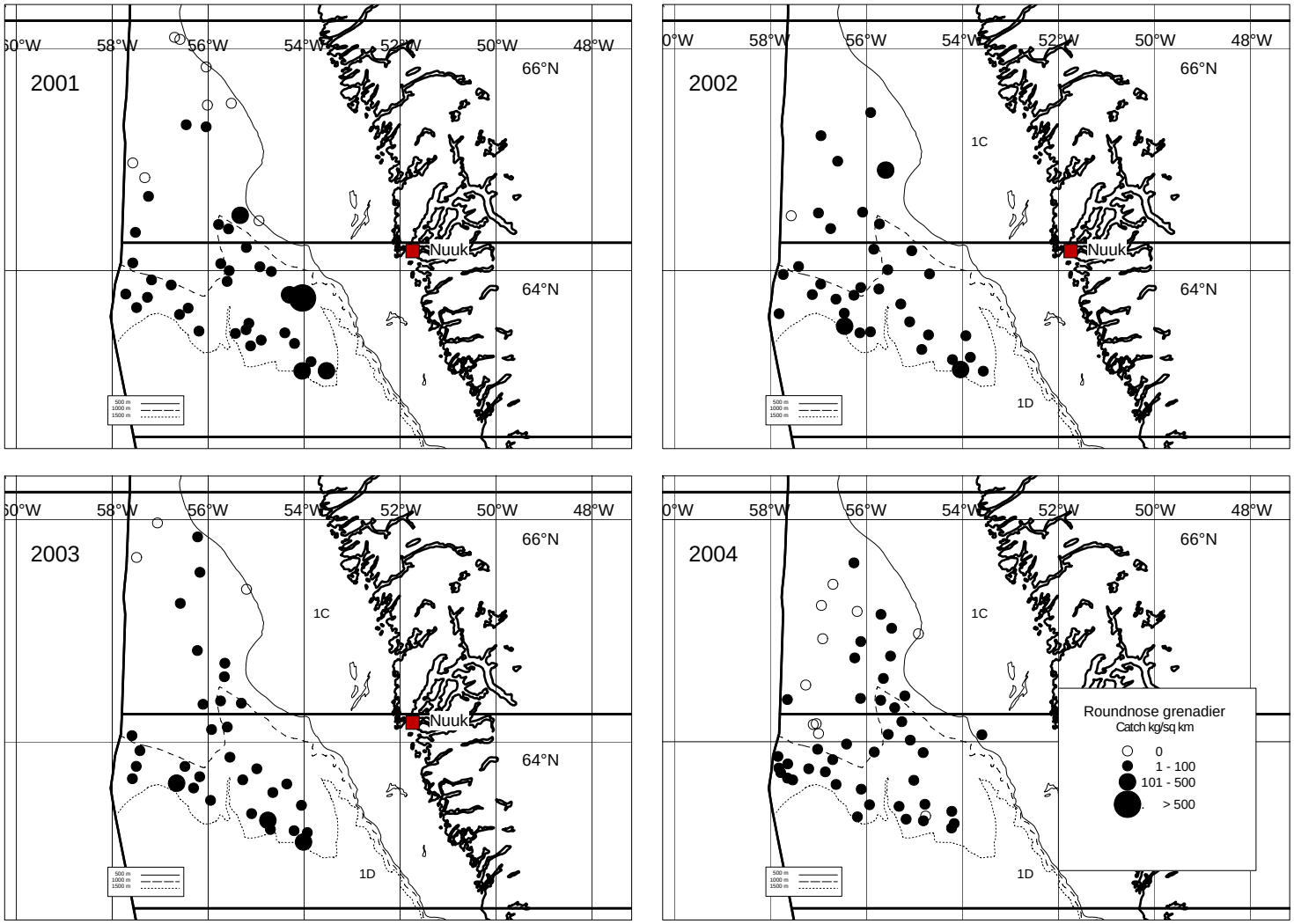


Fig. 7 cont. Distribution of catches of roundnose grenadier during 2001-2004.

