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Survey for Greenland Halibut in NAFO Divisions 1C-1D, 2005

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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 80 900 tons in 2005 compared to 75 900 tons in 2004. The biomass of roundnose grenadier remained at very low level and was estimated as 733 tons only.

Introduction

During the period 1987-1995 Japan Marine Fishery Resources Research Center (JAMARC) and Greenland Institute of Natural Resources jointly conducted 12 bottom trawl surveys (Jørgensen, 1998a) and 4 pelagic surveys (Jørgensen, 1997a) at West Greenland as part of a joint venture agreement on fisheries development and fisheries research in Greenland waters. The bottom trawl surveys were primarily aimed at Greenland halibut (*Reinhardtius hippoglossoides*) in NAFO Div. 1B-1D. In 1997 Greenland Institute of Natural Resources continued the bottom trawl surveys series with the Institute's own vessel PAAMIUT, which had been rigged for deep sea trawling. There has unfortunately not been any comparative trawlings between the Japanese research vessel SHINKAI MARU and PAAMIUT making comparisons between the surveys difficult. The survey traditionally covers NAFO Div. 1CD, but in 2001 the survey area was expanded to include Div. 1A (to 74°N) and Div. 1B and in 2004 the northern part of the Baffin Bay (73°N-77°N) was surveyed, too.

Materials and Methods

The survey in 2005 covered 1CD at depths between 400 and 1 500 m and took place during 29/8-11/9.

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. Each stratum was allocated at least two hauls. The remaining hauls were allocated in order to minimize the variance in the estimation of the biomass of Greenland halibut, i.e. strata with great variation in the catches of Greenland halibut in the previous years surveys have got relatively more hauls than strata with little variation in the catches. In 2004 a new

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

Vessel and gear

The survey was conducted by the 722 GRT trawler PAAMIUT, as in previous years, using an ALFREDO III trawl with a mesh size on 140 mm and a 30 mm mesh-liner in the cod-end. The ground gear was of the rock hopper type. The trawl doors were Greenland Injector weighing 2 700 kg. The Injector otter doors replaced the Perfect doors that have been used until 2003. The average net height was 20 cm higher with the new doors compared to the old, but the difference was not statistically significant (95% level) and it was concluded that the net performance has not changed by the introduction of new doors. Further information about trawl and gear is given in Jørgensen, 1998b.

A Furuno net sonde mounted on the head rope measured net height. SCANMAR sensors measured the distance between the trawl doors. Wingspread, taken as the distance between the outer bobbins, was calculated as: distance between outer bobbins = 10.122 + distance between trawl doors * 0.142

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

Trawling procedure

Towing time was usually 30 min, but towing times down to 15 min were accepted. Average towing speed was 3.0 kn. Towing speed was estimated from the start and end positions of the haul, or in a few cases based on GPS observations (mean of records made every 5 min. during the haul). Trawling took place day and night.

Near-bottom temperatures were measured, by 0.1^{o}C, by a Seamon sensor mounted on a trawl door.

Handling of the catch

After each haul the catch was sorted by species and weighed 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 = 458) were soaked in water and read in transparent light. Age distributions were estimated using age/length keys and survey length frequencies pooled in 3-cm groups.

Results and Discussion

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

In total 84 species or groups of species were recorded (Appendix 1).

Greenland halibut (*Reinhardtius hippoglossoides*)

reenland halibut was caught in all hauls (Fig. 1) and the biomass was estimated at 80 865 tons (S.E. 8 365.7) (Table 2) which is a slight increase compared to 75 869 tons (S.E. 5 186.3) in 2004. The biomass increased in Div. 1D stratum 1 201-1 400 m while it decreased in Div. 1C 601-1000 m. The estimate from 2005 is not statistically different (95% level) from the estimates from 1997-2004 (Jørgensen, 2005, 2004, 2003, 2002, 2001, 2000, 1999 and 1998b). The weighted mean catch per tow also showed an insignificant increase and was in 2005 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	2005
Biomass	56 260.2	70 473.5	64 398.0	59 092.4	77 554.0	71932.4	68 717.2	75 869.4	80865.4
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	8365.7

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

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005
Mean	1.07	1.34	1.27	1.28	1.57	1.56	1.39	1.48	1.54
S.E.	0.08	0.16	0.14	0.11	0.26	0.12	0.13	0.10	0.16

The abundance in Div. 1CD was estimated at $73.001*10^6$ (S.E. 7.319) (Table 3) compared to $74.859*10^6$ (S.E. $5.445*10^6$) in 2004. As for the biomass the abundance decreased in Div. 1C strata 601-1000 and increased in Div. 1D stratum 1 201-1 400 m.

