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Survey for Greenland Halibut in NAFO Divisions 1C-1D, 2002

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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, together with age and maturity data for Greenland halibut. The biomass of Greenland halibut was estimated as 72 000 tons compared to 77 600 tons. The biomass of roundnose grenadier was estimated as 1 600 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.

Materials and Methods

The survey in 2002 covered 1CD and took place during 17/9-23/9.

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 1).

The survey was planned as a Stratified Random Bottom Trawl Survey with in total 70 hauls. Basically hauls were allocated proportional to stratum area. Analysis of previous years surveys in Div. 1CD showed that Div. 1C, depth stratum 601-800 m, traditionally had been oversampled, while depth stratum 1 001-1 200 m and 1 201-1 400 m in Div. 1D had been undersampled. More hauls were, hence, allocated to the two latter strata, than their area justifie, 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, 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 Perfect (370*250 cm) weighing 2 400 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 + 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).

In a few cases the distance between otter boards could not be measured at depths >800 m because of defect Scanmar sounders. The distance between otterboards were then estimated form a linear regression based on pervious hauls at depth >800 m at both West- and East Greenland: Distance between otter boards = 114.4 + fishing depth (m) *0.01.

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 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 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 standardised to 1 km^2 swept prior to further calculations

Otoliths for age determination of Greenland halibut (n = 389) 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 35 successful hauls were made, giving a mean coverage of the surveyed area on 1 317 km^2 per haul (Table 1). The number of tows was reduced compared to the 70 planned mainly due to bad weather. Three strata: 1C 401-600 (3366 km^2), 1D 401-600 (903 km^2) and 601-800 m (1 940 km^2) were not covered at all. Haul by haul information on catches, position, depth, temperature etc. is given in Appendix 1.

In total 66 species or groups of species were recorded (Appendix 2).

Greenland halibut (*Reinhardtius hippoglossoides*)

Greenland halibut was caught in all hauls (Fig. 1) and the biomass was estimated at 71 932.4 tons (S.E. 5 613.9) (Table 2) which was an decrease from 77 554.0 tons in 2001. The decrease is mainly seen in stratum 1D 801-1 000

m, where the biomass was very high in 2001 due to a single large catch. The estimate from 2002 is not statistically different (95% level) from the estimates from 1997-2001. (Jørgensen, 2002; 2001; 2000; 1999 and 1998b).

Biomass of Greenland halibut in Div. 1CD.

Year	1997	1998	1999	2000	2001	2002
Biomass	56 260.2	70 473.5	64 398.0	59 092.4	77 554.0	71932.4
S.E.	4 399.6	8 391.7	6 912.1	5 543.3	13 013.6	5613.9

The three strata that were not covered in 2002 traditionally yield biomasses <1 500 tons.

Weighted mean catch per tow (tons) standardized to catch/km^2.

Year	1997	1998	1999	2000	2001	2002
Mean/tow	1.07	1.34	1.27	1.28	1.57	1.56
S.E.	0.08	0.16	0.14	0.11	0.26	0.12

The abundance in Div. 1CD was estimated at $71.510*10^6$ (S.E. $6.223*10^6$) (Table 3), which was decrease compared to $80.814*10^6$ (S.E.$14.221*10^6$) in 2001, but as for the biomass, the decrease was mainly observed in depth stratum 1D 800-1000 m where the abundance was very high in 2001 due to one large haul. The estimate from 2002 is not statistically different from the 1997-2001 estimates (95% level)

Abundance of Greenland halibut in Div. 1CD.

Year	1997	1998	1999	2000	2001	2002
Abundance	$53.613*10^6$	$67.677*10^6$	$61.366*10^6$	$61.710*10^6$	$80.814*10^6$	$71.510*10^6$
S.E.	$4.118*10^6$	$7.687*10^6$	$6.265*10^6$	$5.976*10^6$	$14.221*10^2$	$6.223*10^6$

The three strata that were not covered in 2002 traditionally yield has an abundance $<2.0*10^6$.

Estimated abundance by age in Div. 1CD is given in Table 4.

The length ranged from 16 cm to 105 cm. Generally the length distributions in the different depth strata were dominated by a single mode. Generally 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 totally dominated by a mode at 47 cm while the mode was at 46 cm in 2001.

The age ranged from 1 to 22 years. Generally the age increased by depth and here the age composition was dominated by ages 5-7. The overall age distribution (weighted by stratum area) in Div. 1CD was monomodal with a mode around age 6 (Fig. 5). Mean weight and length at age is given in Table 5.

Females stated maturing at age 7 and 100% maturity was reached at age 12 (Table 6).

Roundnose grenadier (*Coryphaenoides rupestris*)

Roundnose grenadier was caught in all hauls, except one, but the catches was very low (Appendix 1, Fig. 6) and the biomass was estimated at 1 593.1 tons (S.E. 462.7) which is only slightly higher than the estimate from 2001 and the second lowest estimate in the present survey series. The biomass is hence still very low compared to the late-1980s (Jørgensen, 2002; 2001; 2000; 1999; 1998a and 1998b).

Biomass of roundnose grenadier in Div. 1CD.

Year	1997	1998	1999	2000	2001	2002
Biomass	5 686.5	7 263.3	2 771.8	5 593.7	1 577.2	1593.1
S.E.	926.4	2 530.2	445.5	2 616.8	516.4	462.7

Most of the biomass was found in Div. 1D at 1401-1500 m, which also had the highest density (Table 7).

The abundance in Div. 1C-1D was estimated at $18.610*10^6$ (S.E. $8.910*10^6$) whish is a slight decrease compared to $24.698*10^6$ (S.E. $8.797*10^6$) in 2001 and lowest in the times series (Table 8)

Abundance of roundnose grenadier in Div. 1CD.

Year	1997	1998	1999	2000	2001	2002
Abundance	$32.441*10^6$	$75.243*10^6$	$29.100*10^6$	$99.524*10^6$	$24.698*10^6$	$18.610*10^6$
S.E.	$7.056*10^6$	$27.357*10^6$	$8.963*10^6$	$67.311*10^6$	$8.797*10^6$	$8.910*10^6$

Pre anal fin length ranged from 2 to cm 18 cm. Fish size increased generally with increasing depth (Fig. 7). The overall length distribution (weighted by stratum area) was totally dominated by a broad mode at 4-7 cm as in 2001 (Fig. 8).

Roughhead grenadier (*Macrourus berglax*)

The biomass of roughhead grenadier was estimated at 7 907.6 tons (S.E. 823.6) (Table 9, Fig. 9, Appendix 1) compared to 4 576.6 tons (S.E. 456.3) in 2001.

Biomass of roughhead grenadier in Div. 1CD.

Year	1997	1998	1999	2000	2001	2002
Biomass	2 258.6	4 314.1	5 166.2	7 178.1	4 576.6	7 907.6
S.E.	250.1	377.9	854.1	2 226.5	456.3	823.6

The biomass is probably slightly underestimated due to the lack of coverage the three shallow strata, but the biomass at shallow water is usually low. Most of the biomass was found in deep water in Div. 1D where also the highest densities were observed (Table 9).

The total abundance was estimated at $19.620*10^6$ (S.E. $1.755*10^6$) (Table 10) compared to 13.867*10 (S.E. $1.549*10^6$) in 2001.

Abundance of roughhead grenadier in Div. 1CD.

Year	1997	1998	1999	2000	2001	2002
Abundance	$4.60*10^6$	$11.623*10^6$	$14.074*10^6$	$20.282*10^6$	$13.867*10^6$	$19.620*10^6$
S.E.	$0.45*10^6$	$1.008*10^6$	$2.040*10^6$	$7.182*10^6$	$1.549*10^6$	$1.755*10^6$

Pre anal fin length ranged from 3 to cm 37 cm and the over all length distribution was dominated by modes at 9, 14 and 16 cm. (Fig. 10).

Deep-sea redfish (*Sebastes mentella*)

The catches of Deep-sea redfish was very low, in total 30 fish, probably due to lack of coverage of the shallow strata especially in Div. 1C (Appendix 2)

Year	1997	1998	1999	2000[1)]	2001	2002[1)]
Biomass	2 464.3	2 408.1	2 484.9		2 063.4	
S.E.	787.1	503.9	1 007.7		873.5	

1). Poor coverage of relevant depths.

Year	1997	1998	1999	2000[1)]	2001	2002[1)]
Abundance	$14.690*10^6$	$18.827*10^6$	$12.926*10^6$		$16.337*10^6$	
S.E.	$5.500*10^6$	$4.496*10^6$	$4.093*10^6$		$6.474*10^6$	

1). Poor coverage of relevant depths.

Temperature

The bottom temperature ranged fro 2.7 to 4.1 °C and the temperature was generally decreasing by depth. (Table 11).

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

Div.	Depth stratum (m)						Tot.
	401-600	601-800	801-1000	1001-1200	1201-1400	1401-1500	
1C	3366 (4) 0	16120 (12) 4	6066 (8) 4	611 (2) 1	-	-	26163 (26) 9
1D	903 (2) 0	1940 (3) 0	3874 (5) 4	10140 (18) 12	6195 (12) 7	3091 (4) 3	26143 (44) 26
Tot	4269 (6) 0	18060 (15) 4	9940 (13) 8	10751 (20) 13	6195 (12) 7	3091 (4) 3	52306 (70) 35

Table 2. Biomass (tons) of Greenland halibut by Division and depth stratum, 2002.

