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Survey for Greenland Halibut in NAFO Divisions 1C-1D, 2004

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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 75 900 in 2004 compared to 68 700 tons in 2003. The biomass of roundnose grenadier was estimated as 633 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 (see paper presented at this meeting)

Materials and Methods

The survey in 2004 covered 1CD and took place during 28/10-5/11.

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. 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 previously. 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 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 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 = 372) 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 51 successful hauls were made, giving a mean coverage of the surveyed area on 1 008 km^2 per haul (Table 1). The number of tows was reduced compared to the 70 planned mainly due to bad weather. One stratum: 1D 401-600 (903 km^2) was not covered. Haul by haul information on catches, position, depth, temperature, etc. is given in Appendix 1.

In total 75 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 75 869 tons (S.E. 5 186.3) (Table 2) which was a slight increase compared to 68 717.2 tons (S.E. 6 411.9) in 2003. Generally the biomass

increased in all strata except in the two deep strata in Div. 1D where the biomass showed a decreased compared to 2003. The estimate from 2004 is not statistically different (95% level) from the estimates from 1997-2003. (Jørgensen, 2004; 2003; 2002; 2001; 2000; 1999 and 1998b). The weighted mean catch per tow also showed an insignificant increase and was in 2004 a little above average for the time series (Fig 2.).

Biomass of Greenland halibut in Div. 1CD.

Year	1997	1998	1999	2000	2001	2002	2003	2004
Biomass	56 260.2	70 473.5	64 398.0	59 092.4	77 554.0	71932.4	68 717.2	75 869.4
S.E.	4 399.6	8 391.7	6 912.1	5 543.3	13 013.6	5 613.9	6 411.9	5 186.3

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

Year	1997	1998	1999	2000	2001	2002	2003	2004
Mean	1.07	1.34	1.27	1.28	1.57	1.56	1.39	1.48
S.E.	0.08	0.16	0.14	0.11	0.26	0.12	0.13	0.10

The abundance in Div. 1CD was estimated at $74.859*10^6$ (S.E. $5.445*10^6$) (Table 3) compared to $72.556*10^6$ (S.E. $7.764*10^6$) in 2003. There were only seen minor changes in the distribution between strata between 2003 and 2004, but there was a tendency towards an increase in abundance in Div. 1C and a decrease in the deeper part of Div. 1D.

Abundance of Greenland halibut in Div. 1CD.

Year	1997	1998	1999	2000	2001	2002	2003	2004
Abundance ($*10^6$)	53.613	67.677	61.366	61.710	80.814	71.510	72 556	74.859
S.E.	4.118	7.687	6.265	5.976	14.221	6.223	7.764	5.445

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

The length ranged from 14 cm to 103 cm. 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. 3) as seen in previous surveys (Jørgensen, 1997b). The overall length distribution (weighted by stratum area) was totally dominated by a mode at 48 cm as in 2003 while the mode was at 47 cm in 2002 (Fig. 4).

The age ranged from 1 to 19 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 as seen in previous years (Fig. 6). Mean weight - and length at age is given in Table 5.

Females stated maturing at age 7 and 100% maturity was reached at age 11 (Table 6).

Roundnose grenadier (*Coryphaenoides rupestris*)

Roundnose grenadier was caught in almost all hauls, but the catches were very small (Appendix 1, Fig. 7) and the biomass was estimated at 633.0 tons (S.E. 98.2) compared to 774.2 tons (S.E. 144.0) in 2003. The estimate is the lowest in the present survey series and the biomass is hence still very low compared to the late-1980s (Jørgensen, 2004; 2003; 2002; 2001; 2000; 1999; 1998a and 1998b).

Biomass of roundnose grenadier in Div. 1CD.

Year	1997	1998	1999	2000	2001	2002	2003	2004
Biomass	5 686.5	7 263.3	2 771.8	5 593.7	1 577.2	1 593.1	774.2	633.0
S.E.	926.4	2 530.2	445.5	2 616.8	516.4	462.7	144.0	98.2

Most of the biomass was found in Div. 1D at 1001-1500 m (Table 7).

The abundance in Div. 1C-1D was estimated at 10.564*10^6) S.E. 2.534*10^6 compared to 6.900*10^6 in 2003. The highest densities were found in Div. 1C 801-1 000 m where also almost half of the total abundance was located (Table 8)

Abundance of roundnose grenadier in Div. 1CD.

Year	1997	1998	1999	2000	2001	2002	2003	2004
Abundance (*10^6)	32.441	75.243	29.100	99.52	24.698	18.610	6.900	10.564
S.E. (10*^{6})	7.056	27.357	8.963	67.31	8.797	8.910	1.272	2.534

Pre anal fin length ranged from 3 to cm 18 cm. Fish size generally increased with increasing depth (Fig. 8). The overall length distribution (weighted by stratum area) was totally dominated by a mode at 5 cm (Fig. 9).

Roughhead grenadier (*Macrourus berglax*)

Roughead grenadier was caught in all hauls, but the catches were generally low. The biomass of roughhead grenadier was estimated at 4314.3 (S.E. 452.6) (Table 9, Fig. 10, Appendix 1) which is a decrease compared 2002 and 2003 and the 2004 estimate is below average for the time series (1997-2004)

Biomass of roughhead grenadier in Div. 1CD.

Year	1997	1998	1999	2000	2001	2002	2003	2004
Biomass	2 258.6	4 314.1	5 166.2	7 178.1	4 576.6	7 907.6	5 657.5	4 314.3
S.E.	250.1	377.9	854.1	2 226.5	456.3	823.6	700.8	452.6

The highest densities were found between at depths > 1201 m in Div. 1D and largest biomass was found in Div. 1D 1001 1-200 m (Table 9).

The total abundance was estimated at 11.164*10^6 (Table 10) which is a decrease compared to 15.366*10^6 (S.E. 2.573*10^6) in 2003 and the second lowest in the time series

Abundance of roughhead grenadier in Div. 1CD.

Year	1997	1998	1999	2000	2001	2002	2003	2004
Abundance (*10^6)	4.60	11.623	14.074	20.282	13.867	19.620	15.366	11.164
S.E. (*10^6)	0.45	1.008	2.040	7.182	1.549	1.755	2.573	1.323

Pre anal fin length ranged from 2 to cm 37 cm and the over all length distribution was dominated by modes at 13 and 16 cm. (Fig. 11).

Deep-sea redfish (*Sebastes mentella*)

Deep-sea redfish was caught in 11 of the 51 valid hauls, but the catches were very low, <5 kg, except in one haul (59.2 kg). The biomass was estimated at 2 329.1 which is a minor increase from 1 493 tons in 2003. As in previous years almost all the biomass was found at 401-600 m in Div. 1C. The estimate in this area was however, based on one haul only (Appendix 1).

Biomass of deep sea redfish.

Year	1997	1998	1999	2000[1)]	2001	2002[1)]	2003	2004
Biomass	2 464.3	2 408.1	2 484.9		2 063.4		1 493.4	2 329.1
S.E.	787.1	503.9	1 007.7		873.5		684.5	1 986.8

1). Poor coverage of relevant depths.

Abundance of deep sea redfish.

Year	1997	1998	1999	2000[1)]	2001	2002[1)]	2003	2004
Abundance $*10^6$	14.690	18.827	12.926		16.337		7.131	13.338
S.E.	5.500	4.496	4.093		6.474		3.079	11.314

1). Poor coverage of relevant depths.

The length ranged from 15 to 36 cm with modes at 21, 23 and 25 cm (Fig. 12)

Temperature

The bottom temperature ranged fro 2.8 to 5.0 °C and the mean temperature was generally decreasing by depth (Table 11).

References

Jørgensen, O A. 1997b. Movement patterns of Greenland halibut, *Reinhardtius hippoglossoides* (Walbaum.) at West Greenland, as inferred from Trawl Survey Distribution and Size Data.. *J. Northw. Atl. Fish. Sci*.; **21**:23-37.

Jørgensen, O A. 1997a. Pelagic occurrence of Greenland halibut, *Reinhardtius hippoglossoides* (Walbaum) in West Greenland waters. *J. Northw. Atl. Fish. Sci*.; **21**:39-50.

Jørgensen O. A. 1998a. Results of the Joint Japan Greenland Trawl Surveys at West Greenland 1987-1995 on Greenland Halibut (*Reinhardtius hippoglossoides*) and Roundnose Grenadier (*Coryphaenoides rupestris*). *NAFO Sci. Council Studies* No 31. 21-56.

Jørgensen O.A. 1998b. Survey for Greenland Halibut in NAFO Division 1C-1D. NAFO SCR Doc. 98/25. Serial No. N3010, 26 pp.

Jørgensen O.A. 1999. Survey for Greenland Halibut in NAFO Division 1C-1D, 1998. NAFO SCR Doc. 99/30. Serial No. N4086, 25 pp.

Jørgensen O.A. 2000. Survey for Greenland Halibut in NAFO Division 1C-1D, 1999. NAFO SCR Doc. 00/10. Serial No. N4232, 26 pp.

Jørgensen O.A. 2001. Survey for Greenland Halibut in NAFO Division 1C-1D, 2000. NAFO SCR Doc. 01/23. Serial No. N4392, 23 pp.

Jørgensen O.A. 2002. Survey for Greenland Halibut in NAFO Division 1A-1D, 2001. NAFO SCR Doc. 02/30. Serial No. N4637, 31 pp.

Jørgensen O.A. 2003. Survey for Greenland Halibut in NAFO Division 1C-1D, 2002. NAFO SCR Doc. 03/20. Serial No. N4829, 27 pp.

Jørgensen O.A. 2004. Survey for Greenland Halibut in NAFO Division 1C-1D, 2003. NAFO SCR Doc. 04/19. Serial No. N4967, 26 pp.

Kingsley, M.C.S., P. Kanneworff and D.M. Carlsson. 2004. Buffered random sampling: a sequential inhibited spatial point process applied to sampling in trawl survey for northern shrimp *Pandalus borealis* in West Greenland waters. ICES J. Mar. Sci. 61:12-24.