Abundance of Greenland halibut in Div. 1CD.

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005
Abundance ($*10^6$)	53.613	67.677	61.366	61.710	80.814	71.510	72 556	74.859	73.001
S.E.	4.118	7.687	6.265	5.976	14.221	6.223	7.764	5.445	7.317

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

The length ranged from 15 cm to 108 cm (excluding a few larvae on 7-8 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 and 2004 (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 7 while the mode was at age 6 in 2004 (Fig. 6). Mean weight - and length at age is given in Table 5.

Females stated maturing at age 8 and 100% maturity was reached at age 13 (Table 6).

Roundnose grenadier (*Coryphaenoides rupestris*)

Roundnose grenadier was caught in most of the survey area but the catches were very low (Table 1, 7, Fig. 7). The biomass was estimated at 733 tons (S.E. 116) (Table 7) and hence remained at the very low level seen in recent years and far below the level seen in the late 80' (Jørgensen, 2005, 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	2005
Biomass	5 686.5	7 263.3	2 771.8	5 593.7	1 577.2	1 593.1	774.2	633.0	733.0
S.E.	926.4	2 530.2	445.5	2 616.8	516.4	462.7	144.0	98.2	116.0

Most of the biomass was found in Div. 1D at 1 001-1 500 m (Table 7).

The abundance in Div. 1C-1D was estimated at $12.179*10^6$ (S.E. 3.75010^6) compared to $10.564*10^6$ (S.E. $2.534*10^6$) in 2004. The highest densities were found in Div. 1C 601-1000 m where about 3/4 of the total abundance was located (Table 8)

Abundance of roundnose grenadier in Div. 1CD.

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005
Abundance (*10^6)	32.441	75.243	29.100	99.52	24.698	18.610	6.900	10.564	12.179
S.E. (10*^{6})	7.056	27.357	8.963	67.31	8.797	8.910	1.272	2.534	3.750

Pre anal fin length ranged from 2 to cm 17 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 as in previous years (Fig. 9).

Roughhead grenadier (*Macrourus berglax*)

Roughhead grenadier was caught in all hauls except one, but the catches were generally low. The biomass of roughhead grenadier was estimated at 5602.5 (S.E. 419.5) compared to 4314.3 (S.E. 452.6) in 2004 (Table 1, 9, Fig. 10). The 2005 estimate is about average for the time series (1997-2005)

Biomass of roughhead grenadier in Div. 1CD.

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005
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	5602.6
S.E.	250.1	377.9	854.1	2 226.5	456.3	823.6	700.8	452.6	419.5

The highest densities were found between at depths >1 001 m in Div. 1D and largest biomass was found in Div. 1D 1 001 - 1 200 m (Table 9).

The total abundance was estimated at 14.004*10^6 (S.E. 1.311*10^6) (Table 10) compared to 11.164*10^6 in 2004.

Abundance of roughhead grenadier in Div. 1CD.

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005
Abundance (*10^6)	4.60	11.623	14.074	20.282	13.867	19.620	15.366	11.164	14.004
S.E. (*10^6)	0.45	1.008	2.040	7.182	1.549	1.755	2.573	1.323	1.311

Pre anal fin length ranged from 3 to cm 41 cm and the over all length distribution was dominated by a minor mode at 11 cm and a mode at 14 cm. (Fig. 11).