Division	Depth (m)	Area	Hauls	Mean sq/km	Biomass	SE
1C	601-800	16120	4	0.2437	3927.8	1386.7
	801-1000	6066	4	1.02	6187.6	1740.2
	1001-1200	611	1	2.8622	1748.8	.
1D	801-1000	3874	4	1.4299	5539.3	644.4
	1001-1200	10140	12	2.8616	29016.9	2988.8
	1201-1400	6195	7	3.2101	19886.7	1368.7
	1401-1500	3091	3	1.8199	5625.3	2074.4
All		46097	35	1.5605	71932.4	5613.91

Table 3. Abundance of Greenland halibut by Division and depth stratum, 2002.

Division	Depth (m) Area	Hauls		Mean sq/km	Abundance	SE
1C	601-800	16120	4	334.5	5.392E+06	2.230E+06
	801-1000	6066	4	1276.3	7.742E+06	2.093E+06
	1001-1200	611	1	2784	1.701E+06	.
1D	801-1000	3874	4	1564.6	6.061E+06	8.446E+05
	1001-1200	10140	12	2663.9	2.701E+07	2.817E+06
	1201-1400	6195	7	2939.4	1.821E+07	1.307E+06
	1401-1500	3091	3	1745.3	5.395E+06	2.650E+06
All		46097	35	1551.34	7.151E+07	6.223E+06

Table 4. Estimated abundance by age from Div. 1C-1D from the surveys in 1997-2001. The Age-length key from 1998 is applied on the 1997 data.

AGE	1997	1998	1999	2000	2001	2002
1	0	0	0	78826	15585	71512
2	536130	609093	184098	109496	281013	214536
3	1704893	3722237	920490	479059	511722	285367
4	3023773	4662948	4172888	3074341	4835796	2361529
5	9961295	14760362	11291344	15090231	20601616	11779876
6	15370847	19057854	15893794	16838191	26595603	26697300
7	13558728	14083592	19759852	14711646	17922784	18561065
8	5436358	5766084	4786548	5026106	4674899	6201987
9	1200931	1515966	859124	3214208	2550178	1857799
10	948950	1211419	920490	1040152	780082	1340261
11	584382	764751	613660	717770	705656	905723
12	466433	527881	675026	350292	369836	166242
13	187646	351921	429562	318336	345397	257412
14	96503	155657	429562	122157	195607	143024
15	262704	236870	184098	230208	225277	263139
16	187646	115051	61366	128242	91540	178780
17	64336	128586	61366	95352	80275	107268
18	16084	0	61366	57045	22628	35756
19	0	0	0	27474	32325	83431
20+	0	0	0	0	8081	0
SUM	53607639	67670271	61304634	61709132	80845900	71512007

Table 5. Mean weight and mean length-at-age of Greenland halibut, 1995-2002.

	1995		1996		1997		1998		1999		2000		2001		2002	
AGE	weight	length	weight	length	weight	length	weight	length	weight	length	weight	length	weight	length	weight	length
1											25.0	13.5	27.9	14.4	20.0	16.0
2	50.0	20.0			23.3	15.3	38.2	18.7	64.0	21.0	75.0	21.0	85.4	21.0	60.0	21.7
3	140.0	27.0	175.0	30.5	58.2	19.8	175.5	28.5	206.1	27.4	145.8	26.3	173.3	26.7	200.0	29.6
4	339.4	35.1	378.3	36.4	137.0	26.1	347.5	35.3	342.1	34.4	329.3	33.6	366.4	34.2	341.0	35.5
5	495.5	40.1	555.6	41.2	271.8	32.8	551.4	40.9	570.7	40.3	528.0	39.5	574.4	39.7	486.6	39.9
6	691.6	45.0	794.1	45.7	443.9	38.0	854.2	46.8	793.4	45.6	764.4	44.5	848.7	44.9	747.0	45.6
7	986.6	49.8	1056.0	49.9	736.9	43.9	1218.1	51.9	1195.5	51.4	1073.5	49.8	1158.6	49.9	1132.2	51.7
8	1360.0	54.5	1447.0	55.3	1070.2	49.9	1572.3	56.8	1665.4	57.9	1375.6	53.7	1540.5	54.8	1369.7	55.6
9	1817.0	59.6	2092.2	61.5	1453.7	55.6	2074.8	60.6	2057.1	61.1	1630.8	56.8	1843.6	58.0	1844.1	60.7
10	2163.5	62.7	2740.6	65.8	2042.9	61.2	2293.5	63.1	2440.7	64.1	2076.8	61.5	2258.9	61.8	2037.4	62.5
11	2679.6	66.3	3241.7	68.4	2814.6	66.7	2866.6	66.5	2812.1	66.9	2502.5	63.9	3316.2	65.0	2507.6	66.0
12	3248.6	69.9	4100.2	73.0	3827.7	72.6	3453.2	69.9	4000.1	72.9	3014.4	67.5	3449.6	68.7	3011.4	69.7
13	4133.6	73.4	4994.0	76.4	4840.0	77.3	4537.5	74.7	5678.6	79.5	3612.4	70.4	3866.4	71.3	3557.7	71.6
14	5685.6	79.8	5946.7	80.6	6679.4	84.0	5112.0	77.6	7613.2	86.7	3892.5	72.8	5256.7	77.8	4650.0	78.5
15	6631.1	83.6	7523.7	86.8	7711.1	87.8	7140.6	85.1	8476.7	91.2	5409.0	78.3	6323.5	81.9	5149.2	79.0
16	7533.0	89.0	8663.0	89.9	9166.0	94.6	8385.0	88.9	9925.0	88.5	6873.3	85.5	7203.3	86.0	6786.0	84.8
17	10413.6	94.6	9208.3	91.9	10796.7	97.8	10684.0	95.4			8492.0	91.8	8954.0	92.4	8520.0	90.3
18	11180.0	97.0	10127.3	95.3					12500.0	99.0	8590.0	92.3	8760.0	93.0	9385.0	93.0
19	11566.7	98.3	11168.2	98.5			12850.0	99.0			9645.0	91.5	11500.0	102.0	8553.3	90.3
20	11326.7	100.3	11100.0	95.0									14400.0	105.0		
21	13100.0	103.5	11250.0	98.3												
22	13700.0	104.0													13350.0	105.0
24	15300.0	115.0														

Table 6. Maturity-at-age in percent, females, Div. 1C-1D, 2002. 1 immature, 2 maturing.

	MAT		
	1	2	
	Pct	Pct	N
AGE			
2	100		2
3	100		3
4	100		13
5	100		14
6	100		14
7	80	20	20
8	53.85	46.15	13
9	37.5	62.5	16
10	28.57	71.43	14
11	46.67	53.33	15
12	.	100	3
13	8.33	91.67	12
14	.	100	4
15	.	100	11
16	.	100	5
17	.	100	3
18	.	100	2
19	33.33	66.67	3
22	.	100	1

Table 7. Biomass of (tons) roundnose grenadier by Division and depth stratum, 2002.

Division	Depth (m)	Area	Hauls	Mean sq/km	Biomass	SE
1C	601-800	16120	4	0.0027	43.4	22
	801-1000	6066	4	0.0712	432.1	394.3
	1001-1200	611	1	0.0617	37.7	.
1D	801-1000	3874	4	0.0029	11.2	1.3
	1001-1200	10140	12	0.0241	244.3	59.3
	1201-1400	6195	7	0.0323	200.1	68.5
	1401-1500	3091	3	0.2020	624.3	211.6
All		46097	35	0.0346	1593.1	462.7

Table 8. Abundance of roundnose grenadier by Division and depth stratum, 2002.

Division	Depth (m)	Area	Hauls	Mean sq/km	Abundance	SE
1C	601-800	16120	4	100.6	1.622E+06	9.250E+05
	801-1000	6066	4	1552.4	9.417E+06	8.685E+06
	1001-1200	611	1	1165.7	7.123E+05	.
1D	801-1000	3874	4	86.1	3.334E+05	9.526E+04
	1001-1200	10140	12	275.6	2.795E+06	5.113E+05
	1201-1400	6195	7	193.8	1.201E+06	2.875E+05
	1401-1500	3091	3	817	2.525E+06	8.103E+05
All		46097	35	403.6	1.861E+07	8.910E+06

Table 9. Biomass (tons) of roughhead grenadier by Division and depth stratum, 2002.

Division	Depth (m)	Area	Hauls	Mean sq/km	Biomass	SE
1C	601-800	16120	4	0.1394	2247.2	496.9
	801-1000	6066	4	0.1057	641.2	91.6
	1001-1200	611	1	0.2743	167.6	.
1D	801-1000	3874	4	0.1162	450.3	83.2
	1001-1200	10140	12	0.1848	1873.6	284
	1201-1400	6195	7	0.2448	1516.3	178.4
	1401-1500	3091	3	0.3476	1074.4	449.6
All		46097	35	0.1729	7970.6	823.6

Table 10. Abundance of roughhead grenadier by Division and depth stratum, 2002

Division	Depth (m)	Area	Hauls	Mean sq/km	Abundance	SE
1C	601-800	16120	4	448.5	7.230E+06	1.126E+06
	801-1000	6066	4	321.2	1.948E+06	2.426E+05
	1001-1200	611	1	672	4.106E+05	.
1D	801-1000	3874	4	317.8	1.231E+06	2.065E+05
	1001-1200	10140	12	434.2	4.403E+06	8.519E+05
	1201-1400	6195	7	407.3	2.523E+06	2.095E+05
	1401-1500	3091	3	605.2	1.871E+06	4.942E+05
All		46097	35	425.6	1.962E+07	1.755E+06

Table 11. Mean temperature, S.E and number of observations by NAFO Division and depth stratum.