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 (2) 1	16120 (7) 5	6066 (10) 10	611 (2) 2	-	-	26163 (21) 18
1D	903 (2) 0	1940 (2) 3	3874 (4) 3	10140 (18) 11	6195 (17)12	3091 (6) 4	26143 (49) 33
Tot	4269 (4) 1	18060 (9) 8	9940 (14)13	10751 (20) 13	6195 (17)12	3091 (6) 4	52306 (70) 51

Table 2. Biomass (tons) of Greenland halibut by Division and depth stratum, 2004.

Division	Depth (m)	Area	Hauls	Mean sq/km	Biomass	SE
1C	401-600	3366	1	0.0575	193.6	.
	601-800	16120	5	0.5424	8743.4	1697.2
	801-1000	6066	10	2.1531	13060.7	3281.7
	1001-1200	611	2	4.5652	2789.3	310.4
1D	601-800	1940	3	0.4894	949.4	514.7
	801-1000	3874	3	1.5672	6071.5	1215.5
	1001-1200	10140	11	2.5149	25501.4	2829.4
	1201-1400	6195	12	2.1803	13506.8	1398.1
	1401-1500	3091	4	1.6348	5053.3	1187.6
All				1.4759	75869.4	5186.3

Table 3. Abundance of Greenland halibut by Division and depth stratum, 2004.

Division	Depth (m)	Area	Hauls	Mean sq/km	Abundance	SE
1C	401-600	3366	1	49.8	167652.7	.
	601-800	16120	5	662.5	10680118.5	1864391.2
	801-1000	6066	10	2322.1	14085923	3582470
	1001-1200	611	2	4116.9	2515409.8	419470.2
1D	601-800	1940	3	475.8	923103.1	361239
	801-1000	3874	3	1701.1	6590131.5	1022552.5
	1001-1200	10140	11	2217	22480504.7	2662873.2
	1201-1400	6195	12	2070.7	12827764	1681487.1
	1401-1500	3091	4	1484.3	4588003.9	1429880.3
All				1456.3	74858611.3	5445462.89

Table 4. Estimated abundance by age from Div. 1C-1D from the surveys in 1997-2003. The Age-length key from 1998 is applied on the 1997 data.

AGE	1997	1998	1999	2000	2001	2002	2003	2004
1	0	0	0	78825.87	15585.4751	71512.0069	833451.55	314357.93
2	536130	609093	184098	109495.741	281013.097	214536.021	3187890.35	255510.648
3	1704893	3722237	920490	479059.231	511722.04	285366.961	1468105.48	274564.102
4	3023773	4662948	4172888	3074340.67	4835796.05	2361529.23	2417000.54	4465950.06
5	9961295	14760362	11291344	15090231.1	20601616.2	11779875.8	12348566.9	14877198.2
6	15370847	19057854	15893794	16838191.5	26595602.8	26697299.7	21816458.1	30067732
7	13558728	14083592	19759852	14711646.2	17922783.8	18561064.7	18499540.5	14298141.8
8	5436358	5766084	4786548	5026105.86	4674899.01	6201986.51	6534965.54	6252193.86
9	1200931	1515966	859124	3214207.72	2550178.16	1857799.2	2403541.86	1724258.96
10	948950	1211419	920490	1040151.56	780081.724	1340260.74	1244102.3	944765.961
11	584382	764751	613660	717769.971	705655.7	905723.5	581491.491	392534.283
12	466433	527881	675026	350292.285	369836.044	166242.198	224915.327	230819.759
13	187646	351921	429562	318336.426	345397.059	257412.267	264203.081	158686.713
14	96503	155657	429562	122157.05	195606.944	143024.014	207744.6	163836.261
15	262704	236870	184098	230208.418	225276.682	263139.419	67269.68	218713.051
16	187646	115051	61366	128241.854	91539.7399	178780.017	206590.463	71775.18
17	64336	128586	61366	95351.6445	80274.8173	107268.01	72545.7333	96351.965
18	16084	0	61366	57045.0375	22627.8009	35756.0035	41219.1667	6649.87
19	0	0	0	27473.812	32325.4298	83430.6747	58531.2167	37874.14
20	0	0	0	0	8081.35745	0	22258.35	
21						0	7419.45	
SUM	53607639	67670271	61304634	61709132	80845899.9	71512006.9	72507811.7	74851914.8

Table 5. Mean weight and mean length-at-age of Greenland halibut, 1997-2004.

	1997		1998		1999		2000		2001		2002		2003		2004	
AGE	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				
2	23	15.3	38	18.7	64	21.0	75	21.0	85	21.0	60	21.7	85	23.0		
3	58	19.8	176	28.5	206	27.4	146	26.3	173	26.7	200	29.6	192	29.4		
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
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
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
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
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
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
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
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
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
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
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
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
16	9166	94.6	8385	88.9	9925	88.5	6873	85.5	7203	86.0	6786	84.8	5747	81.3		
17	10797	97.8	10684	95.4			8492	91.8	8954	92.4	8520	90.3	6200	84.0	6498	82.0
18					12500	99.0	8590	92.3	8760	93.0	9385	93.0			8930	93.0
19			12850	99.0			9645	91.5	11500	102.0	8553	90.3			10220	93.0
20									14400	105.0						

Table 6. Maturity-at-age in percent, females, Div. 1C-1D, 2004. 1 immature, 2 maturing.

	Maturity		
	1	2	
	Pct	Pct	N
Age			
4	100.0		11
5	100.0		9
6	100.0		14
7	78.6	21.4	14
8	71.4	28.6	14
9	50.0	50.0	12
10	42.9	57.1	14
11		100.0	14
12		100.0	11
13	12.5	87.5	8
14		100.0	6
15		100.0	6
17		100.0	2
18		100.0	1
19		100.0	1

Table 7. Biomass of (tons) roundnose grenadier by Division and depth stratum, 2004.

Div.	Stratum(m)	Area	Hauls	Mean	Biomass	SE
1C	401-600	3366	1	0	0.0	.
	601-800	16120	5	0.0025	39.7	34.9
	801-1000	6066	10	0.0273	165.8	73.4
	1001-1200	611	2	0.0118	7.2	1.0
1D	601-800	1940	3	0.0032	6.2	4.5
	801-1000	3874	3	0.0069	26.8	16.7
	1001-1200	10140	11	0.0103	104.9	29.7
	1201-1400	6195	12	0.02	124.0	20.2
	1401-1500	3091	4	0.0512	158.3	37.9
All				0.0123	633.0	98.2

Table 8. Abundance of roundnose grenadier by Division and depth stratum, 2004.

Div.	Stratum(m)	Area	Hauls	Mean	Abundance	SE
1C	401-600	3366	1	0	0	.
	601-800	16120	5	101.1	1630165.1	1448680.8
	801-1000	6066	10	720.5	4370273.1	1939553.4
	1001-1200	611	2	287.2	175458.2	32126.9
1D	601-800	1940	3	46.9	91022.1	32998.2
	801-1000	3874	3	176.5	683682.8	501378.1
	1001-1200	10140	11	130.6	1323778.6	314505.1
	1201-1400	6195	12	178.2	1103774.8	330147.2
	1401-1500	3091	4	383.6	1185557.7	318706.9
All				205.5	10563712.4	2534468.2

Table 9. Biomass (tons) of roughhead grenadier by Division and depth stratum, 2004.

Div.	Stratum(m)	Area	Hauls	Mean	Biomass	SE
1C	401-600	3366	1	0.0127	42.6	.
	601-800	16120	5	0.0577	930.2	302.1
	801-1000	6066	10	0.1081	655.6	125.0
	1001-1200	611	2	0.0649	39.6	6.5
1D	601-800	1940	3	0.0774	150.2	73.7
	801-1000	3874	3	0.036	139.5	86.2
	1001-1200	10140	11	0.0936	949.6	156.1
	1201-1400	6195	12	0.1223	757.4	118.0
	1401-1500	3091	4	0.2101	649.6	212.2
All				0.0839	4314.3	452.6

Table 10. Abundance of roughhead grenadier by Division and depth stratum, 2004

Div.	Stratum(m)	Area	Hauls	Mean	Abundance	SE
1C	401-600	3366	1	29.9	100592	.
	601-800	16120	5	164.1	2644623	873340
	801-1000	6066	10	327.1	1984321	445007
	1001-1200	611	2	166.1	101477	7728
1D	601-800	1940	3	166.4	322815	161775
	801-1000	3874	3	124.8	483284	288280
	1001-1200	10140	11	227.2	2303939	427854
	1201-1400	6195	12	268.5	1663623	321366
	1401-1500	3091	4	504.4	1559150	618577
All				217.2	11163822	1322566

Table 11. 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	5.0		1	3.4	.27	5	3.7	.14	10	3.6	.01	2						
1D				3.5	.12	3	3.8	.07	3	3.5	.04	11	3.4	.03	12	3.4	.03	4