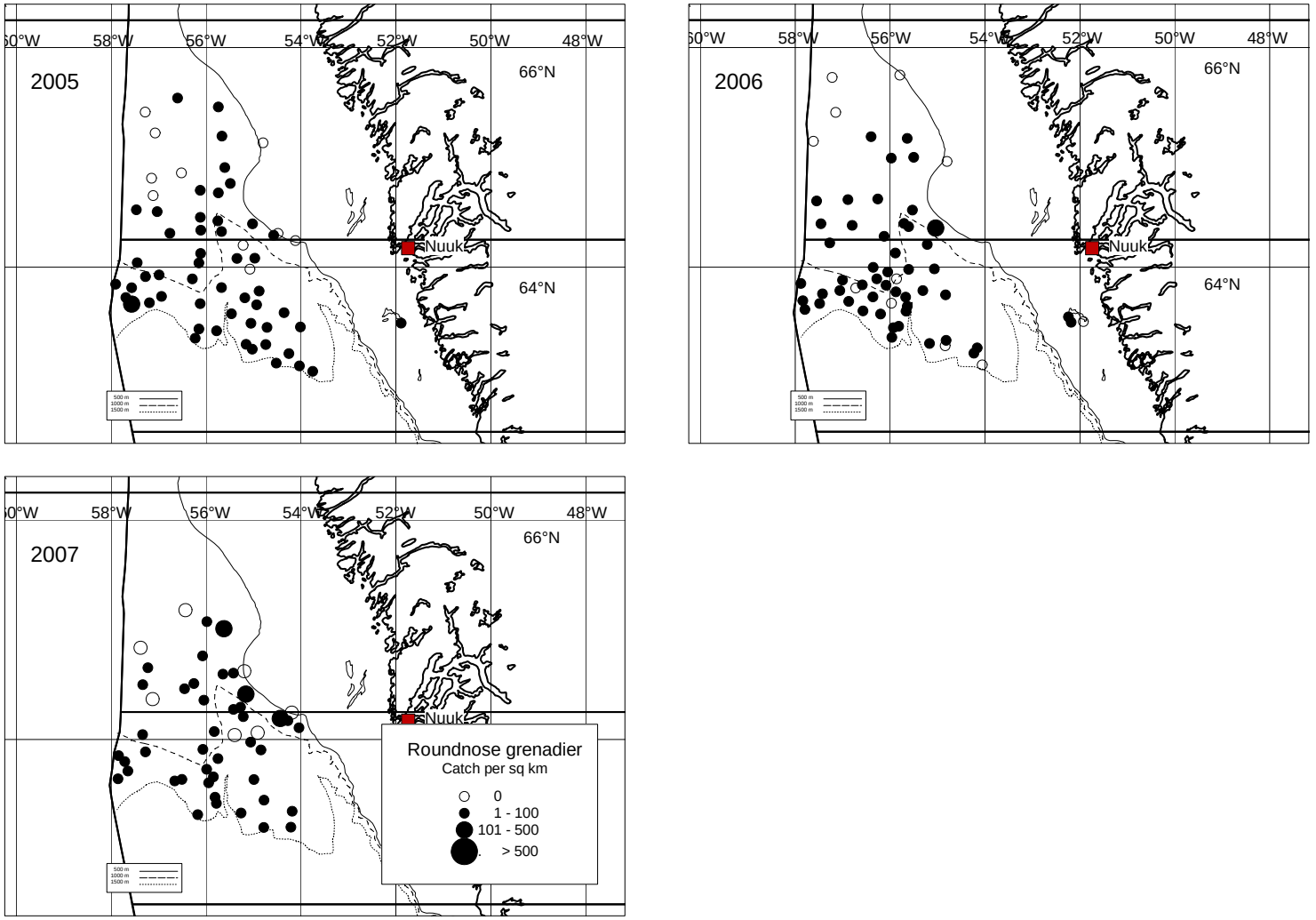


Fig. 7 cont. Distribution of catches of roundnose grenadier during 2005-2007.

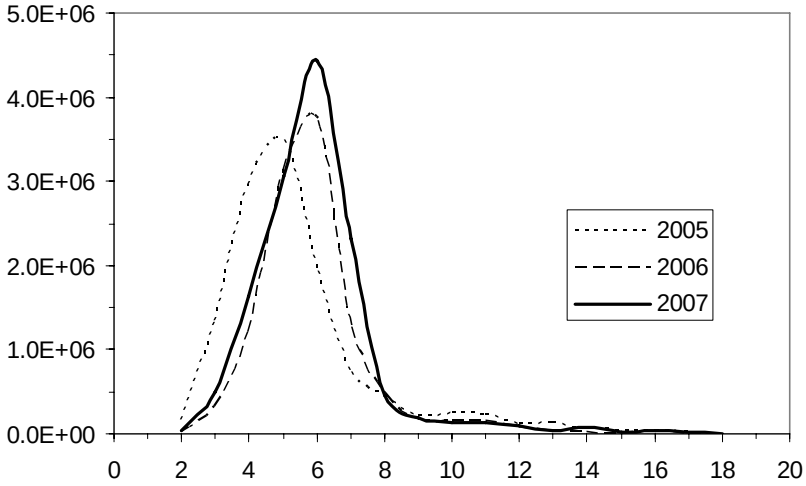


Fig. 8. Overall length distribution of roundnose grenadier (pre anal fin length) in numbers (weighted by stratum area) by year.