Deep-sea redfish (*Sebastes mentella*)

Deep-sea redfish was caught in 24 of the 61 valid hauls, but the catches were very low, <5 kg, except two hauls on 19.2 and 71.9 kg (Table 1). The biomass was estimated at 2 546.2 tons (S.E. 1 683.3) (Table 11) which is at the same level as in 2004 and a little above average for the time series (1997-2004). In contradiction to previous almost all the biomass was found at 601-801 in Div. 1C where it use be located in depth stratum 401-600 m.

Biomass of deep sea redfish.

Year	1997	1998	1999	2000[1)]	2001	2002[1)]	2003	2004	2005
Biomass	2 464.3	2 408.1	2 484.9		2 063.4		1 493.4	2 329.1	2 546.2
S.E.	787.1	503.9	1 007.7		873.5		684.5	1 986.8	1 683.3

1). Poor coverage of relevant depths.

Abundance of deep sea redfish.

Year	1997	1998	1999	2000[1)]	2001	2002[1)]	2003	2004	2005
Abundance *10^6	14.690	18.827	12.926		16.337		7.131	13.338	7.275
S.E.	5.500	4.496	4.093		6.474		3.079	11.314	3.159

1). Poor coverage of relevant depths.

The abundance was estimated as 7.275*10^6 (S.E. 3.159*10*^{6}) which is the second lowest estimate in the time series. (Table 12)

The length ranged from 11 to 46 cm with more large and less small fish were observed compared to previous years (Fig. 12).

Temperature

The bottom temperature ranged from 2.4 to 5.3°C and the mean temperature was generally decreasing by depth (Table 13).

The mean temperatures were 0.2-0.4°C higher in all strata in 2005 compared to 2004.

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Table.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. 23 hauls have been excluded as invalid.