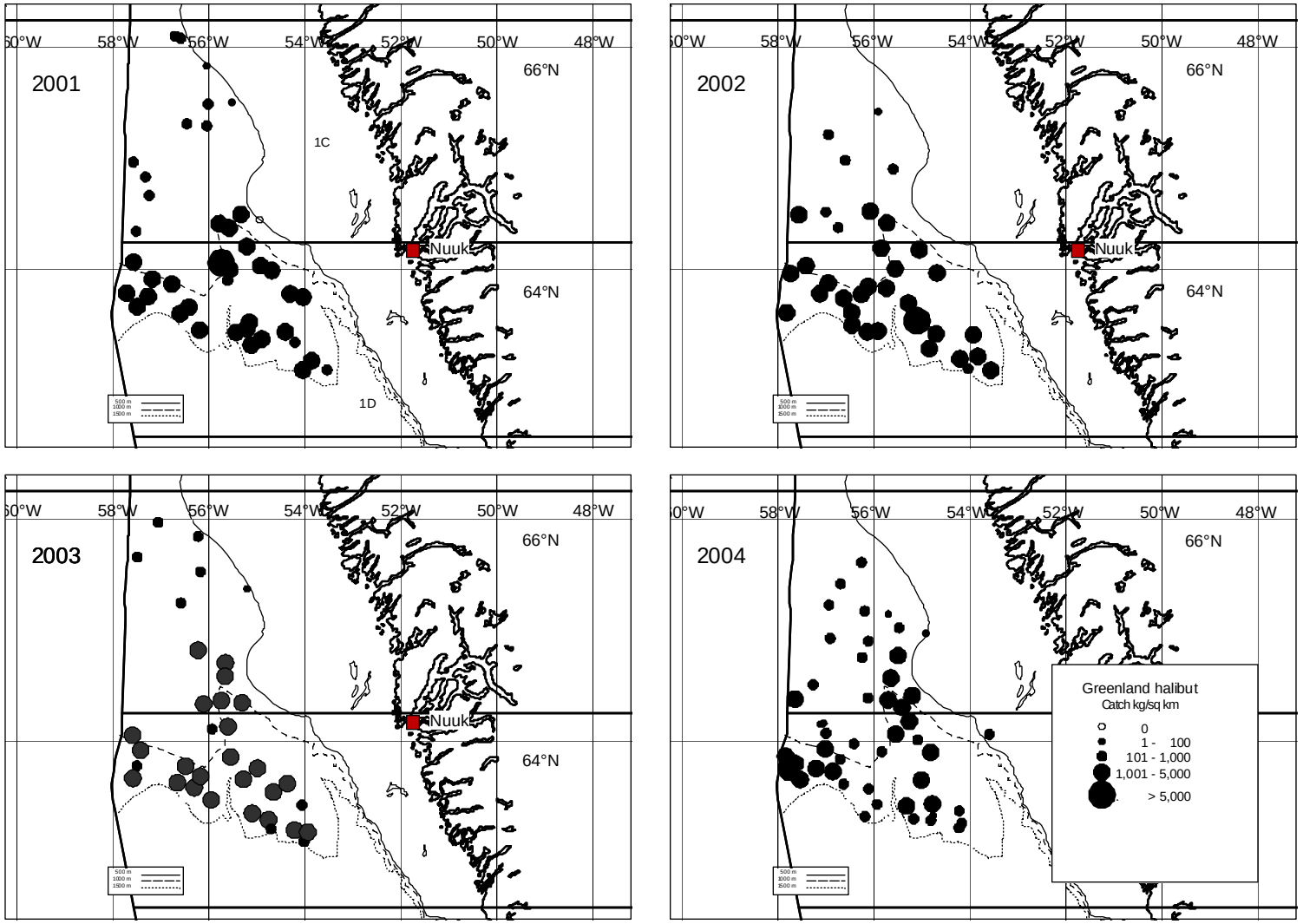

Fig. 1. Distribution of catches of Greenland halibut in 2001 - 2003 in kg km^{-2}

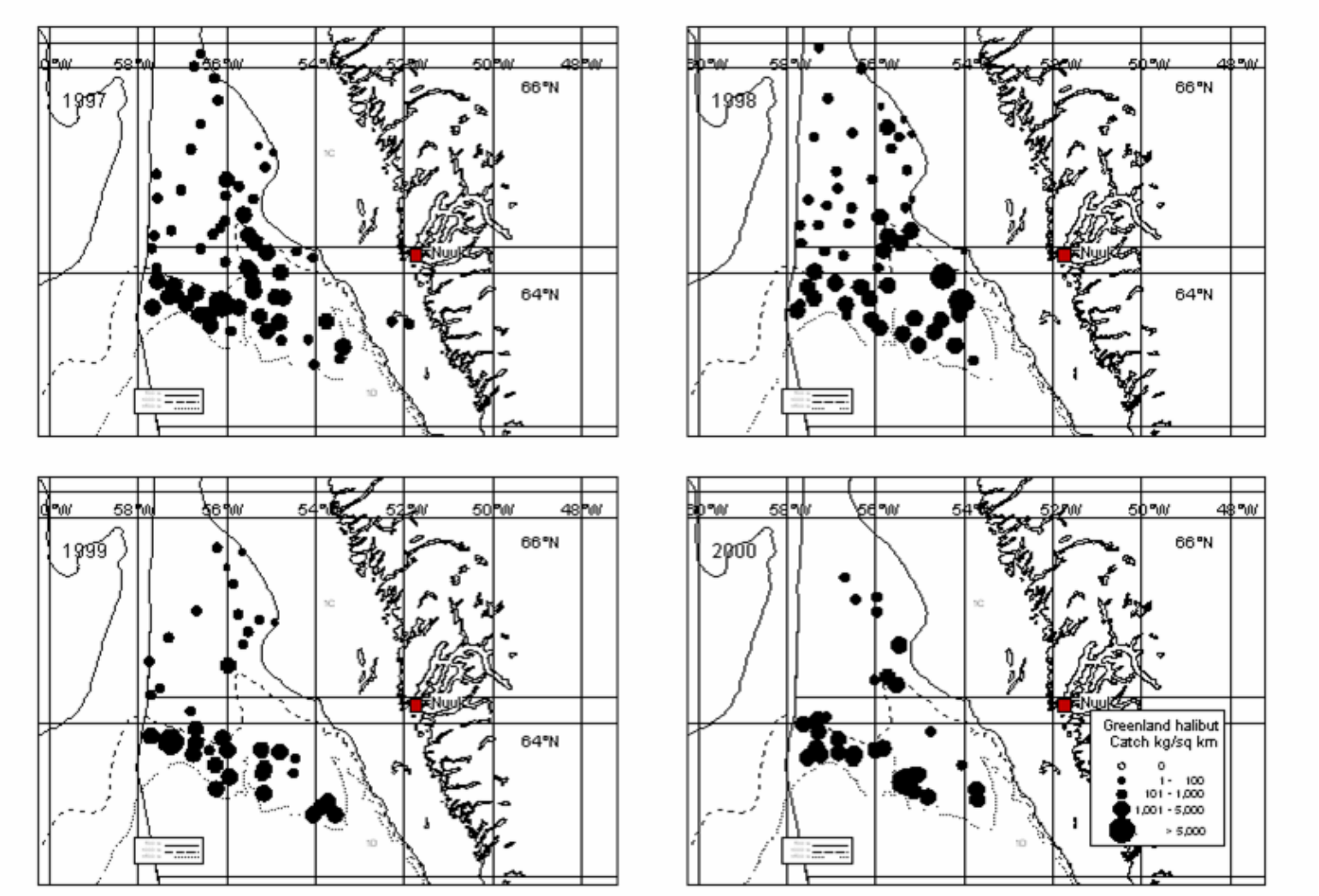

Fig. 1 (cont'd). Distribution of catches of Greenland halibut during 1997-2000 in kg km^{-2}.

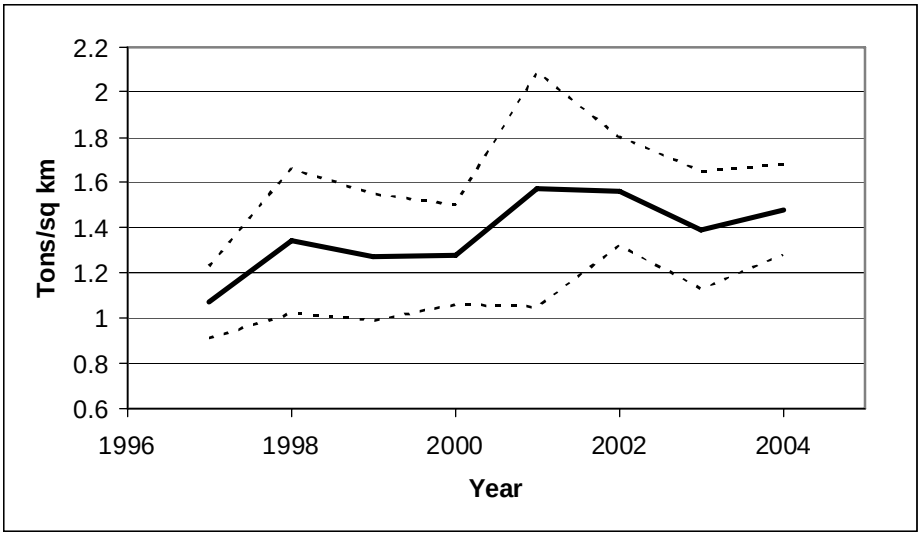

Fig. 2. Mean catch of Greenland halibut per sq. km (tons) standardized by stratum area with 2* +/- S.E.

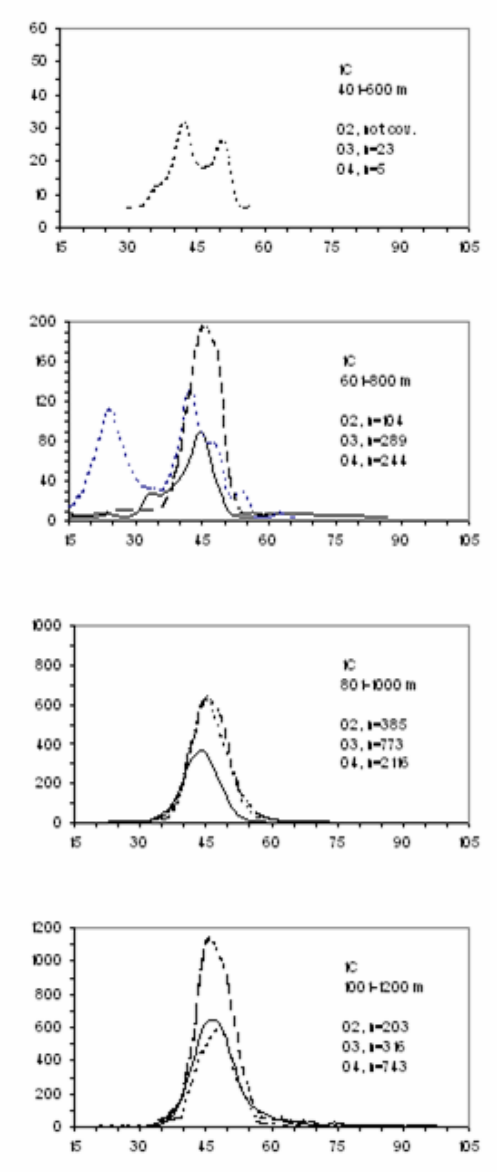

Fig. 3. Length distribution in numbers/km^2 of Greenland halibut (3 cm groups) by year, and depth stratum in Div. 1C. Note different scales on y-axis.. 2002: Solid line. 2003. Dotted line 2004: Dashed line.