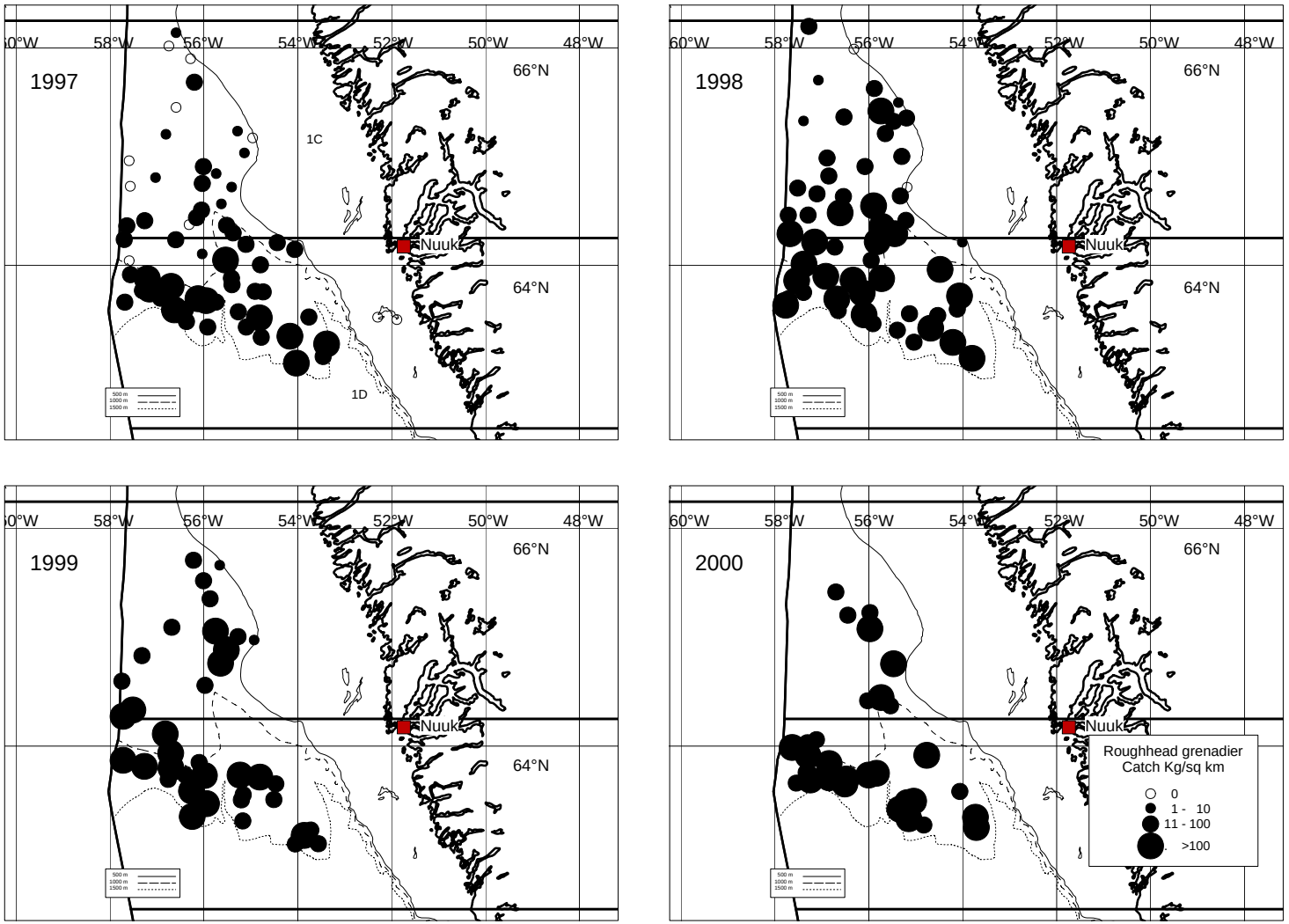


Fig. 9. Distribution of catches of roughhead grenadier in 1997-2000 in kg km^{-2}.