Div.	Depth (m)														
	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
1C	3.4	.33	4	3.8	.06	4	3.7		1						
1D				3.6	.05	4	3.5	.03	12	3.4	.03	7	3.3	.06	3

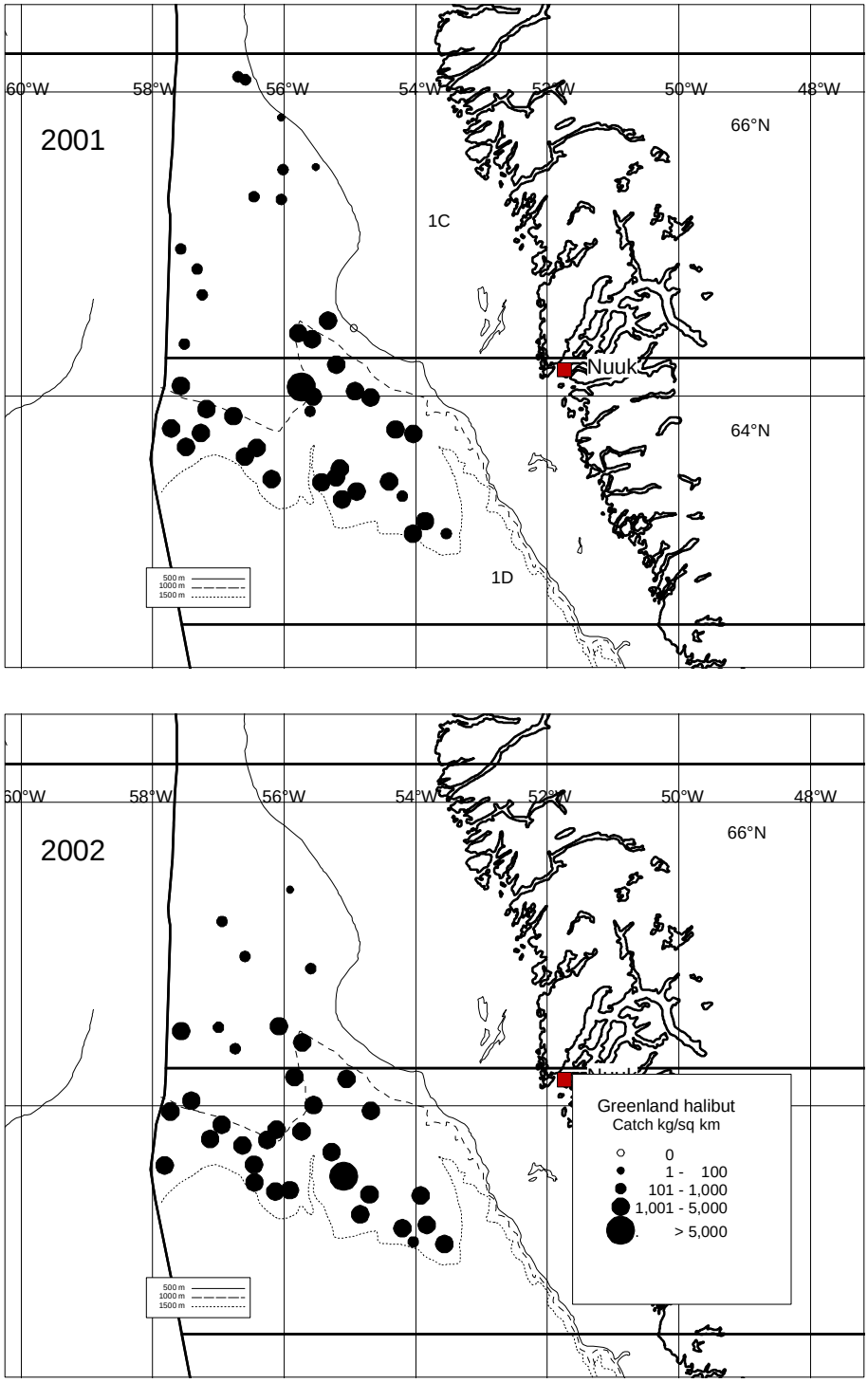

Fig 1. Distribution of catches of Greenland halibut in 2001 and 2002 in kg km^{-2}

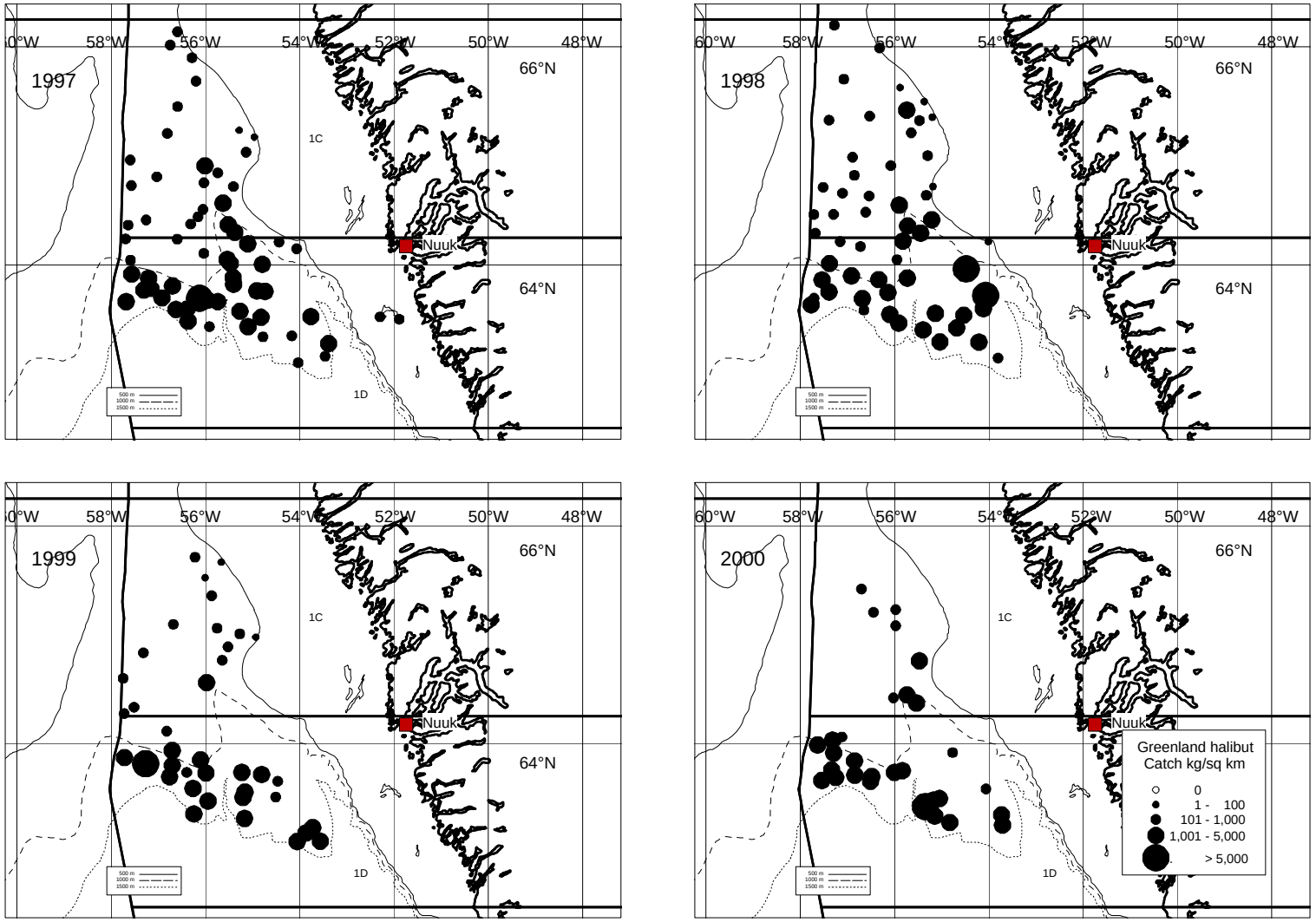

Fig. 1. cont. Distribution of catches of Greenland halibut during 1997-2000 in kg km^{-2}