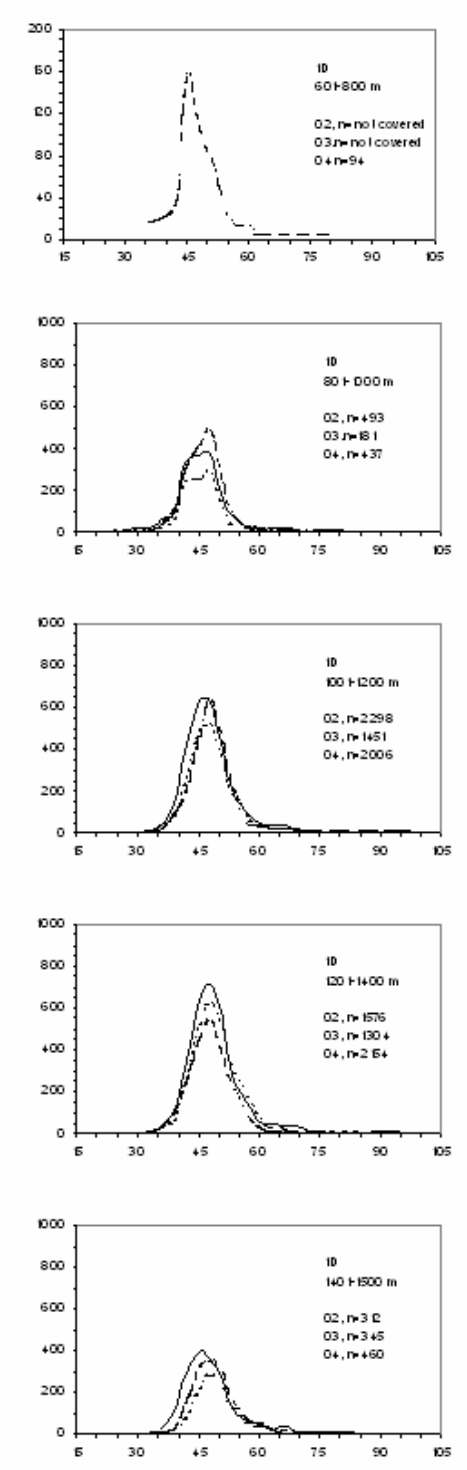

Fig. 3. (cont'd) Length distribution in numbers/km^2 of Greenland halibut (3 cm groups) by year, and depth stratum in Div. 1D. Note different scales on y-axis. 2002: Solid line. 2003. Dotted line. 2004: Dashed line.

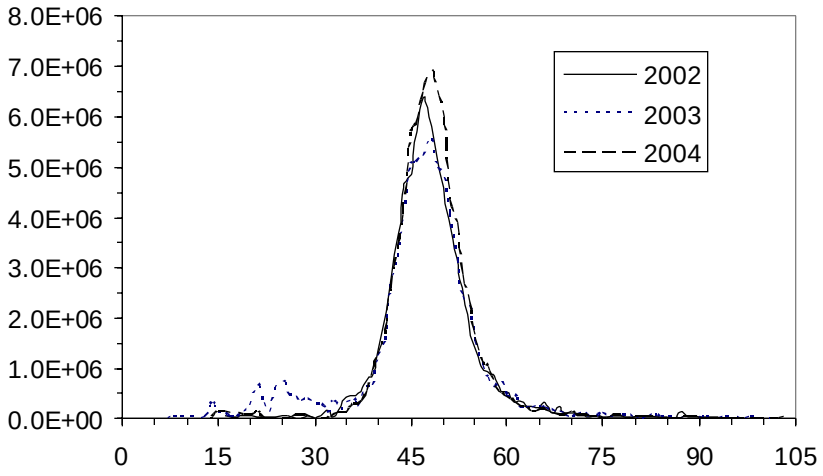

Fig. 4. Over all length distribution of Greenland halibut in numbers (weighted by stratum area) by year.

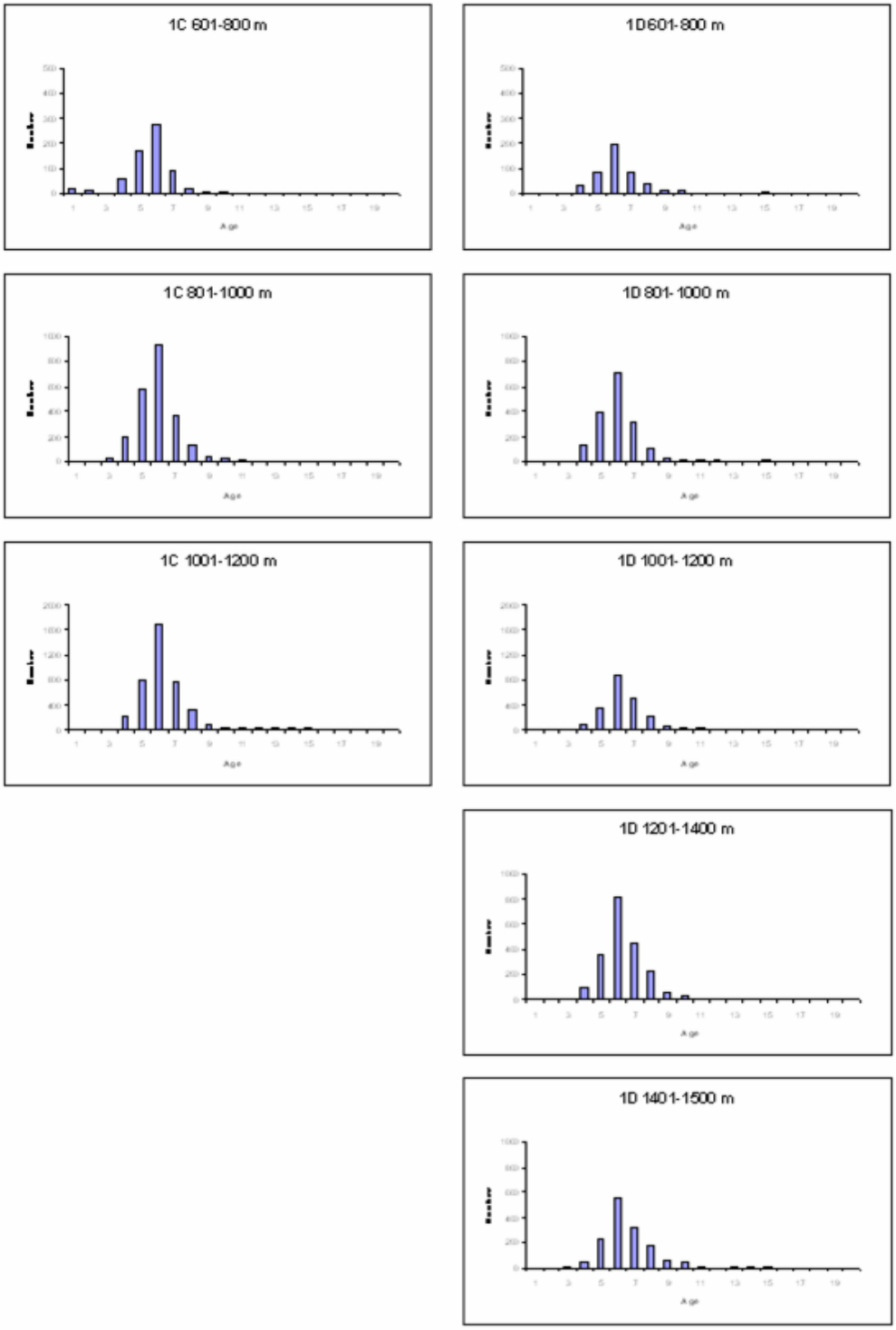

Fig. 5. Age distribution (number km^{-2}) by NAFO Division and depth stratum. Note different scales on y-axis

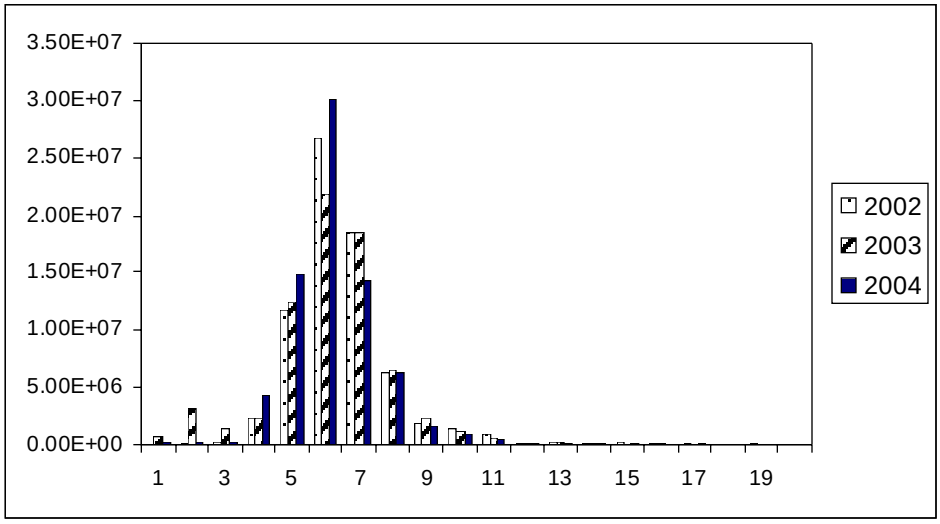

Fig. 6. Total age distribution in numbers (weighted by stratum area) of Greenland halibut in NAFO Div. 1C-1D in 2002- 2004.