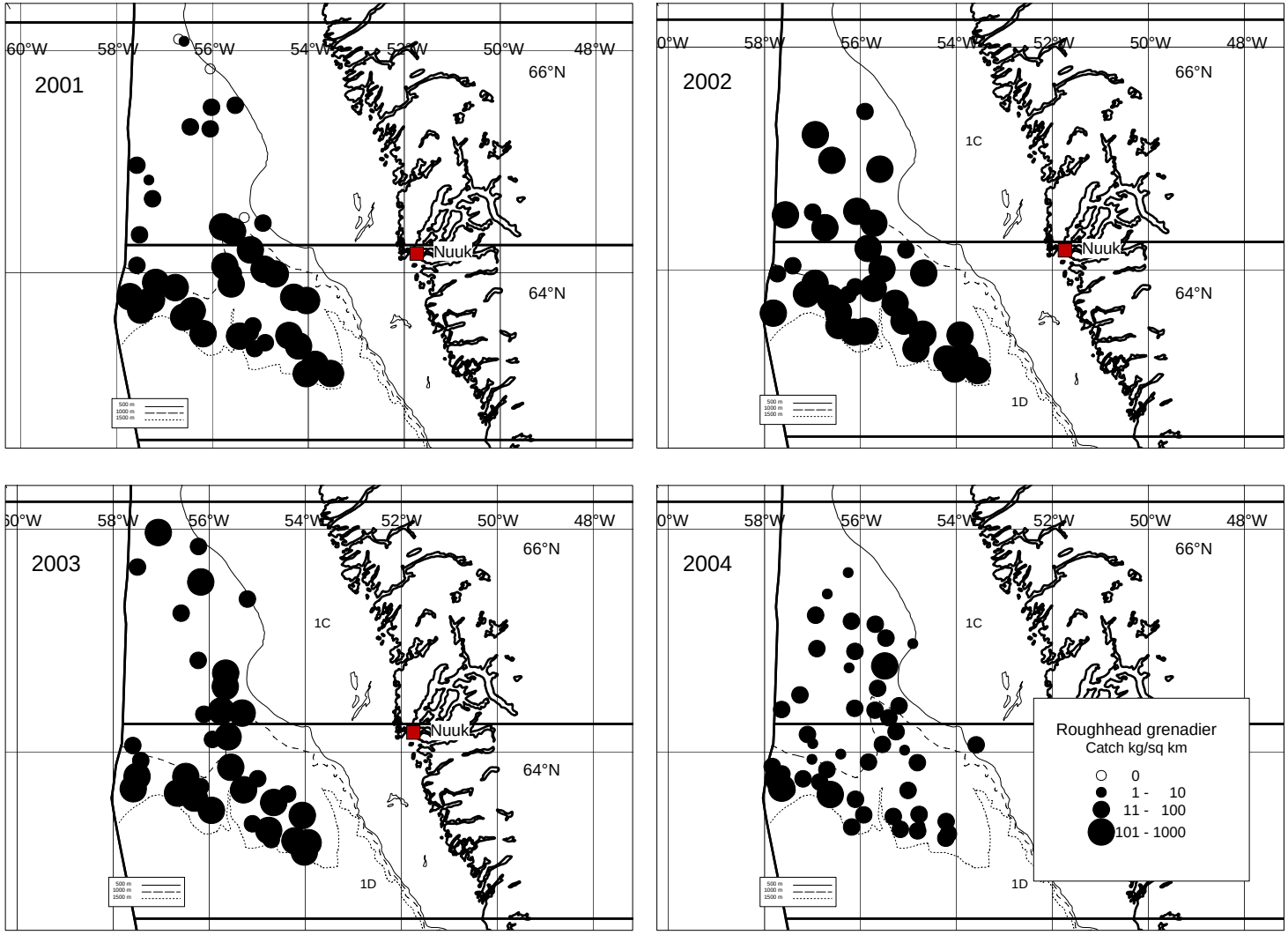


Fig. 9 cont.. Distribution of catches of roughhead grenadier during 2001-2004

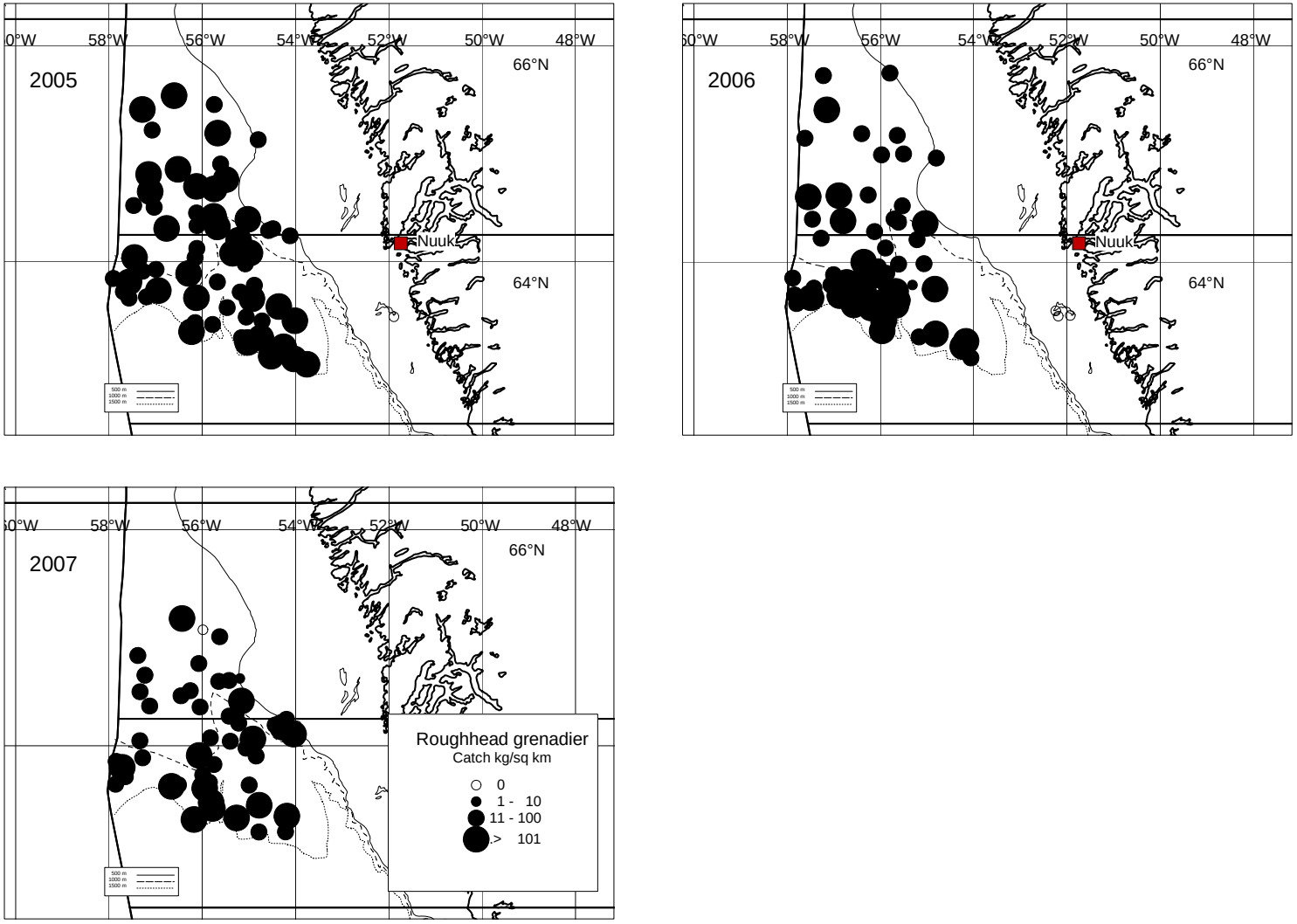


Fig. 9 cont.. Distribution of catches of roughhead grenadier during 2005-2007