					Grl. halibut		Roundnose gre.		Roughhead gre.		*S. mentella*	
St. No	Depth	S. Area	Div.	Temp.	Weight	Number	Weight	Number	Weight	Number	Weight	Number
5	866.5	0.0592	1C	4.1	89.1	85	1.3	33	8.5	29	0.0	0
6	949.0	0.0510	1C	4.0	223.1	193	0.5	19	7.9	23	0.0	0
7	890.0	0.0831	1C	4.2	191.2	170	1.3	41	12.0	23	0.0	0
9	863.0	0.0515	1C	4.2	41.6	50	4.0	102	2.5	10	0.2	1
13	801.5	0.0770	1C	4.1	67.0	73	0.9	27	12.8	31	0.3	2
14	423.5	0.0738	1C	5.1	1.9	4	0.0	0	3.1	10	5.6	22
16	731.0	0.0430	1C	4.2	8.2	11	0.5	18	4.0	9	1.0	3
17	685.0	0.0671	1C	4.2	25.6	36	0.2	2	8.7	18	2.9	14
18	627.5	0.0803	1C	2.4	45.6	73	0.0	1	11.2	31	3.2	25
19	653.5	0.0780	1C	3.5	9.4	25	0.0	0	5.4	13	0.8	6
20	699.5	0.0757	1C	4.0	24.0	32	0.0	0	11.7	39	0.8	4
21	794.5	0.0793	1C	4.2	42.8	47	0.0	0	13.7	51	1.2	5
22	818.5	0.0774	1C	4.0	88.0	80	0.0	0	8.5	31	0.0	0
23	826.5	0.0756	1C	4.0	91.3	100	0.3	2	5.4	12	0.1	1
24	826.5	0.0806	1C	4.0	85.6	89	0.2	2	5.1	20	0.0	0
25	737.5	0.0732	1C	4.4	20.4	22	1.0	24	7.7	23	4.6	13
28	795.0	0.0638	1D	4.1	61.1	58	0.4	12	3.2	14	1.0	2
30	843.0	0.0507	1D	4.1	43.9	40	0.4	8	2.2	2	0.0	0
31	882.5	0.0771	1C	4.1	73.1	66	0.0	2	2.8	8	0.4	1
32	897.5	0.0779	1C	4.1	88.0	106	0.3	10	2.9	9	0.0	0
33	1074.5	0.0766	1C	3.8	344.9	324	1.8	46	20.9	46	0.2	1
34	1036.0	0.0792	1C	3.9	321.3	313	1.9	42	8.4	23	0.0	0
35	1137.0	0.0554	1D	3.8	52.7	39	0.0	0	13.5	21	0.0	0
36	1132.0	0.0782	1D	3.7	64.6	54	0.2	2	10.4	29	0.0	0
37	1149.0	0.0727	1D	3.7	396.3	337	1.4	27	9.4	24	0.0	0
38	1214.0	0.0391	1D	3.6	96.4	90	0.0	0	1.0	2	0.2	1
39	1189.0	0.0497	1D	3.7	80.8	63	0.1	3	2.9	7	0.0	0
40	1246.0	0.0773	1D	3.8	182.3	144	0.3	4	6.4	17	0.0	0
41	1170.0	0.0825	1D	3.7	82.5	68	0.7	2	3.1	7	0.0	0
42	905.0	0.0744	1D	3.8	97.3	75	0.2	4	8.0	11	0.0	0
44	1022.5	0.0807	1D	3.7	116.0	116	0.1	3	2.7	11	0.0	0
45	962.0	0.0789	1D	4.2	157.1	159	0.4	2	8.9	15	0.3	1
46	1089.5	0.0801	1D	3.7	177.3	180	0.1	2	3.3	11	0.0	0
47	1239.0	0.0791	1D	3.6	298.5	296	1.0	3	11.6	28	0.0	0
48	1170.0	0.0844	1D	3.7	220.3	237	2.2	15	3.5	10	0.0	0
49	1342.0	0.0798	1D	3.6	236.0	218	1.1	5	3.5	7	0.4	1
50	1446.0	0.0837	1D	3.6	401.8	330	8.7	26	4.2	11	0.0	0
51	1485.0	0.0801	1D	3.6	340.4	250	2.6	12	4.6	12	0.0	0
52	1359.5	0.0810	1D	3.6	393.7	316	0.7	2	9.4	26	0.0	0
54	1425.5	0.0481	1D	3.7	26.6	13	4.1	11	19.1	39	0.0	0
55	1233.5	0.0805	1D	3.7	101.0	73	2.4	10	7.0	14	0.0	0
56	1173.0	0.0861	1D	3.7	288.0	217	0.3	5	16.9	20	0.0	0
57	1326.5	0.0306	1D	3.8	57.9	43	0.6	3	2.2	5	0.0	0
60	1334.5	0.0455	1D	3.7	83.9	60	0.3	2	3.0	7	0.0	0
61	1378.5	0.0580	1D	3.8	215.1	203	2.4	17	1.5	4	0.0	0
62	1344.0	0.0647	1D	3.1	925.3	792	5.6	56	15.3	25	0.0	0
63	1477.5	0.0443	1D	3.4	30.7	20	2.3	11	7.1	12	0.1	1
65	1430.5	0.0837	1D	3.6	68.0	41	5.5	22	11.3	23	0.0	0
66	1422.0	0.0516	1D	3.7	67.6	46	1.4	11	12.9	19	0.0	0

Table.1. (continued)

68	1244.0	0.0754	1D	3.7	140.7	89	2.2	10	9.6	19	0.0	0
72	1287.5	0.0523	1D	3.6	168.8	123	1.8	14	6.3	15	0.0	0
74	1120.5	0.0836	1D	3.7	429.2	327	1.1	5	5.9	15	0.0	0
75	1127.5	0.0860	1D	3.2	293.6	230	0.8	9	8.6	21	0.0	0
76	1068.5	0.0710	1D	3.7	154.8	138	2.1	47	25.1	56	0.0	0
77	1105.0	0.0681	1D	3.7	223.1	185	0.2	3	12.8	39	0.3	1
78	1162.0	0.0695	1D	3.7	159.4	115	1.0	7	11.7	34	0.0	0
80	422.0	0.0695	1C	5.2	0.53	1	0.0	0	0.8	3	1.9	15
81	715.0	0.0835	1C	4.9	35.35	42	3.7	148	7.2	14	71.9	140
82	864.5	0.0857	1C	4.6	190.6	205	4.2	122	9.2	19	6.9	13
83	411.5	0.0577	1D	5.3	2.03	2	0.0	0	3.0	9	3.3	39
84	417.5	0.0827	1D	4.7	58.4	115	0.2	1	0.0	0	19.2	100

Table 2. Biomass (tons) of Greenland halibut by Division and depth stratum, 2005.