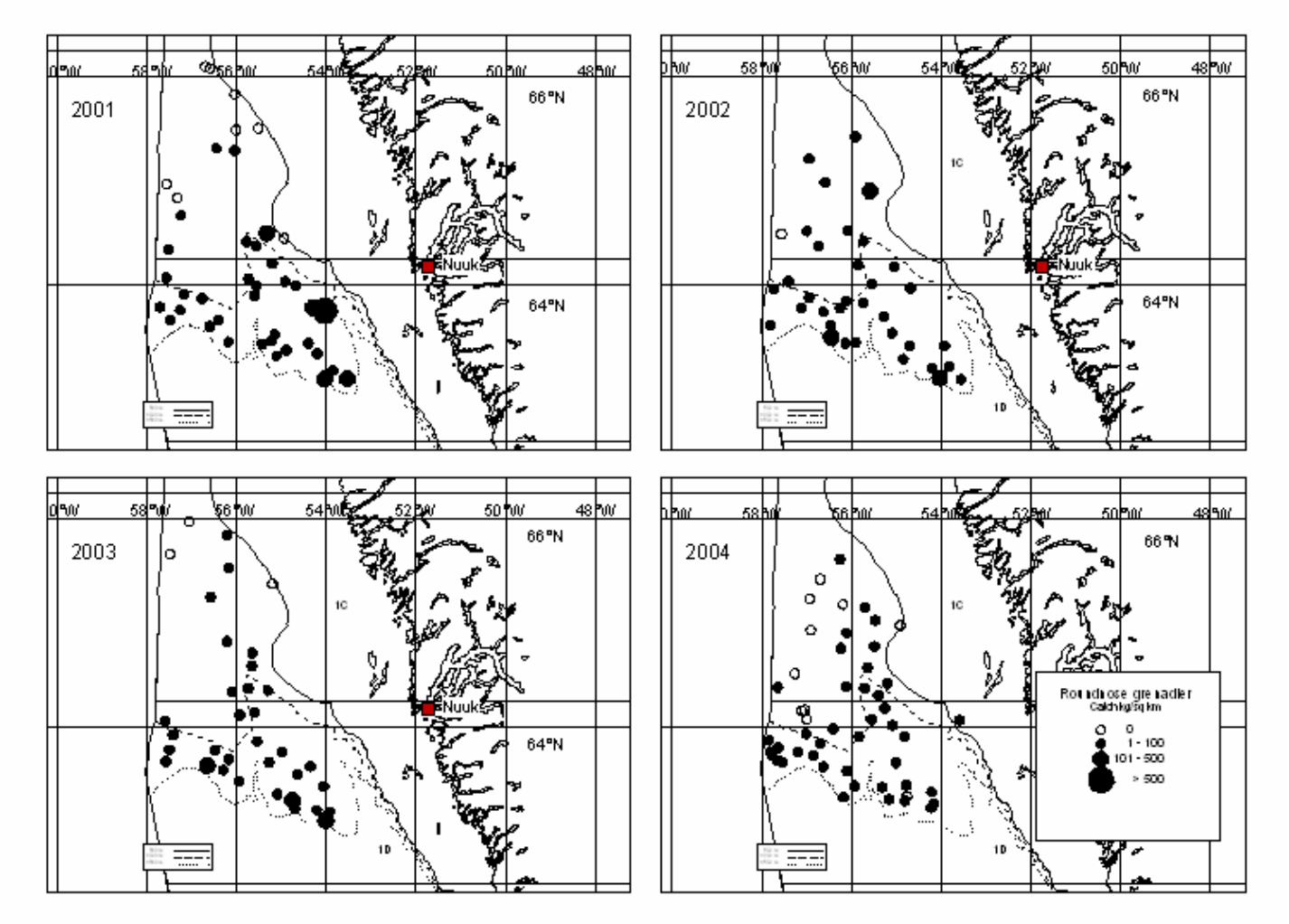

Fig. 7. Distribution of catches of roundnose grenadier in 2001-2004 in kg km^{-2}.

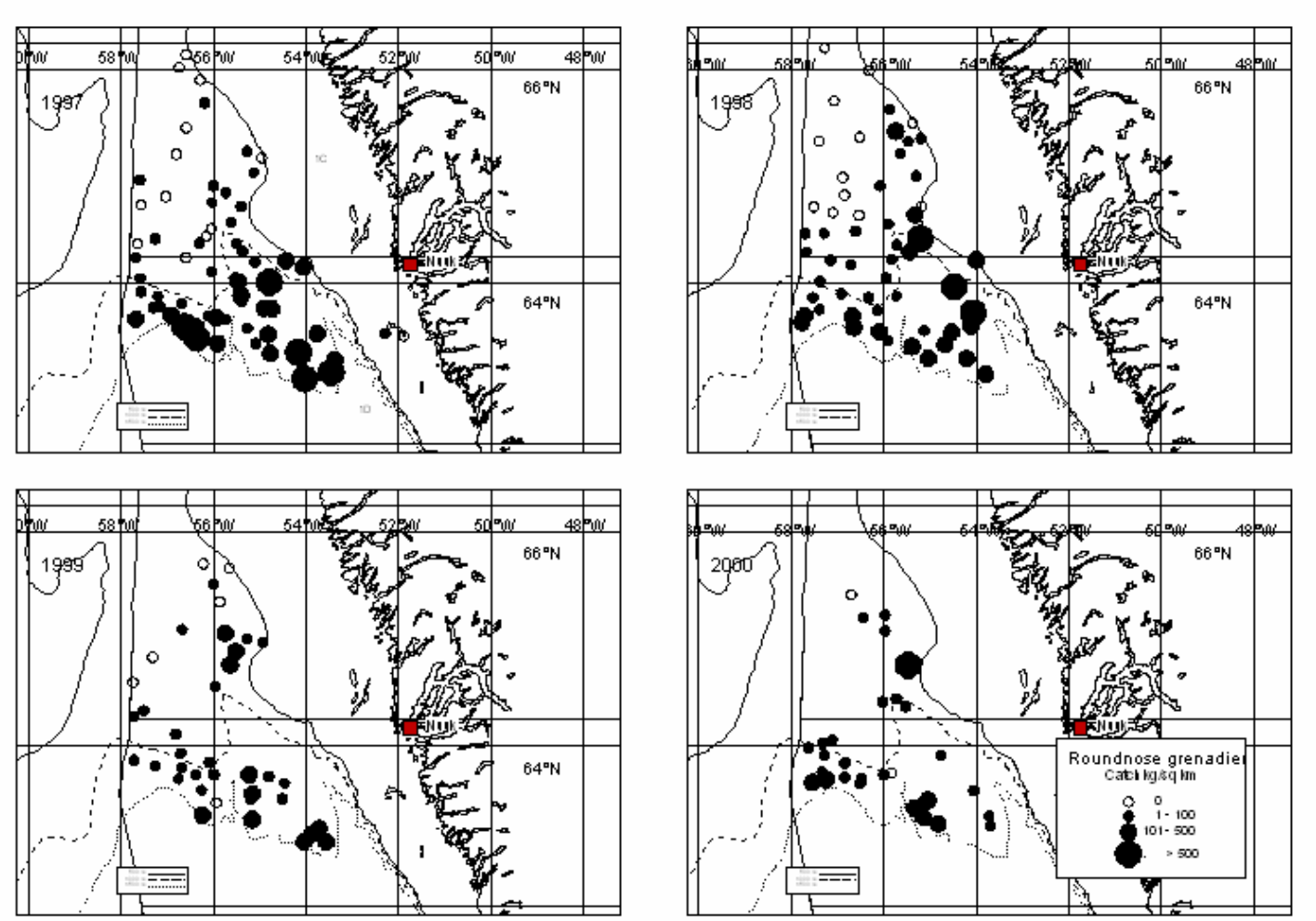

Fig. 7 cont. Distribution of catches of roundnose grenadier during 1997-2000.