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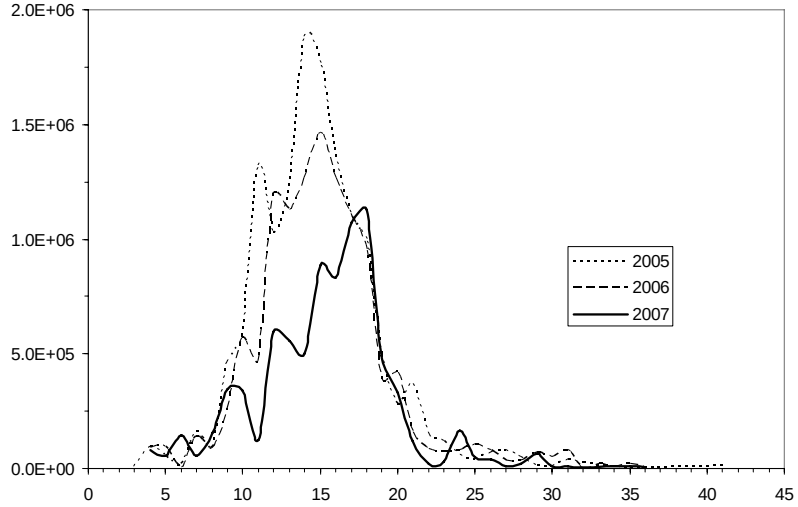

Fig. 10. Overall length distribution (pre anal fin length) of roughhead grenadier in numbers (weighted by stratum area) by year.