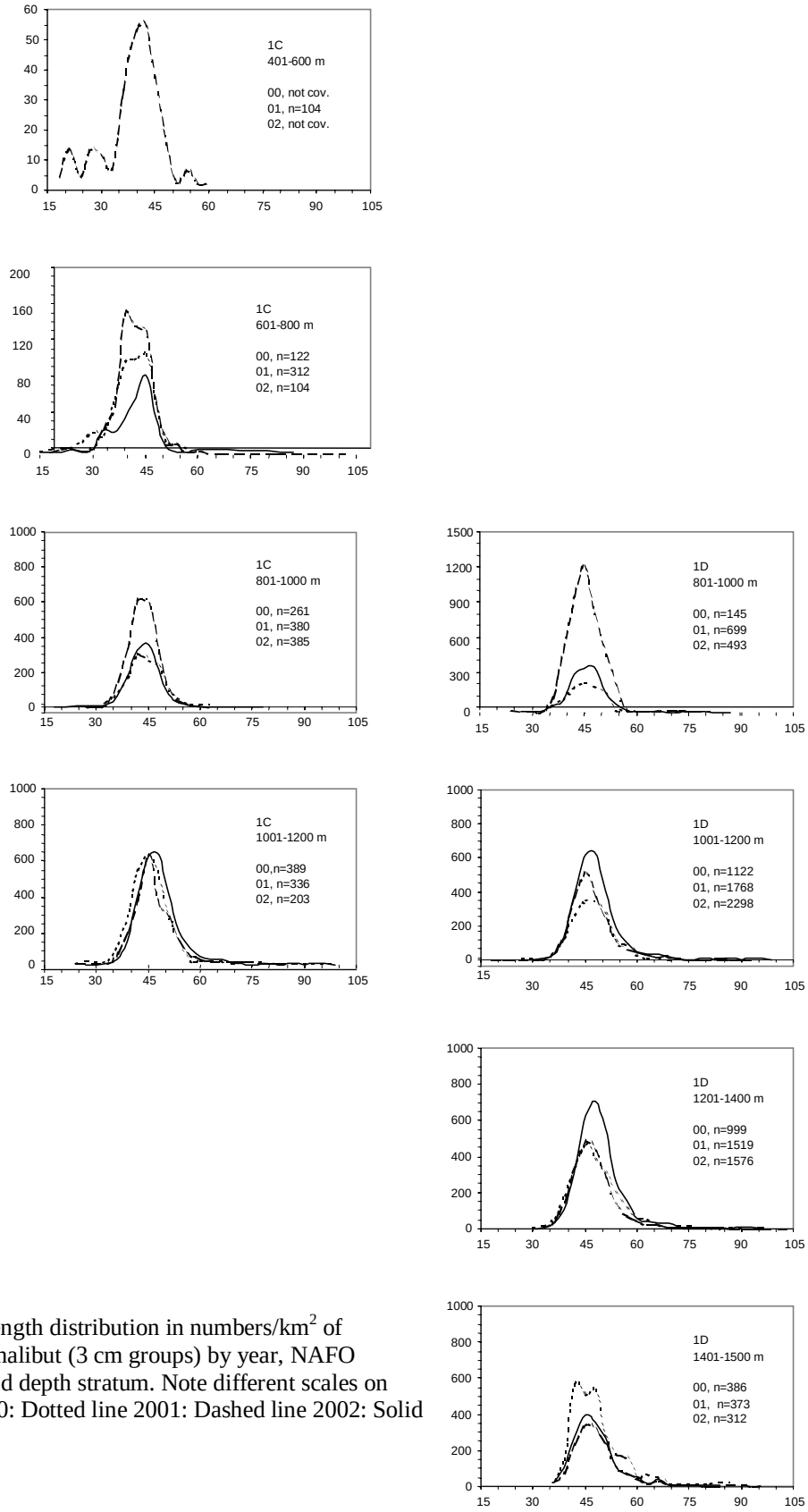

Fig. 2. Length distribution in numbers/km^2 of Greenland halibut (3 cm groups) by year, NAFO Division and depth stratum. Note different scales on y-axis. 2000: Dotted line 2001: Dashed line 2002: Solid line.

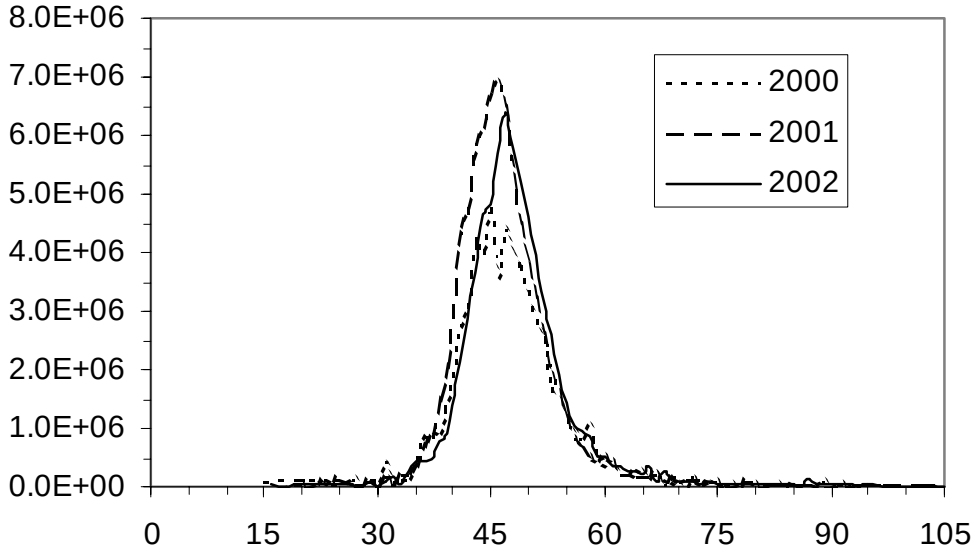

Fig. 3. Overall length distribution of Greenland halibut in numbers (weighted by stratum area) by year.

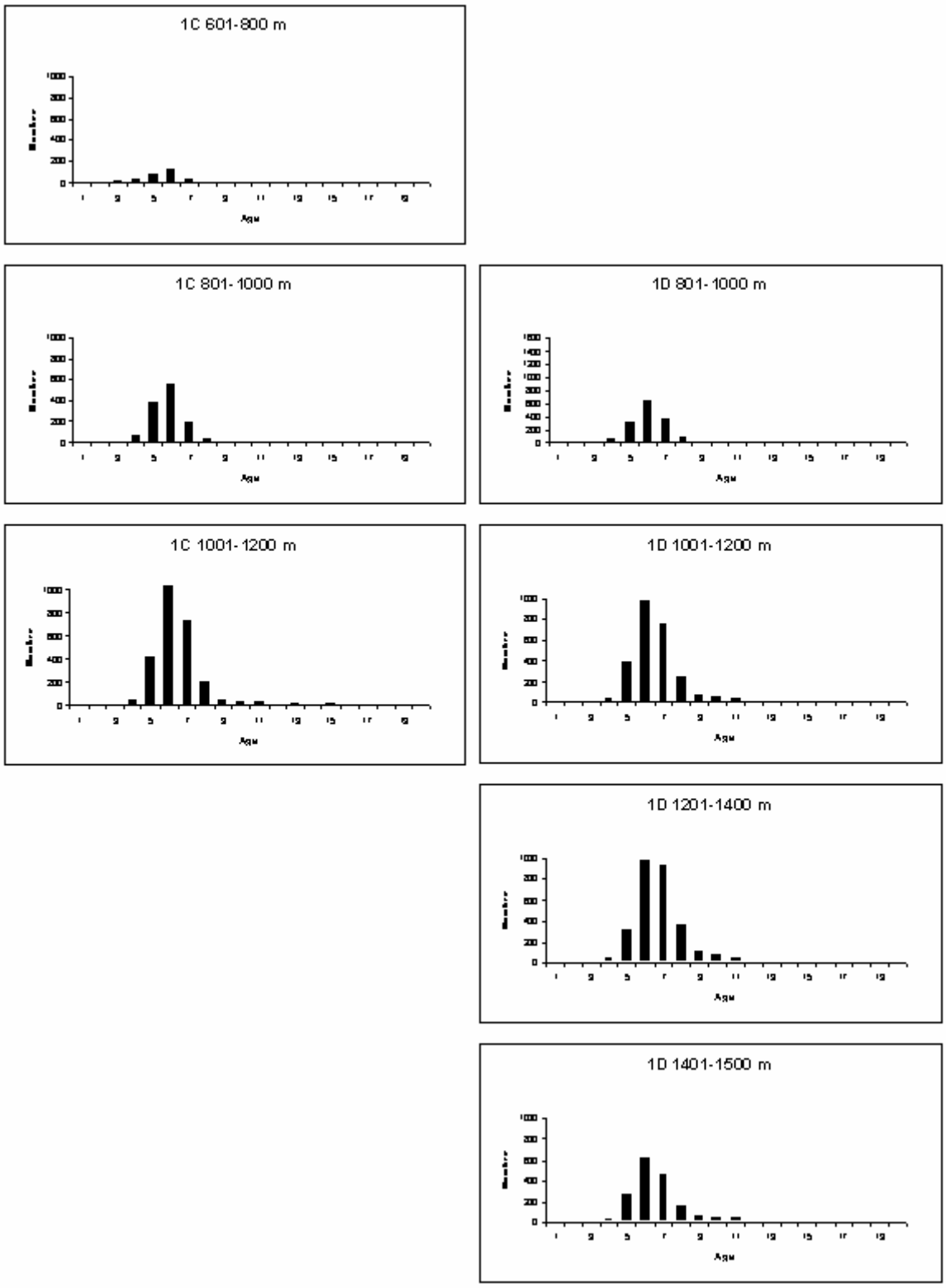

Fig. 4. Age distribution (number km^{-2}) by NAFO Division and depth stratum. Note different scales on y-axis.

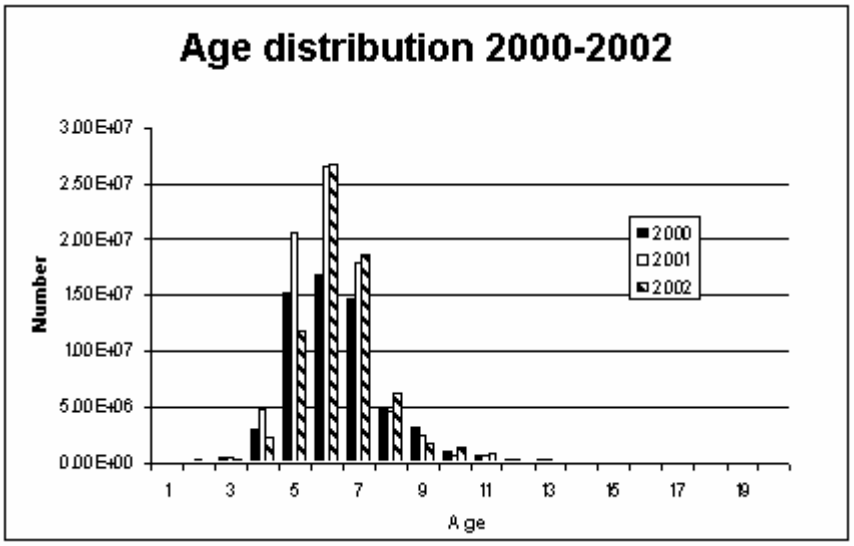

Fig. 5. Overall age distribution (weighted by stratum area) of Greenland halibut in NAFO Div. 1C-1D in 2000 - 2002.