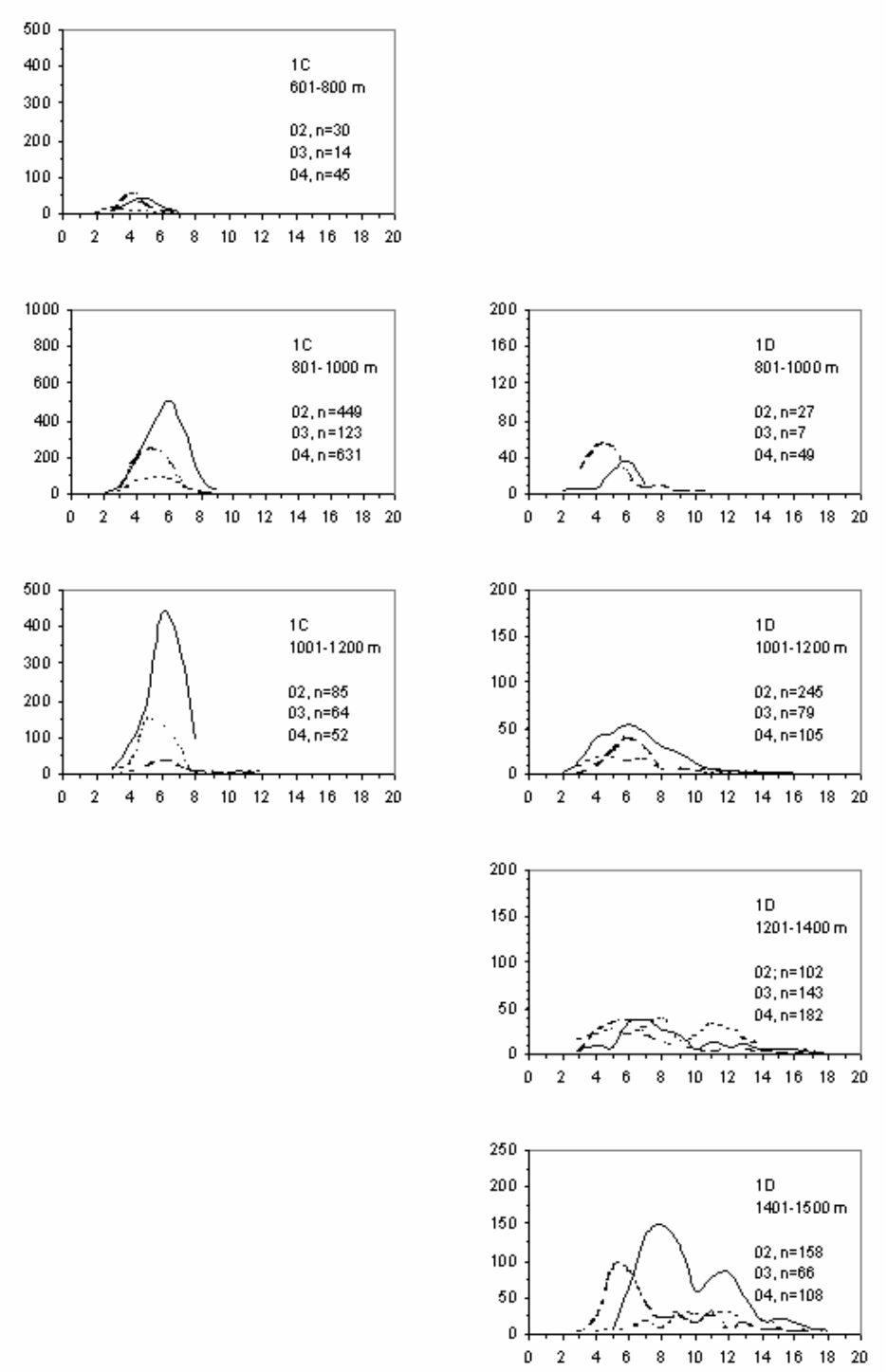

Fig. 8. Length distribution (pre anal fin length) of roundnose grenadier in numbers/km^2 by year and depth strata. Dashed line: 2001. Solid line: 2002. Dotted line: 2003

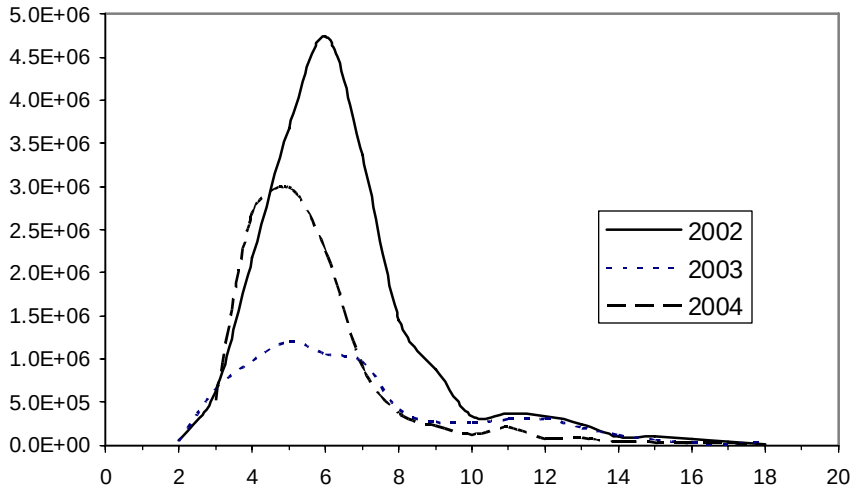

Fig. 9. Overall length distribution of roundnose grenadier (pre anal fin length) in numbers (weighted by stratum area) by year.

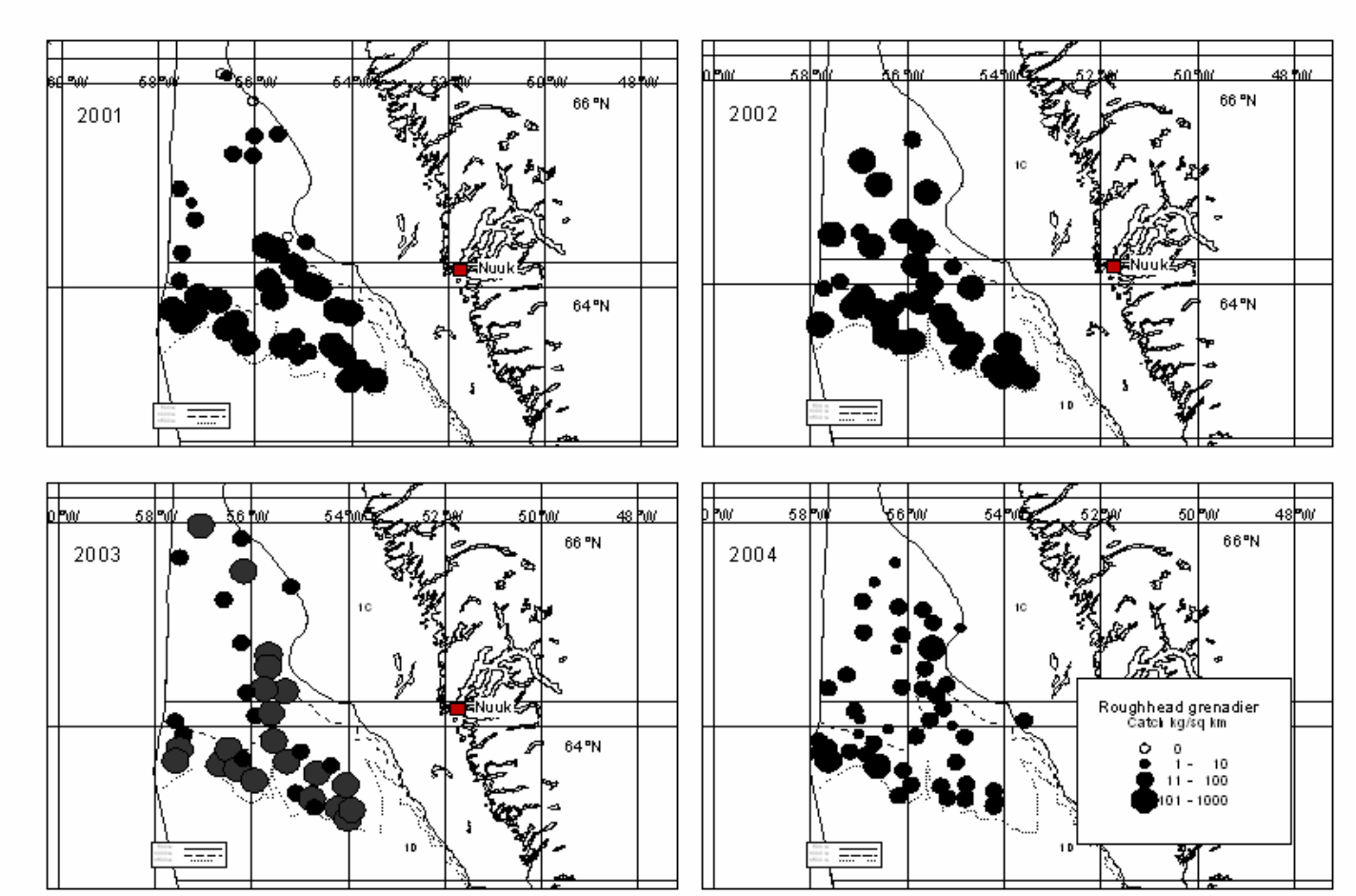

Fig. 10. Distribution of catches of roughhead grenadier in 2001-2004 in kg km^{-2}.