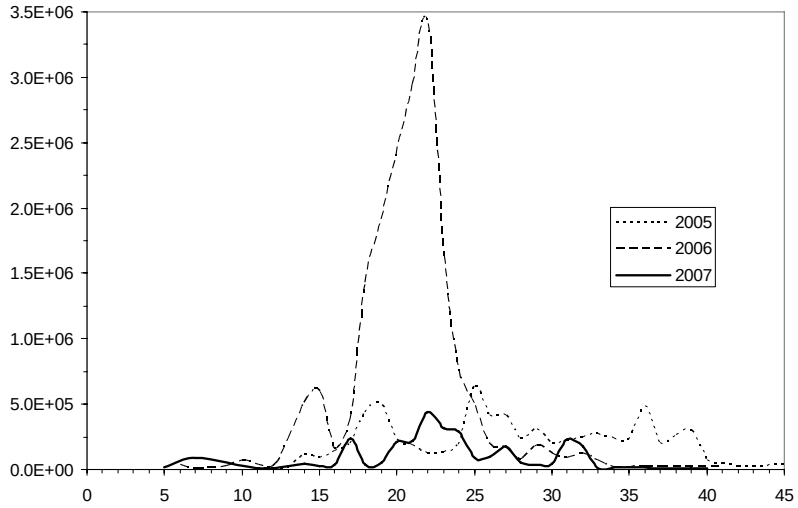

Fig. 11. Overall length distribution (pre anal fin length) of deep *Sebastes mentella* + *Sebastes* sp. in numbers (weighted by stratum area) by year.

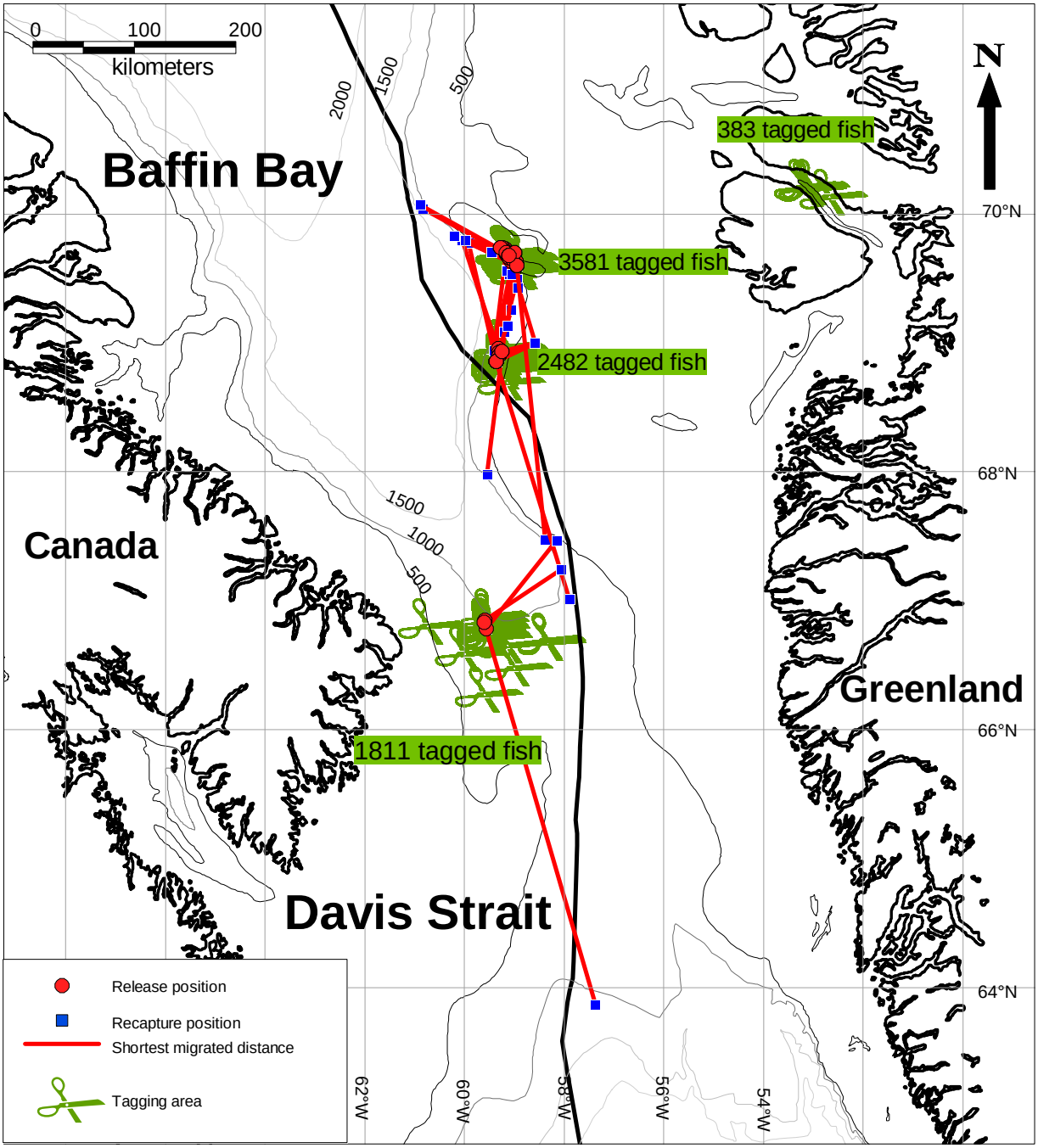

Fig. 12 Greenland halibut tagging and recapturing positions (to February 2008) and number of tagged fish.