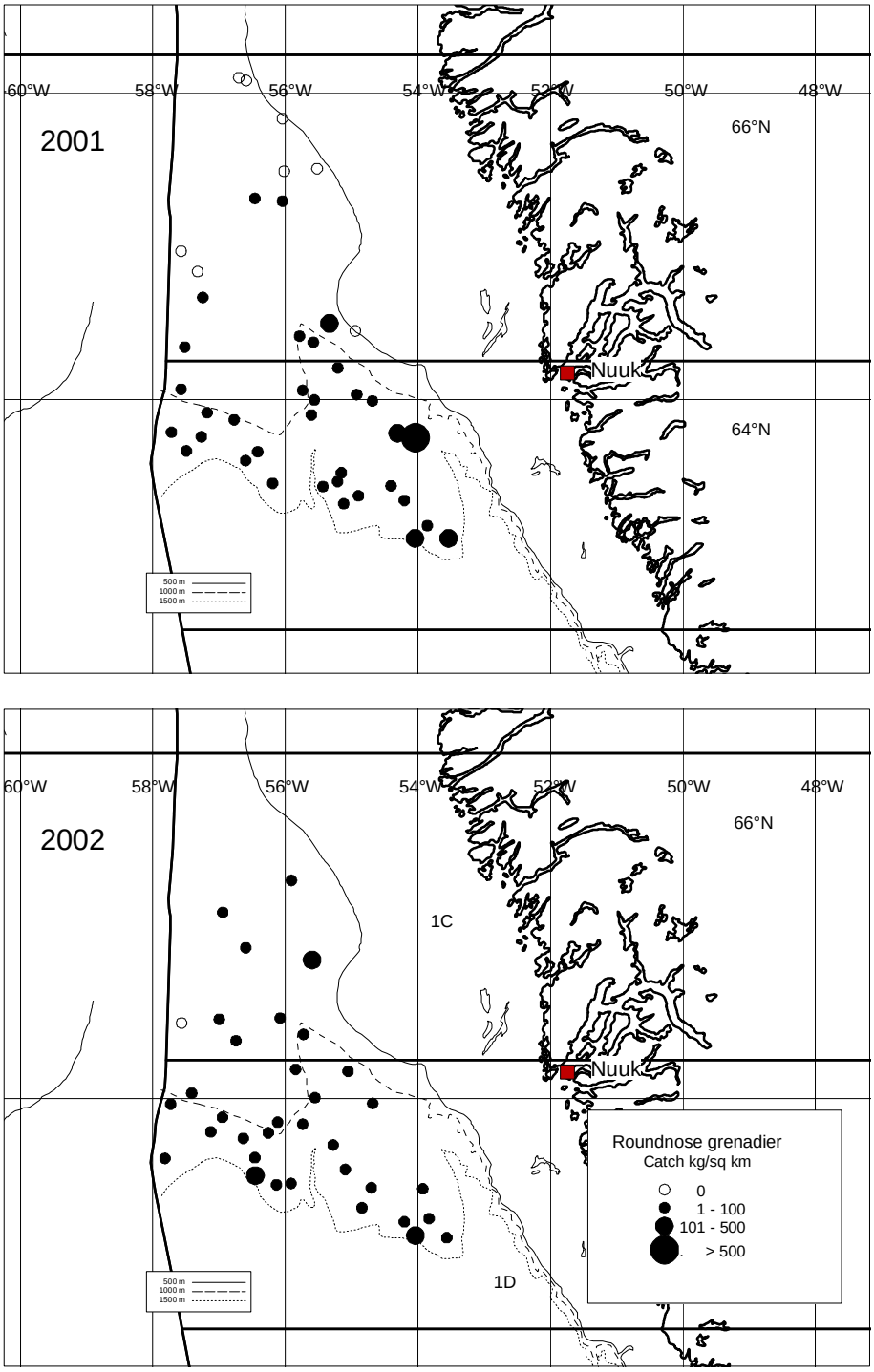

Fig. 6. Distribution of catches of roundnose grenadier in 2001and 2002 in kg km^{-2}.

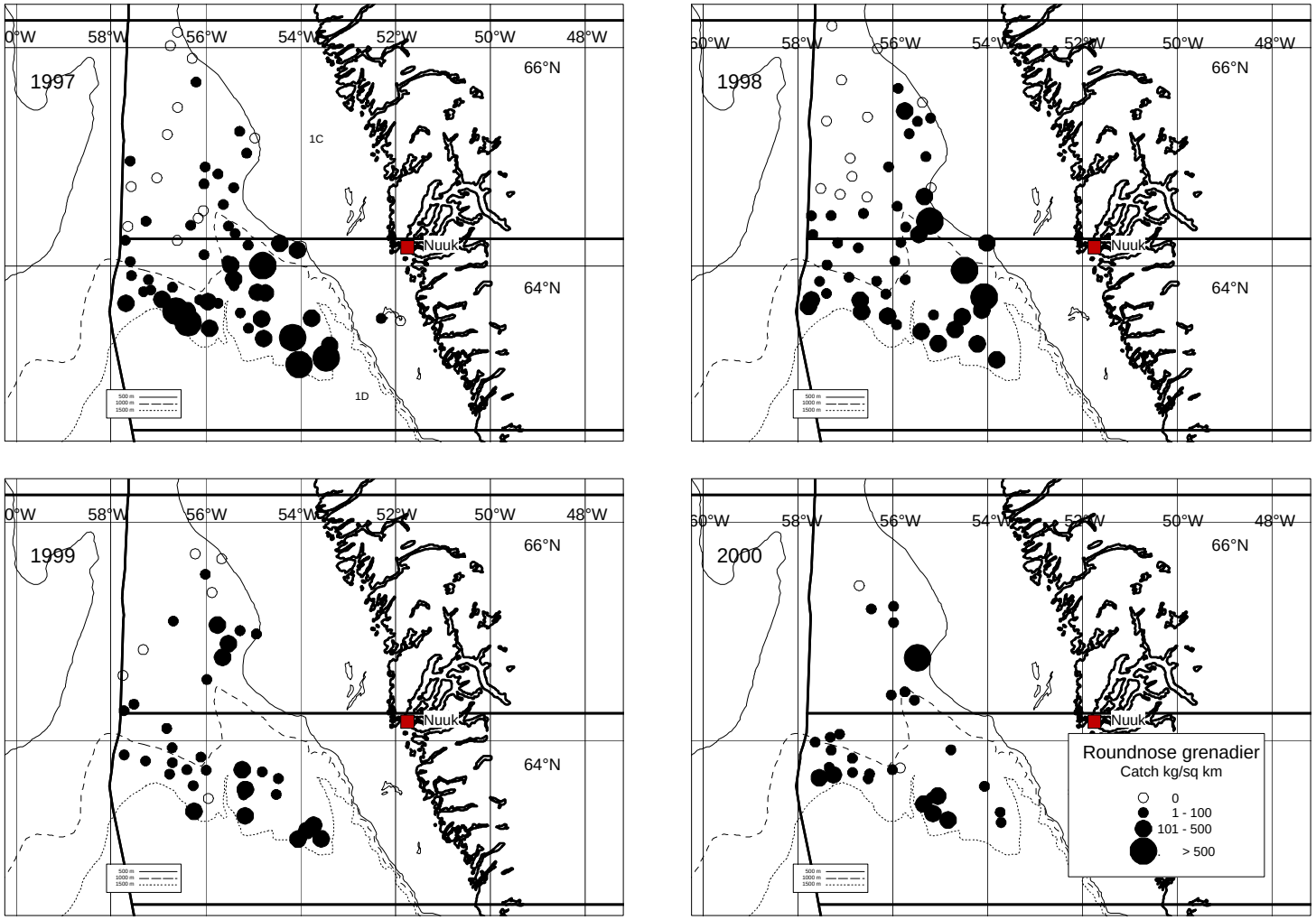

Fig. 6. cont. Distribution of catches of roundnose grenadier during 1997-2000.