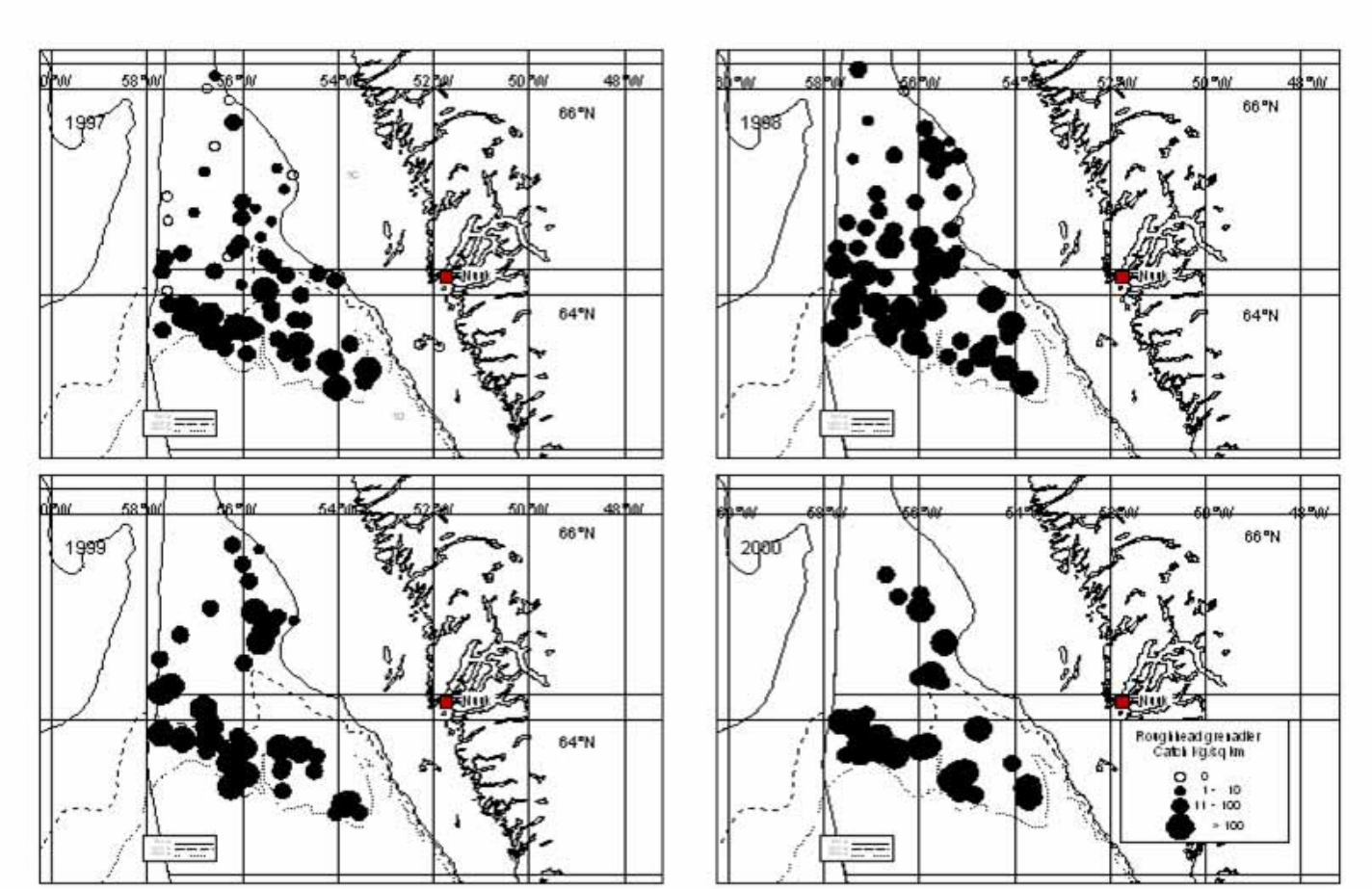

Fig. 10 cont.. Distribution of catches of roughhead grenadier during 1997-2000.

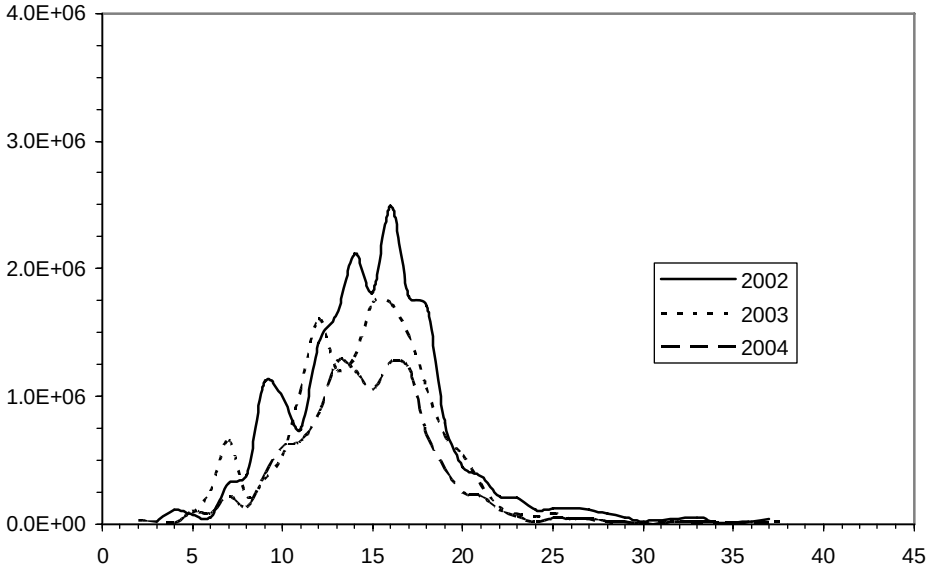

Fig. 11. Overall length distribution (pre anal fin length) of roughhead grenadier in numbers (weighted by stratum area) by year.

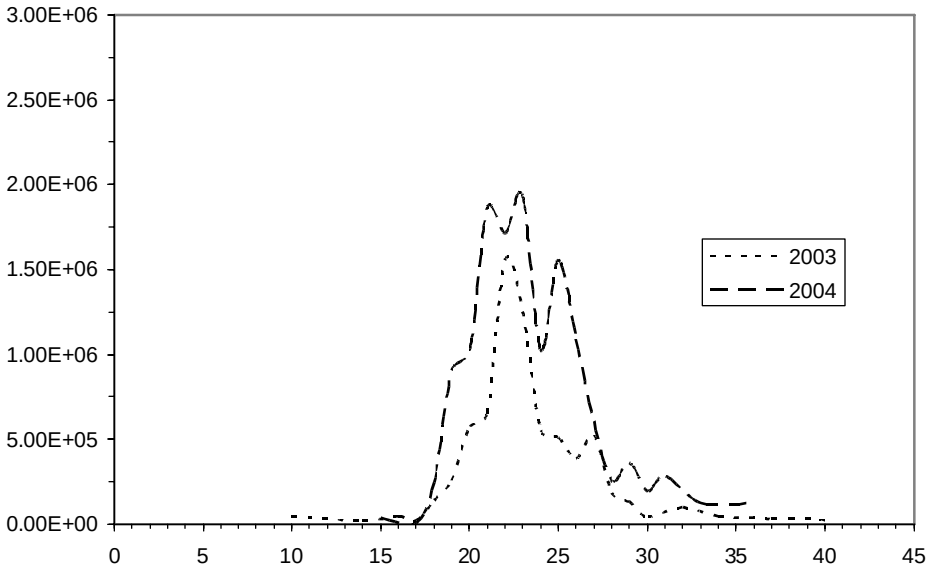

Fig. 12. Overall length distribution (pre anal fin length) of deep sea redfish in numbers (weighted by stratum area) by year (No obs. in 2002)

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. Six hauls have been excluded as invalid.

						Grl. halibut		Roundnose gre.		Roughhead gre.		*S. mentella*	
St. No	Depth	S. Area	Div.	Duration	Temp.	Number	Weight	Number	Weight	Number	Weight	Number	Weight
1	573.5	0.1004	1C	30	5.0	5	5.8	0	0.0	3	1.3	337	59.2
4	703.5	0.0892	1C	30	4.3	58	51.0	41	1.0	2	1.2	14	3.1
5	670.0	0.0406	1C	16	3.0	14	11.3	0	0.0	2	1.0	5	0.9
6	628.0	0.0364	1C	17	2.8	20	14.3	0	0.0	10	4.2	10	1.4
7	770.5	0.0847	1C	30	3.3	89	76.3	1	0.0	17	4.7	2	0.4
8	815.0	0.0456	1C	19	3.2	8	9.5	25	0.7	15	5.9	1	0.2
9	810.0	0.0752	1C	30	4.4	66	53.8	30	1.2	11	4.5	0	0.0
10	848.0	0.0858	1C	30	3.2	101	86.4	7	0.4	24	11.0	0	0.0
11	745.0	0.0880	1C	30	3.5	63	50.0	3	0.1	24	7.1	3	0.2
12	845.5	0.0923	1C	30	3.1	104	122.6	11	0.4	6	1.7	1	0.2
14	867.0	0.0858	1C	30	4.2	405	305.8	282	10.3	66	20.7	0	0.0
15	984.0	0.0915	1C	30	4.0	397	395.4	82	2.7	47	14.2	0	0.0
16	834.0	0.0906	1C	30	3.4	89	83.2	1	0.1	43	8.4	0	0.0
17	870.0	0.0792	1C	32	3.7	218	197.9	24	1.0	39	10.3	0	0.0
18	946.0	0.0965	1D	30	3.8	199	182.6	42	1.5	26	7.7	0	0.0
19	1153.0	0.1004	1D	30	3.6	260	240.1	11	0.6	38	11.1	0	0.0
20	1250.0	0.0887	1D	30	3.5	290	274.4	12	0.8	45	18.3	0	0.0
21	1273.0	0.0895	1D	30	3.5	273	254.9	22	1.0	35	11.0	0	0.0
22	1419.5	0.0406	1D	17	3.4	33	32.3	12	0.9	44	14.7	0	0.0
23	1467.5	0.0959	1D	30	3.4	267	252.0	37	4.6	16	5.8	0	0.0
24	1330.5	0.0919	1D	30	3.4	268	251.8	21	1.3	55	18.7	0	0.0
25	1358.0	0.0950	1D	30	3.4	292	280.8	10	2.1	38	14.3	0	0.0
26	1356.5	0.0881	1D	30	3.5	255	257.9	17	1.1	28	15.5	0	0.0
28	1433.5	0.0704	1D	31	3.3	106	122.4	47	5.8	29	20.0	0	0.0
29	1108.5	0.0935	1D	30	3.6	54	59.7	0	0.4	10	4.3	0	0.0
30	1021.5	0.0933	1D	30	3.7	207	228.7	5	0.6	3	1.8	1	0.3
31	826.0	0.0607	1D	22	3.6	72	57.0	3	0.0	5	1.3	0	0.0
32	781.5	0.0489	1D	18	3.3	13	9.9	1	0.0	16	7.1	1	0.2
33	774.5	0.0636	1D	26	3.7	20	15.7	5	0.1	3	0.9	0	0.0
34	1019.5	0.0863	1D	30	3.7	133	159.8	4	0.2	9	2.9	0	0.0
35	1066.5	0.0886	1D	30	3.7	339	329.5	10	0.6	13	4.9	0	0.0
36	893.0	0.0896	1D	30	3.9	166	167.5	4	0.4	2	0.6	0	0.0
37	887.5	0.0804	1C	30	3.9	132	134.1	6	0.2	4	2.3	0	0.0
38	1058.5	0.0895	1C	30	3.5	430	454.2	21	0.9	16	6.8	0	0.0
39	1082.0	0.0912	1C	30	3.6	313	370.2	31	1.2	14	5.0	0	0.0
40	952.5	0.1098	1C	25	3.6	597	582.3	163	7.5	19	11.0	3	0.6
41	1151.5	0.0801	1D	30	3.6	242	268.0	17	0.8	14	7.9	1	0.2
42	1206.0	0.0838	1D	30	3.7	123	131.7	59	3.3	5	1.7	0	0.0
43	1185.5	0.0774	1D	29	3.3	220	297.0	8	0.7	17	6.6	0	0.0
44	1168.0	0.0870	1D	30	3.5	208	252.0	19	1.2	25	12.9	0	0.0
46	1276.5	0.0926	1D	30	3.4	166	169.6	4	1.9	8	4.5	0	0.0
47	1192.0	0.0864	1D	30	3.4	155	174.0	2	0.2	16	11.8	0	0.0
48	1448.5	0.0648	1D	22	3.4	54	89.3	12	3.4	23	8.8	0	0.0
49	1211.0	0.0782	1D	30	3.4	181	227.3	20	2.9	6	8.9	0	0.0
50	1382.5	0.0744	1D	30	3.2	81	101.9	5	1.0	25	3.5	0	0.0
51	1291.0	0.0799	1D	30	3.4	84	102.2	4	1.4	19	11.3	0	0.0
52	1228.0	0.0741	1D	30	3.4	80	103.6	3	0.6	10	4.0	0	0.0
53	1121.5	0.0337	1D	15	3.3	70	86.1	11	0.6	14	4.0	0	0.0
54	1125.5	0.0783	1D	30	3.5	119	154.0	18	2.9	36	14.0	0	0.0
56	1228.0	0.0721	1D	27	3.5	62	89.8	5	2.6	21	13.4	0	0.0
57	640.0	0.0720	1D	24	3.5	61	73.4	3	0.6	9	5.3	0	0.0