Div.	Depth (m)	Area	Hauls	Mean	Biomass	SE
1C	401-600	3366	2	0.0169	57.0	31.3
	601-800	16120	8	0.3521	5675.4	900.9
	801-1000	6066	11	1.5967	9685.3	1923.8
	1001-1200	611	2	4.2801	2615.1	137.0
1D	401-600	903	2	0.3705	334.6	302.8
	601-800	1940	1	0.9564	1855.4	
	801-1000	3874	3	1.3881	5377.6	1269.9
	1001-1200	10140	14	2.5536	25893.4	3927.9
	1201-1400	6195	12	3.7088	22976.1	6242.4
	1401-1500	3091	6	2.0691	6395.6	2430.9
All				1.54601	80865.4	8365.7

Table 3. Abundance of Greenland halibut by Division and depth stratum, 2005.

Division	Depth (m)	Area	Hauls	Mean sq/km	Abundance	SE
1C	401-600	3366	2	34.3	115401.1	66979.7
	601-800	16120	8	480.1	7738571.1	1203586.9
	801-1000	6066	11	1568.6	9515215.1	1604367.4
	1001-1200	611	2	4091.2	2499724.3	855982
1D	401-600	903	2	712.3	643179.7	611894.6
	601-800	1940	1	908.6	1762674.0	
	801-1000	3874	3	1270.8	4923189.5	1464269.0
	1001-1200	10140	14	2145.0	21750788.4	3188052.2
	1201-1400	6195	12	3120.3	19330470.8	5452636.6
	1401-1500	3091	6	1527.5	4721488.2	2002106.9
All				1395.7	73000702.3	7318695.4

Table 4. Estimated abundance by age from Div. 1C-1D from the surveys in 1997-2005. The Age-length key from 1998 is applied on the 1999 data.

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

Table 5. Mean weight and mean length-at-age of Greenland halibut, 1997-2005.

	1997		1998		1999		2000		2001		2002		2003		2004		2005	
AGE	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						
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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			893	93.0	9570	97.0
19			12850	99.0			9645	91.5	11500	102.0	8553	90.3			10220	93.0	14150	101.0
20									14400	105.0								

Table 6. Maturity-at-age in percent, females, Div. 1C-1D, 2005. 1 immature, 2 maturing.

	Maturity		
	1	2	
	Pct	Pct	N
Age			
4	100.0		16
5	100.0		18
6	90.9	9.1	11
7	100.0		13
8	78.8	21.2	33
9	66.7	33.3	3
10	34.3	65.7	35
11	16.7	83.3	6
12	9.1	90.9	55
13		100.0	3
14	8.0	92.0	25
15		100.0	3
16		100.0	1
18		100.0	1
19		100.0	1

Table 7. Biomass of (tons) roundnose grenadier by Division and depth stratum, 2005.

Div.	Depth (m)	Area	Hauls	Mean	Biomass	SE
1C	401-600	3366	2	0.000	0.0	0.0
	601-800	16120	8	0.009	144.9	86.0
	801-1000	6066	11	0.018	108.0	44.3
	1001-1200	611	2	0.023	14.3	0.2
1D	401-600	903	2	0.001	1.3	1.3
	601-800	1940	1	0.006	11.7	
	801-1000	3874	3	0.006	21.2	6.6
	1001-1200	10140	14	0.010	96.4	26.7
	1201-1400	6195	12	0.024	147.7	42.2
	1401-1500	3091	6	0.061	187.5	37.6
All				0.014	733.0	116.0

Table 8. Abundance of roundnose grenadier by Division and depth stratum, 2005.