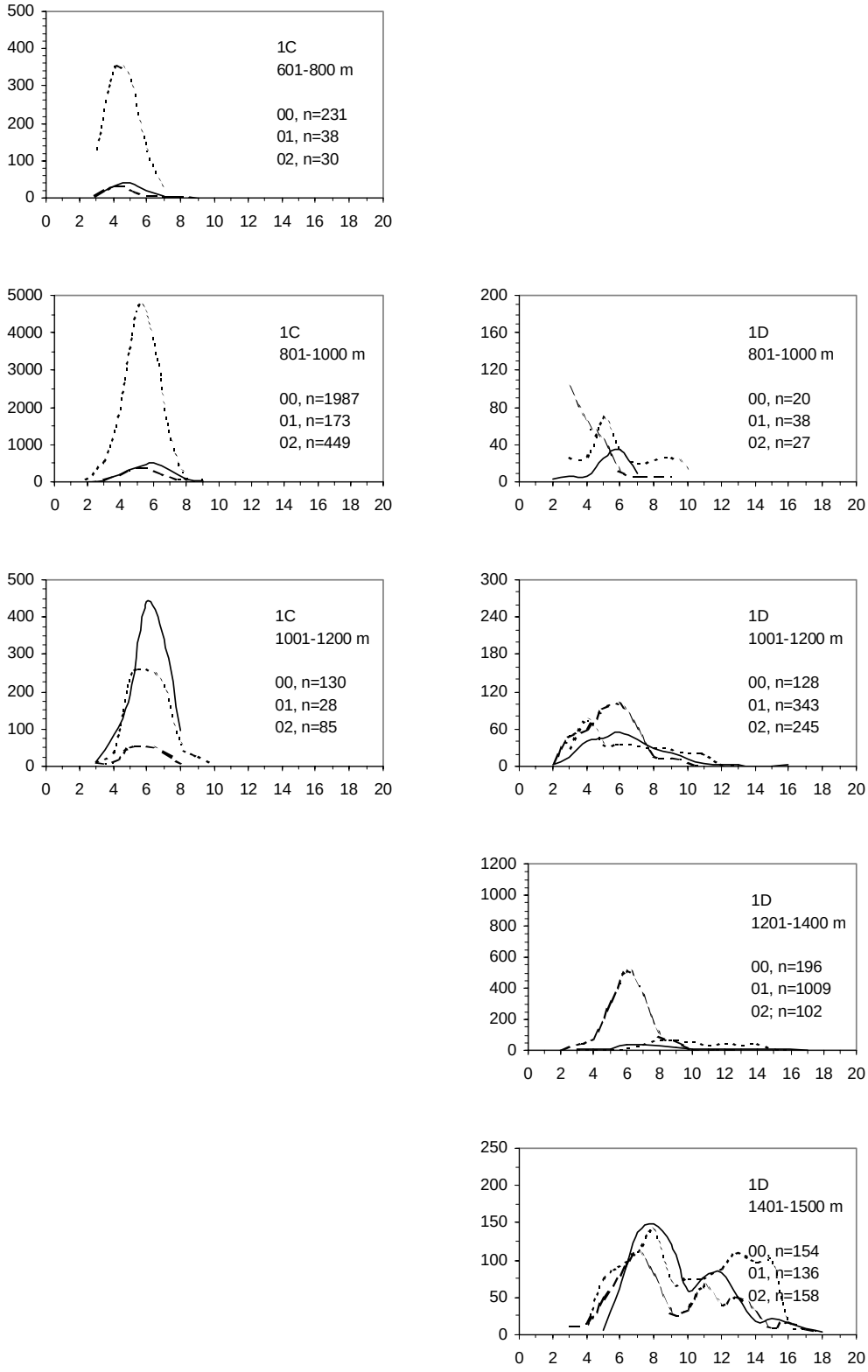

Fig. 7. Length distribution (pre anal fin length) of roundnose grenadier in numbers/km^2 by year and depth strata. Dotted line:2000. Dashed line: 2001. Solid line: 2002.

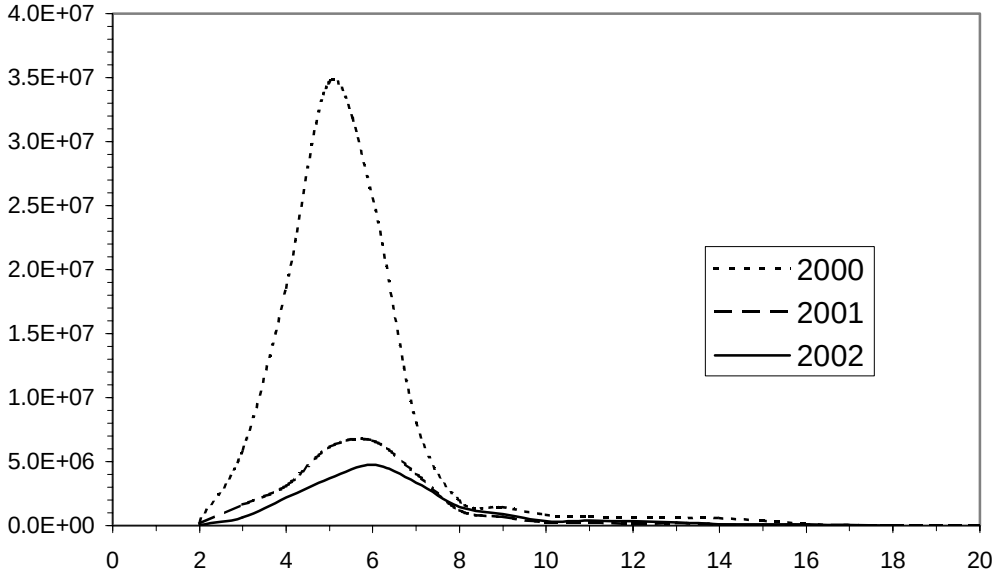

Fig. 8. Overall length distribution of roundnose grenadier (pre anal fin length) in numbers (weighted by stratum area) by year.

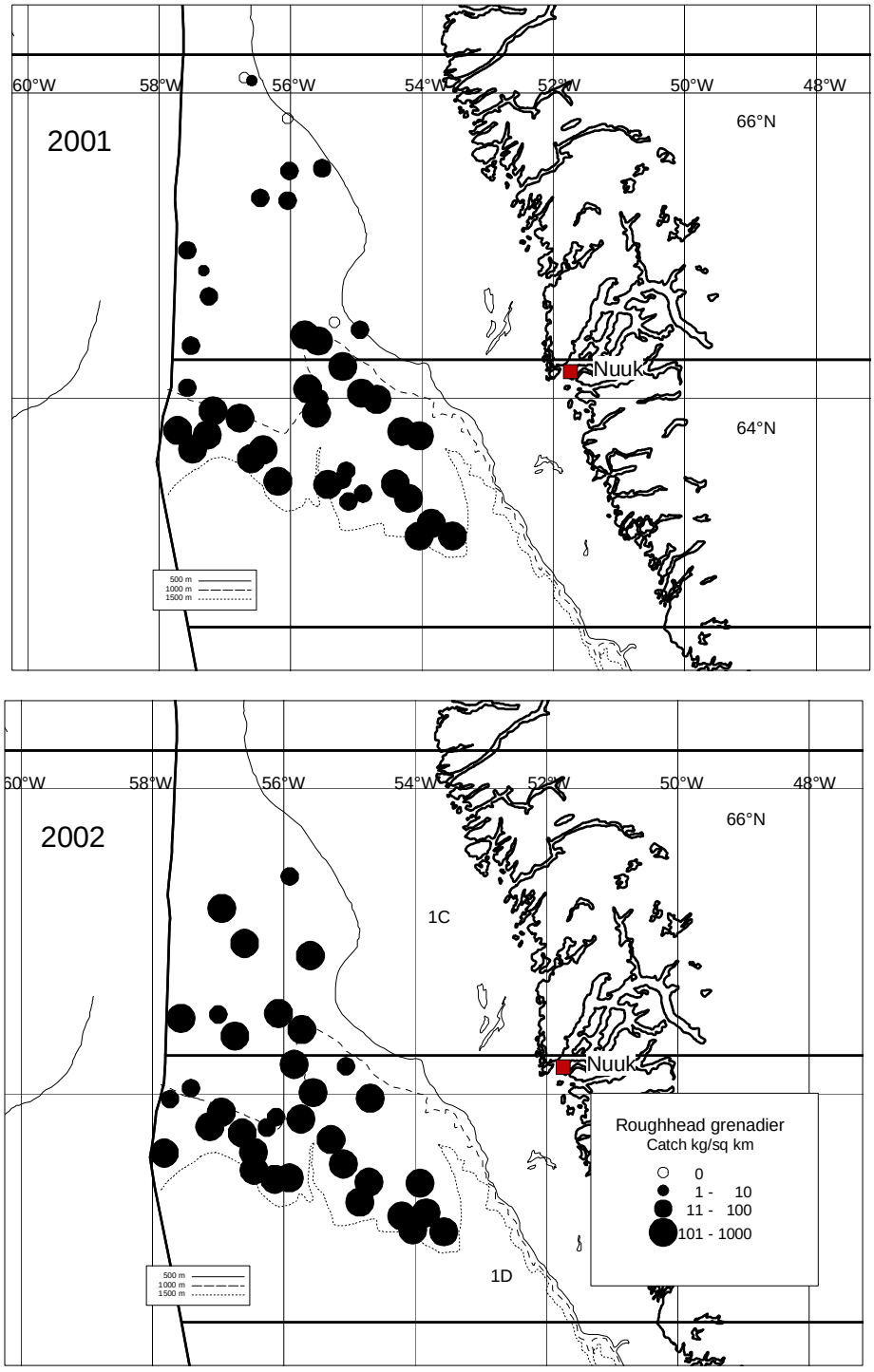

Fig. 9. Distribution of catches of roughhead grenadier in 2001 and 2002 in kg km^{-2}.