Appendix 1. List of species and groups of species recorded in Div. 1C-D in 2007 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	NY1	Sp. 1	0.1	1	859.0	859.0	4.8	4.8	64.1723
2	NY2	SP. 2	0.3	1	859.0	859.0	4.8	4.8	64.1723
3	ALA	Alepocephalus agassizzi	21.5	19	859.0	1460.5	3.6	4.8	64.1723
4	CAD	Anarhichas denticulatus	5.7	2	439.5	1362.0	4.0	4.9	65.0742
5	CAS	Anarhichas minor	5.5	1	487.0	487.0	4.9	4.9	64.6227
6	ANT	Antimora rostrata	29.0	50	726.0	1467.5	3.6	4.9	65.1791
7	ARZ	Arctozenius rissoi	0.6	11	425.5	839.0	4.8	4.9	65.0102
8	BAT	Bathylagus euryops	4.1	94	726.0	1467.5	3.6	4.9	65.1791
9	BSE	Bathypolypus sp.	0.1	1	829.0	829.0	4.2	4.2	64.5104
10	BSP	Bathyraja spinicauda	15.7	1	729.0	1357.5	3.6	4.9	64.6046
11	BEG	Benthosema glaciale	0.1	44	425.5	1467.5	3.6	4.9	65.1791
12	BOA	Borostomias antarctica	0.5	5	791.5	1460.5	3.6	4.9	65.0742
13	CFB	Centroscyllium fabricii	34.1	49	825.0	1362.0	3.9	4.9	65.0742
14	CHA	Chauliodus sloani	0.6	4	729.0	1362.0	3.6	4.9	65.0742
15	CHN	Chiasmodon niger	0.1	4	791.5	1359.0	3.6	4.9	65.0742
16	CRQ	Chionocetes opilio	28.3	60	425.5	425.5	4.9	4.9	63.4832
17	CIR	Cirotheuthis sp.	2.4	1	1137.5	1137.5	4.9	4.9	64.2090
18	CIM	Cirroteuthis mulleri	5.9	3	1121.5	1460.5	3.6	4.2	63.9769
19	CBB	Coryphaenoides brevibarbis	0.3	3	726.0	1460.5	3.8	4.8	65.1791
20	CGR	Coryphaenoides guntheri	2.2	28	791.5	1467.5	3.6	4.8	64.4136
21	RNG	Coryphaenoides rupestris	12.3	273	425.5	1467.5	3.6	4.9	65.0742
22	COM	Cottunculus microps	0.2	2	726.0	1118.0	4.1	4.8	65.1791
23	COT	Cottunculus thomsonii	0.9	2	817.5	970.0	4.1	4.9	65.0742
24	LUM	Cyclopterus lumpus	2.1	3	829.0	1450.5	3.9	4.2	64.5104
25	CLM	Cyclothone microdon	0.0	18	780.5	1467.5	3.6	4.8	65.0742
26	EUR	Eurypharynx pelecanoides	0.2	1	833.0	1189.0	3.6	4.3	64.4995
27	COD	Gadus morhua	55.7	64	425.5	487.0	4.9	4.9	64.6227
28	ONA	Gaidropsarus argentatus	0.0	1	791.5	934.0	4.3	4.4	64.3678
29	ONN	Gaidropsaurus ensis	2.3	4	726.0	1467.5	3.6	4.9	65.1791
30	WIT	Glyptocephalus cynoglossus	0.5	1	780.5	866.5	4.3	4.9	65.0742
31	GOB	Gonostoma bathyphilum	0.0	1	896.5	1131.0	4.0	4.8	64.7616
32	PLA	Hippoglossoides platessoides	27.0	171	425.5	896.5	4.2	4.9	70.1767
33	HOA	Holtbyrnia anomala	0.1	1	921.0	1460.5	4.2	4.3	64.3595
34	HMC	Holtbyrnia macrops	0.1	1	1102.0	1357.5	3.6	3.6	64.2736
35	HAF	Hydrolagus affinis	25.0	3	1362.0	1460.5	3.9	4.3	64.1067
36	LMC	Lampanyctus macdonaldi	11.3	140	439.5	1467.5	3.6	4.9	65.1791
37	LEP	Lepedion eques	0.4	3	439.5	931.5	3.9	4.9	65.0742
38	LIF	Liparis fabricii	0.0	1	726.0	954.0	4.3	4.8	65.1791
39	KCT	Lithodes maja	1.8	2	729.0	859.0	4.1	4.9	64.6539
40	LYM	Lycodes mirabilis	0.0	1	829.0	1335.5	4.0	4.2	64.5104
41	ELZ	Lycodes sp.	0.2	1	1168.0	1168.0	4.0	4.0	63.8543
42	LSQ	Lycodes squamiventer	0.3	1	1139.5	1139.5	4.0	4.0	63.8257
43	LYT	Lycodes terranova	0.1	1	1131.0	1131.0	4.0	4.0	63.8883
44	LYV	Lycodes vahli	4.1	41	425.5	425.5	4.9	4.9	63.4832
45	RHG	Macrourus berglax	15.9	28	439.5	1467.5	3.6	4.9	65.1791
46	MAL	Malacosteus niger	0.1	1	1263.5	1357.5	3.6	4.0	63.7993
47	CAP	Mallotus villosus	0.0	1	425.5	425.5	4.9	4.9	63.4832
48	MMI	Maulisa microlepis	0.1	1	1120.5	1453.0	3.8	4.3	64.0409
49	WHB	Micromesistius poutassou	0.3	3	439.5	439.5	4.8	4.8	64.2450
50	MYP	Myctophum punctatum	0.1	1	882.0	1420.0	3.6	4.8	64.2736
51	MYX	Myxine glutinosa	0.1	1	425.5	425.5	4.9	4.9	63.4832
52	NEM	Nemichthys scolopaceus	0.2	4	1189.0	1189.0	4.2	4.2	63.6059
53	NEG	Neolithodes grimaldi	3.5	2	1081.0	1357.5	3.6	4.8	64.2955
54	NZA	Nezumia aequalis	0.4	2	825.0	829.0	4.2	4.8	65.0742
55	NZB	Nezumia bairdi	0.3	2	817.5	1263.5	4.0	4.8	65.0102
56	NOT	Notacanthus chemnitzii	9.5	7	425.5	1467.5	3.8	4.9	65.1791
57	ONE	Oneiroides eschrichti	0.1	1	829.0	829.0	4.2	4.2	64.5104
58	OPI	Ophisthoteuthis sp.	1.2	1	1335.5	1335.5	4.1	4.1	63.4188
59	PAC	Paraliparis copei	0.1	1	839.0	1131.0	4.0	4.8	65.0102
60	PAG	Paraliparis garmani	0.1	4	726.0	833.0	4.3	4.8	65.1791
61	POL	Polyacanthonotus rissoanus	0.2	1	882.0	1453.0	3.8	4.8	64.3595
62	RBT	Raja bathyphila	16.1	5	1078.5	1420.0	3.9	4.3	64.1067
63	RFL	Raja fyllae	0.9	1	780.5	1453.0	3.8	4.9	65.0102
64	RHB	Raja hyperborea	11.5	1	1357.5	1357.5	3.6	3.6	63.3308
65	RRD	Raja radiata	6.1	8	425.5	425.5	4.9	4.9	63.4832
Obs	art	species	maxwgt	maxno	mindepth	maxdepth	mintemp	maxtemp	maxpos