Appendix 2. List of species and groups of species recorded in Div. 1C-D in 2004 with observedmaximum catch weight (kg), maximum number, 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	New		0.090	1	1185.5	1192.0	3.3	3.4	63.9017
2	New		0.012	1	1228.0	1228.0	3.4	3.4	63.3308
3	ALB	Alepocephalus bairdii	0.040	1	1121.5	1121.5	3.3	3.3	63.4367
4	ALE	Alepocephalus sp.	0.004	1	984.0	1206.0	3.7	4.0	64.5708
5	CAD	Anarhichas denticulatus	3.300	1	774.5	1192.0	3.4	3.7	64.5108
6	ANC	Anopologaster cornuta	0.240	2	1358.0	1358.0	3.4	3.4	63.7567
7	ANT	Antimora rostrata	14.500	45	640.0	1467.5	3.0	4.4	65.4192
8	ARZ	Arctozenius rissoi	0.036	1	1206.0	1433.5	3.3	3.7	64.0150
9	AGH	Argyropelecus hemigymnus	0.001	1	1228.0	1228.0	3.4	3.4	63.3308
10	BAM	Bajacalifornia megalops	0.264	2	952.5	1433.5	3.3	3.6	64.4142
11	BAT	Bathylagus euryops	2.266	58	640.0	1467.5	3.0	4.4	65.6117
12	BBA	Bathypolypus baridii	0.054	1	573.5	573.5	5.0	5.0	64.9733
13	BSE	Bathypolypus sp.	0.142	4	770.5	834.0	3.3	3.4	65.1742
14	BSP	Bathyraja spinicauda	6.500	1	1419.5	1419.5	3.4	3.4	63.6733
15	BEG	Benthosema glaciale	0.072	25	573.5	1467.5	2.8	5.0	65.6983
16	BOA	Borostomias antarctica	0.170	2	745.0	1448.5	3.2	3.8	64.9275
17	CFB	Centroscyllium fabricii	396.000	17	573.5	1358.0	3.3	5.0	65.0225
18	CHO	Ceratias holboelli	0.520	1	1228.0	1228.0	3.5	3.5	63.2225
19	CHA	Chauliodus sloani	0.172	4	640.0	1467.5	3.2	4.4	65.0225
20	CHN	Chiasmodon niger	0.194	4	640.0	1467.5	3.1	4.2	65.1742
21	CIM	Cirroteuthis mulleri	4.248	2	1058.5	1467.5	3.4	3.5	64.3742
22	CBB	Coryphaenoides brevibarbis	0.576	6	774.5	1467.5	3.3	3.7	63.9792
23	CGR	Coryphaenoides guntheri	5.950	61	640.0	1433.5	3.3	3.7	64.4142
24	RNG	Coryphaenoides rupestris	10.300	282	640.0	1467.5	3.1	4.6	65.6983
25	COM	Cottunculus microps	0.484	1	770.5	870.0	3.3	4.4	65.1742
26	COT	Cottunculus thomsonii	2.740	4	815.0	1358.0	3.2	4.2	65.1467
27	LUM	Cyclopterus lumpus	2.878	2	670.0	1250.0	3.0	3.9	65.4192
28	CYB	Cyclothone braueri	0.004	2	1108.5	1433.5	3.3	3.6	63.8392
29	CLM	Cyclothone microdon	0.040	19	628.0	1467.5	2.8	4.4	65.2275
30	EUR	Eurypharynx pelecanoides	0.064	1	1211.0	1211.0	3.4	3.4	63.4183
31	COD	Gadus morhua	0.654	1	495.0	495.0	5.5	5.5	65.7142
32	ONA	Gaidropsarus argentatus	0.110	1	770.5	1166.0	3.3	3.4	65.1742
33	ONN	Gaidropsaurus ensis	4.012	8	628.0	1467.5	2.8	3.9	65.2275
34	WIT	Glyptocephalus cynoglossus	0.888	1	867.0	893.0	3.9	4.2	64.7717
35	GOB	Gonostoma bathyphilum	0.020	2	1192.0	1291.0	3.4	3.4	63.4333
36	PLA	Hippoglossoides platessoides	0.710	4	495.0	867.0	3.0	5.5	65.7142
37	HOA	Holtbyrnia anomala	0.040	1	887.5	1166.0	3.4	3.9	64.3908
38	HMC	Holtbyrnia macrops	0.028	1	946.0	1291.0	3.4	3.8	64.0625
39	HAF	Hydrolagus affinis	31.200	3	1423.0	1448.5	3.3	3.4	63.5967
40	LMC	Lampanyctus macdonaldi	1.564	89	495.0	1467.5	2.8	5.5	65.7142
41	LEP	Lepedion eques	0.295	3	867.0	1382.5	3.2	4.2	64.7717
42	EUD	Leptagonus decagonus	0.010	1	867.0	867.0	4.2	4.2	64.7717
43	LIF	Liparis fabricii	0.076	2	774.5	834.0	3.4	3.7	64.5108
44	KCT	Lithodes maja	0.350	1	867.0	867.0	4.2	4.2	64.7717
45	LSQ	Lycodes squamiventer	0.434	1	774.5	1467.5	3.3	4.0	64.5708
46	RHG	Macrourus berglax	20.684	66	573.5	1467.5	2.8	5.0	65.6117
47	MAA	Magnisudis atlantica	0.060	1	946.0	946.0	3.8	3.8	64.0625
48	MAL	Malacosteus niger	0.124	1	887.5	1433.5	3.3	4.0	64.5708
49	MMI	Maulisa microlepis	0.120	2	1358.0	1433.5	3.2	3.4	63.7567
50	MAT	Melanostigma atlanticum	0.012	1	1058.5	1058.5	3.5	3.5	64.3742
51	BLI	Molva dypterygia	0.386	1	810.0	810.0	4.4	4.4	65.0225
52	MYP	Myctophum punctatum	0.012	1	1151.5	1166.0	3.4	3.6	64.1808
53	NEG	Neolithodes grimaldi	2.226	1	946.0	1168.0	3.4	3.8	64.1808
54	NZB	Nezumia bairdi	1.252	22	870.0	1467.5	3.4	3.9	64.4142
55	NOT	Notacanthus chemnitzii	8.950	12	640.0	1419.5	3.2	4.4	65.0225
56	OND	Oneirodes sp.	0.636	1	1419.5	1419.5	3.4	3.4	63.6733
57	PAC	Paraliparis copei	0.014	1	1382.5	1448.5	3.2	3.4	63.3242
58	PAG	Paraliparis garmani	0.190	24	670.0	946.0	3.0	4.4	65.6117
59	SKP	Platytroctidae	0.076	1	867.0	984.0	4.0	4.2	64.7717
60	POL	Polyacanthonotus rissoanus	0.424	2	640.0	1467.5	3.3	3.7	63.9083
61	RFL	Raja fyllae	0.876	1	628.0	1228.0	2.8	4.4	65.2275
62	RSP	Raja spinacidermis	0.575	1	867.0	867.0	4.2	4.2	64.7717
63	GHL	Reinhardtius hippoglossoides	582.250	597	573.5	1467.5	2.8	5.0	65.6983
64	RHD	Rhadinestes decimus	0.058	1	1228.0	1228.0	3.4	3.4	63.3308
65	SAS	Sagamichthys sachakenbergi	0.005	1	867.0	867.0	4.2	4.2	64.7717
66	SCB	Scopelogadus beani	0.050	1	770.5	770.5	3.3	3.3	65.1742
67	SCO	Scopelosarus lepidus	0.418	4	640.0	1276.5	3.4	4.2	64.7717
68	REG	Sebastes marinus	1.228	3	774.5	1192.0	3.4	4.4	65.0225
69	REB	Sebastes mentella	59.150	337	495.0	1151.5	2.8	5.5	65.7142
70	RED	Sebastes sp.	0.002	1	810.0	810.0	4.4	4.4	65.0225
71	SER	Serrivomer beani	0.502	5	640.0	1467.5	3.2	4.0	64.5708
72	STO	Stomias boa	0.140	24	628.0	1448.5	2.8	4.4	65.4192
73	SYN	Synapobranchus kaupi	6.305	39	640.0	1467.5	3.0	4.4	65.4192
74	TRA	Trachyrynchus murrayi	0.740	3	774.5	946.0	3.7	3.8	64.0625
75	XEC	Xenodermichthys copei	0.034	1	952.5	1276.5	3.4	3.6	64.4142