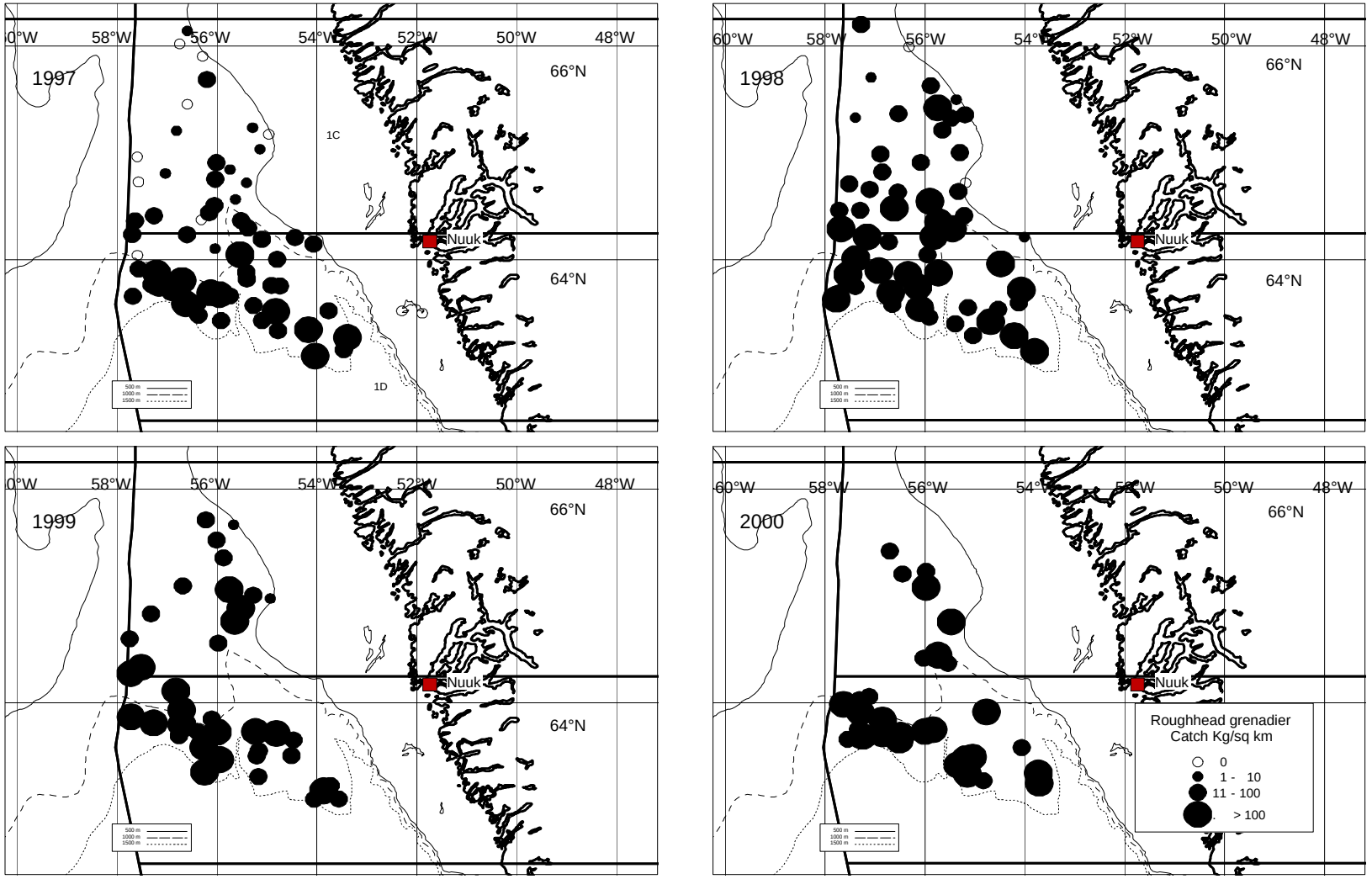

Fig. 9 cont.. Distribution of catches of roughhead grenadier during 1997-2000.

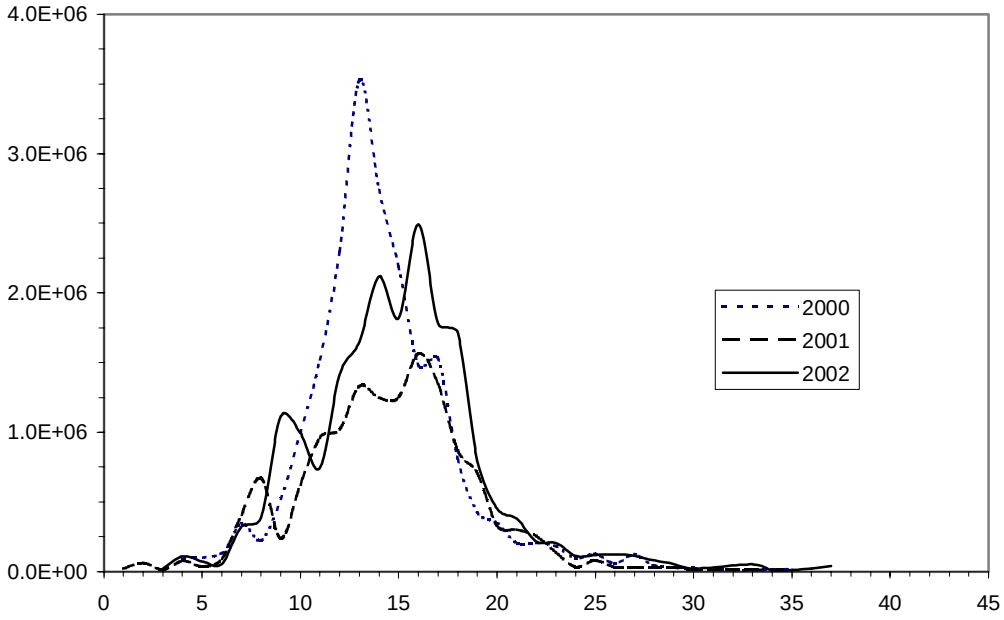

Fig. 10. Overall length distribution (pre anal fin length) of roughhead grenadier in numbers (weighted by stratum area) by year.

Appendix 1. Catch weight and - numbers (not standardised to kg/km^2) of Greenland halibut, roundnose and roughhead grenadier and *Sebastes mentella* 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	Month	Day	Depth	S. AREA	Div.	Duration	Temp.	Number	Weight	Number	Weight	Number	Weight	Number	Weight
1	9	17	865.5	0.0718	1C	30	3.9	68	56.7	420	19.1	30	8.2	0	0.0
2	9	17	748.5	0.0737	1C	30	4.1	1	0.7	20	0.5	19	4.8	4	1.7
3	9	17	637.0	0.0683	1C	30	2.7	14	15.0	3	0.1	39	8.7	5	1.0
4	9	18	683.5	0.0784	1C	30	3.0	49	28.7	2	0.1	34	16.8	11	1.7
5	9	18	831.0	0.0704	1C	30	3.8	99	75.6	0	0.0	25	9.0	1	0.3
6	9	18	826.0	0.0817	1C	30	3.7	47	35.3	4	0.2	20	5.0	0	0.0
7	9	18	773.5	0.0809	1C	30	3.8	40	30.7	5	0.1	43	12.2	4	1.0
8	9	18	926.0	0.0785	1C	30	3.6	171	140.2	25	1.3	21	9.4	1	0.1
9	9	19	975.5	0.0814	1D	30	3.5	109	106.7	9	0.2	28	10.9	0	0.0
10	9	19	1071.0	0.0466	1D	19	3.5	106	108.7	2	0.2	14	4.8	0	0.0
11	9	19	949.0	0.0743	1D	30	3.5	80	75.6	4	0.2	29	6.0	0	0.0
12	9	19	1077.5	0.0757	1D	30	3.5	235	222.1	12	0.6	20	6.5	0	0.0
13	9	19	896.0	0.0771	1D	30	3.6	139	126.1	11	0.3	29	13.0	1	0.1
14	9	20	956.5	0.0809	1D	30	3.7	165	142.0	3	0.2	13	6.6	1	0.3
15	9	20	1057.0	0.0733	1D	30	3.2	188	156.9	12	1.7	7	4.9	0	0.0
16	9	20	1481.0	0.0592	1D	30	3.3	200	183.3	18	3.9	39	16.7	1	0.2
17	9	20	1308.5	0.0763	1D	30	3.4	286	336.7	5	0.4	32	12.8	1	0.3
18	9	20	1109.5	0.0806	1D	30	3.5	271	255.0	9	0.9	30	20.2	0	0.0
19	9	20	1365.0	0.0722	1D	30	3.3	236	234.7	20	3.7	35	18.9	0	0.0
20	9	20	1490.0	0.0540	1D	25	3.2	75	83.6	63	13.9	46	33.8	0	0.0
21	9	20	1229.0	0.0756	1D	30	3.5	260	259.3	27	6.2	25	25.7	0	0.0
22	9	20	1194.5	0.0516	1D	20	3.4	88	111.8	3	0.3	21	8.9	0	0.0
23	9	21	1135.0	0.0674	1D	30	3.5	139	155.3	19	1.0	70	23.0	0	0.0
24	9	21	1266.5	0.0861	1D	30	3.5	218	244.8	2	0.7	29	16.6	0	0.0
25	9	21	1141.5	0.0763	1D	30	3.5	364	412.0	16	1.6	22	12.3	0	0.0
26	9	21	1144.5	0.0707	1D	30	3.5	265	264.0	36	5.4	44	15.5	0	0.0
27	9	22	1284.5	0.0771	1D	30	3.4	180	225.8	10	0.6	23	15.6	0	0.0
28	9	22	1419.0	0.0785	1D	30	3.4	37	64.2	77	22.2	24	10.6	0	0.0
29	9	22	1266.5	0.0752	1D	30	3.5	217	205.3	20	3.7	33	14.5	0	0.0
30	9	22	1274.5	0.0756	1D	30	3.5	179	217.4	18	1.7	41	26.9	0	0.0
31	9	22	1174.0	0.0709	1D	30	3.5	97	110.8	26	1.8	31	19.3	0	0.0
32	9	22	1053.5	0.0736	1D	30	3.4	207	266.6	35	2.6	69	23.1	0	0.0
33	9	23	1143.5	0.0782	1D	30	3.5	181	204.4	39	3.4	20	14.1	0	0.0
34	9	23	1108.5	0.0837	1D	30	3.4	157	197.8	36	1.7	16	4.2	0	0.0
35	9	23	1054.5	0.0729	1C	30	3.7	203	208.7	85	4.5	49	20.0	0	0.0

Appendix 2. List of species and groups of species recorded in Div. 1C-D in 2002 with observed minimum and maximum catch weight (kg), minimum and maximum number, minimum and maximum length (cm), minimum and maximum depth(m)and minimum and maximum bottom temperature (°C), respectively (Weight < 50 g given as 0.0 kg).