66	GHL	Reinhardtius hippoglossoides	472.2	409	425.5	1467.5	3.6	4.9	70.2400
67	RHD	Rhadinestes decimus	0.1	2	1189.0	1359.0	4.0	4.2	63.7130
68	RME	Rossia megaptera	0.0	1	1120.5	1120.5	4.3	4.3	64.0409
69	ROM	Roulina maderensis	0.1	1	1161.5	1161.5	.	.	63.6364
70	SAC	Sccopharynx ampullaceus	0.1	1	1081.0	1081.0	4.8	4.8	64.2955
71	SCO	Scopelosarus lepidus	1.8	16	825.0	1453.0	3.6	4.9	65.0742
72	REG	Sebastes marinus	1.4	2	425.5	1081.0	4.8	4.9	64.6227
73	REB	Sebastes mentella	16.7	115	425.5	1357.5	3.6	4.9	65.1791
74	RED	Sebastes sp.	2.3	17	487.0	1263.5	4.0	4.9	65.0742
75	SEK	Serasia koefoedi	0.1	1	1081.0	1081.0	4.8	4.8	64.2955
76	SER	Serrivomer beani	1.7	4	780.5	1467.5	3.6	4.8	64.8355
77	STO	Stomias boa	0.1	5	425.5	1467.5	3.6	4.9	65.0742
78	SYN	Synapobranchus kaupi	3.3	25	780.5	1467.5	3.6	4.9	65.0102
79	TRA	Trachyrynchus murrayi	2.4	10	859.0	954.0	4.2	4.8	64.1923
80	XEC	Xenodermichthys copei	0.1	1	726.0	1362.0	4.0	4.8	65.1791