Obs	ART	species	min wgt	max wgt	min no	max no	min length	max length	min depth	max depth	min temp	max temp
1	ALA	Alepocephalus agassizzi	0.4	587.2	1	482	17.0	68.0	1194.5	1490.0	3.2	3.5
2	CAD	Anarhichas denticulatus	0.8	17.4	1	2	44.0	113.0	831.0	1481.0	3.3	3.8
3	ANC	Anopologaster cornuta	0.1	0.1	1	1	13.0	14.0	926.0	1135.0	3.5	3.6
4	ANT	Antimora rostrata	0.0	26.7	1	84	14.0	66.0	637.0	1490.0	2.7	4.1
5	ARZ	Arctozenius rissoi	0.0	0.0	1	1	28.0	28.0	1077.5	1077.5	3.5	3.5
6	BAM	Bajacalifornia megalops	0.0	0.4	1	1	20.0	42.0	1057.0	1490.0	3.2	3.5
7	BAT	Bathylagus euryops	0.0	3.2	1	83	9.0	24.0	637.0	1490.0	2.7	3.9
8	BEG	Benthosema glaciale	0.0	0.0	1	15	2.0	2.0	637.0	1481.0	2.7	4.1
9	BOA	Borostomias antarctica	0.0	3.1	1	3	12.0	68.0	637.0	1490.0	2.7	3.8
10	CAG	Caristidae	0.3	0.3	1	1	24.0	24.0	1266.5	1266.5	3.5	3.5
11	CFB	Centroscyllium fabricii	0.0	44.1	1	51	29.0	84.0	748.5	1481.0	3.2	4.1
12	CHA	Chauliodus sloani	0.0	0.1	1	3	21.0	30.0	926.0	1481.0	3.2	3.7
13	CHN	Chiasmodon niger	0.0	0.6	1	5	13.0	25.0	773.5	1490.0	3.2	3.9
14	CBB	Coryphaenoides brevibarbis	0.0	0.0	1	4	3.0	8.0	1071.0	1490.0	3.2	3.5
15	CGR	Coryphaenoides guntheri	0.0	9.0	1	54	3.5	15.0	975.5	1490.0	3.2	3.5
16	RNG	Coryphaenoides rupestris	0.1	22.2	2	420	2.5	18.0	637.0	1490.0	2.7	4.1
17	COM	Cottunculus microps	0.0	0.3	2	4	5.0	18.0	637.0	683.5	2.7	3.0
18	COT	Cottunculus thomsonii	0.1	1.2	1	3	19.0	47.0	683.5	1274.5	3.0	4.1
19	LUM	Cyclopterus lumpus	0.0	0.7	1	8	25.0	25.0	683.5	1141.5	3.0	3.5
20	CLM	Cyclothone microdon	0.0	0.0	1	21	.	.	773.5	1490.0	3.2	3.8
21	EUR	Eurypharynx pelecanoides	0.0	0.3	1	2	44.0	62.0	826.0	1481.0	3.3	3.7
22	WIT	Glyptocephalus cynoglossus	0.3	1.0	1	2	33.0	43.0	637.0	831.0	2.7	3.8
23	GOB	Gonostoma bathyphilum	0.0	0.1	1	3	10.0	19.0	773.5	1490.0	3.2	3.8
24	PLA	Hippoglossoides platessoides	0.1	0.3	1	2	18.0	33.0	637.0	865.5	2.7	4.1
25	HOA	Holtbyrnia anomala	0.0	0.2	1	2	10.0	23.0	865.5	1490.0	3.2	3.9
26	HAF	Hydrolagus affinis	19.4	44.3	1	6	121.0	141.0	1419.0	1490.0	3.2	3.4
27	LMC	Lampanyctus macdonaldi	0.0	2.8	3	177	.	.	637.0	1490.0	2.7	4.1
28	LEP	Lepedion eques	0.0	0.0	1	1	.	.	1109.5	1109.5	3.5	3.5
29	LIF	Liparis fabricii	0.1	0.3	1	9	.	.	637.0	773.5	2.7	3.8
30	KCT	Lithodes maja	0.8	1.7	1	1	.	.	831.0	1365.0	3.3	3.8
31	LYS	Lycenchelys sarsi	0.0	0.0	1	1	28.0	28.0	926.0	926.0	3.6	3.6
32	LYE	Lycodes esmarki	0.3	0.3	1	1	38.0	38.0	748.5	748.5	4.1	4.1
33	LYN	Lycodes eudipleurostictus	0.2	0.2	2	2	25.0	28.0	637.0	637.0	2.7	2.7
34	LYM	Lycodes mirabilis	0.0	0.1	1	30	18.0	38.0	773.5	1143.5	3.5	3.8
35	ELZ	Lycodes sp.	0.3	0.3	1	1	42.0	42.0	1365.0	1365.0	3.3	3.3
36	RHG	Macrourus berglax	4.2	33.8	7	70	3.0	37.0	637.0	1490.0	2.7	4.1
37	MAL	Malacosteus niger	0.0	0.1	1	2	14.0	18.0	1057.0	1144.5	3.2	3.5
38	MEJ	Melanocetus johnsoni	0.1	0.5	1	1	16.0	16.0	683.5	1143.5	3.0	3.5
39	MYI	Myxine ios	0.1	0.1	1	1	40.0	40.0	826.0	826.0	3.7	3.7
40	NEM	Nemichthys scolopaceus	0.1	0.1	1	1	12.5	12.5	1053.5	1053.5	3.4	3.4
41	NEG	Neolithodes grimaldi	1.0	5.5	1	2	.	.	1053.5	1481.0	3.3	3.5
42	NZB	Nezumia bairdi	0.1	0.7	1	10	7.5	9.5	773.5	1109.5	3.2	3.8
43	NOT	Notacanthus chemnitzii	0.1	8.4	1	68	30.0	110.0	773.5	1490.0	3.2	3.9
44	OCT	Octopus	0.1	20.7	1	12	.	.	637.0	1490.0	2.7	3.8
45	OND	Oneirodes sp.	0.1	0.1	1	1	.	.	1481.0	1481.0	3.3	3.3
46	ONE	Oneiroides eschrichti	0.0	0.0	1	1	13.0	13.0	826.0	826.0	3.7	3.7
47	ONA	Onogadus argentatus	0.0	0.0	1	9	1.0	9.0	773.5	1077.5	3.5	3.9
48	ONN	Onogadus ensis	0.2	5.2	1	38	4.0	45.0	748.5	1490.0	3.2	4.1
49	PAB	Paraliparis bathybius	0.0	0.0	1	1	.	.	1109.5	1109.5	3.5	3.5
50	PAC	Paraliparis copei	0.0	0.0	1	1	3.0	13.0	1308.5	1490.0	3.2	3.4
51	PAG	Paraliparis garmani	0.0	0.0	1	1	9.0	9.0	637.0	926.0	2.7	4.1
52	PAR	Paralipidae	0.0	0.0	1	1	.	.	1229.0	1229.0	3.5	3.5
53	POL	Polyacanthonotus rissoanus	0.2	0.4	1	53	43.0	52.0	1194.5	1490.0	3.2	3.5
54	POR	Poromitra crassiceps	0.0	0.0	1	1	13.0	13.0	1141.5	1141.5	3.5	3.5
55	RBT	Raja bathyphila	0.2	25.0	1	1	37.0	156.0	831.0	1365.0	3.3	3.8

Appendix 2. (continued)

Obs	ART	species	min wgt	max wgt	min no	max no	min len	max len	min dep	max dep	min temp	max temp
56	RFL	Raja fyllae	0.3	0.6	1	2	32.0	48.0	748.5	1053.5	3.4	4.1
57	GHL	Reinhardtius hippoglossoides	0.7	412.0	1	364	2.2	105.0	637.0	1490.0	2.7	4.1
58	SCO	Scopelosarus lepidus	0.1	0.6	1	4	27.0	39.0	831.0	1419.0	3.2	3.8
59	REB	Sebastes mentella	0.1	1.7	1	11	18.0	34.0	637.0	1481.0	2.7	4.1
60	RED	Sebastes sp.	0.0	0.0	1	1	6.0	6.0	1054.5	1054.5	3.7	3.7
61	SSI	Serasidae	0.0	0.0	0	1	14.0	14.0	773.5	1229.0	3.5	3.8
62	SER	Serrivomer beani	0.0	0.4	1	4	21.0	78.0	773.5	1490.0	3.2	3.8
63	SQT	Squit	0.0	0.6	1	11	.	.	748.5	1481.0	3.2	4.1
64	STO	Stomias boa	0.0	0.1	1	23	17.0	31.0	773.5	1284.5	3.4	3.8
65	SYN	Synapobranchus kaupi	0.0	4.8	1	33	21.0	70.0	637.0	1481.0	2.7	3.8
66	TRA	Trachyrynchus murrayi	0.1	1.5	1	3	10.5	21.5	896.0	1274.5	3.4	3.6