Div.	Depth (m)	Area	Hauls	Mean	Abundace	SE
1C	401-600	3366	2	0.0	0.0	0.0
	601-800	16120	8	320.1	5159637.3	3477159.4
	801-1000	6066	11	489.4	2968703.3	1177984.3
	1001-1200	611	2	565.5	345496.1	215559
1D	401-600	903	2	6.0	5456.8	5456.8
	601-800	1940	1	188.0	364691.2	
	801-1000	3874	3	78.9	305763.3	155765.2
	1001-1200	10140	14	125.0	1267803.5	490310.1
	1201-1400	6195	12	166.8	1033582.2	426684.1
	1401-1500	3091	6	235.5	728043.2	67764.3
All				232.8	12179176.9	3750079.6

Table 9. Biomass (tons) of roughhead grenadier by Division and depth stratum, 2005.

Div.	Depth (m)	Area	Hauls	Mean	Biomass	SE
1C	401-600	3366	2	0.027	89.5	51.4
	601-800	16120	8	0.119	1912.2	204.4
	801-1000	6066	11	0.098	596.3	89.7
	1001-1200	611	2	0.190	115.8	51.0
1D	401-600	903	2	0.026	23.2	23.2
	601-800	1940	1	0.049	95.7	
	801-1000	3874	3	0.088	340.0	87.1
	1001-1200	10140	14	0.128	1297.4	254.9
	1201-1400	6195	12	0.096	592.1	106.1
	1401-1500	3091	6	0.175	540.3	165.6
All				0.107	5602.6	419.5

Table 10. Abundance of roughhead grenadier by Division and depth stratum, 2005

Div.	Depth (m)	Area	Hauls	Mean	Abundace	SE
1C	401-600	3366	2	89.3	300608.2	155343.8
	601-800	16120	8	333.8	5380132.0	980376.2
	801-1000	6066	11	278.4	1688773.7	250270.7
	1001-1200	611	2	445.5	272223.9	94828.1
1D	401-600	903	2	78.0	70391.4	70391.4
	601-800	1940	1	219.3	425473.0	
	801-1000	3874	3	125.8	487443.4	173942.4
	1001-1200	10140	14	300.3	3044841.4	552988.7
	1201-1400	6195	12	209.9	1300512.2	200860.0
	1401-1500	3091	6	334.3	1033473.6	314987.3
All				267.7	14003872.9	1310913.2

Table 11. Biomass of *Sebastes mentella* by Division and depth stratum, 2005

Div.	Depth (m)	Area	Hauls	Mean	Biomass	SE
1C	401-600	3366	2	0.1	173.2	82.2
	601-800	16120	8	0.1	2144.2	1678.6
	801-1000	6066	11	0.0	52.8	43.4
	1001-1200	611	2	0.0	0.8	0.8
1D	401-600	903	2	0.1	130.3	79.2
	601-800	1940	1	0.0	30.3	
	801-1000	3874	3	0.0	4.4	4.4
	1001-1200	10140	14	0.0	3.2	3.2
	1201-1400	6195	12	0.0	5.6	3.8
	1401-1500	3091	6	0.0	1.3	1.3
All				0.0	2546.2	1683.3

Table 12. Abundance of *Sebastes mentella* by Division and depth stratum, 2005

Div.	Depth (m)	Area	Hauls	Mean	Abundance	SE
1C	401-600	3366	2	256.9	864708.4	138386.0
	601-800	16120	8	329.6	5312936.0	3145275.4
	801-1000	6066	11	20.3	123171.5	81580.6
	1001-1200	611	2	6.5	3989.7	3989.7
1D	401-600	903	2	942.1	850714	240655.0
	601-800	1940	1	31.3	60781.9	
	801-1000	3874	3	4.2	16373.4	16373.4
	1001-1200	10140	14	1.0	10641.4	10641.4
	1201-1400	6195	12	3.2	19655.5	14150.3
	1401-1500	3091	6	3.8	11621.4	11621.4
All				139.1	7274593.1	3159257.1

Table 13. 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	5.2	.08	2	4.0	.26	8	4.1	.05	11	3.8	.03	2						
1D	5.0	.33	2	4.1		1	4.0	.12	3	3.7	.04	14	3.6	.05	12	3.6	.04	6

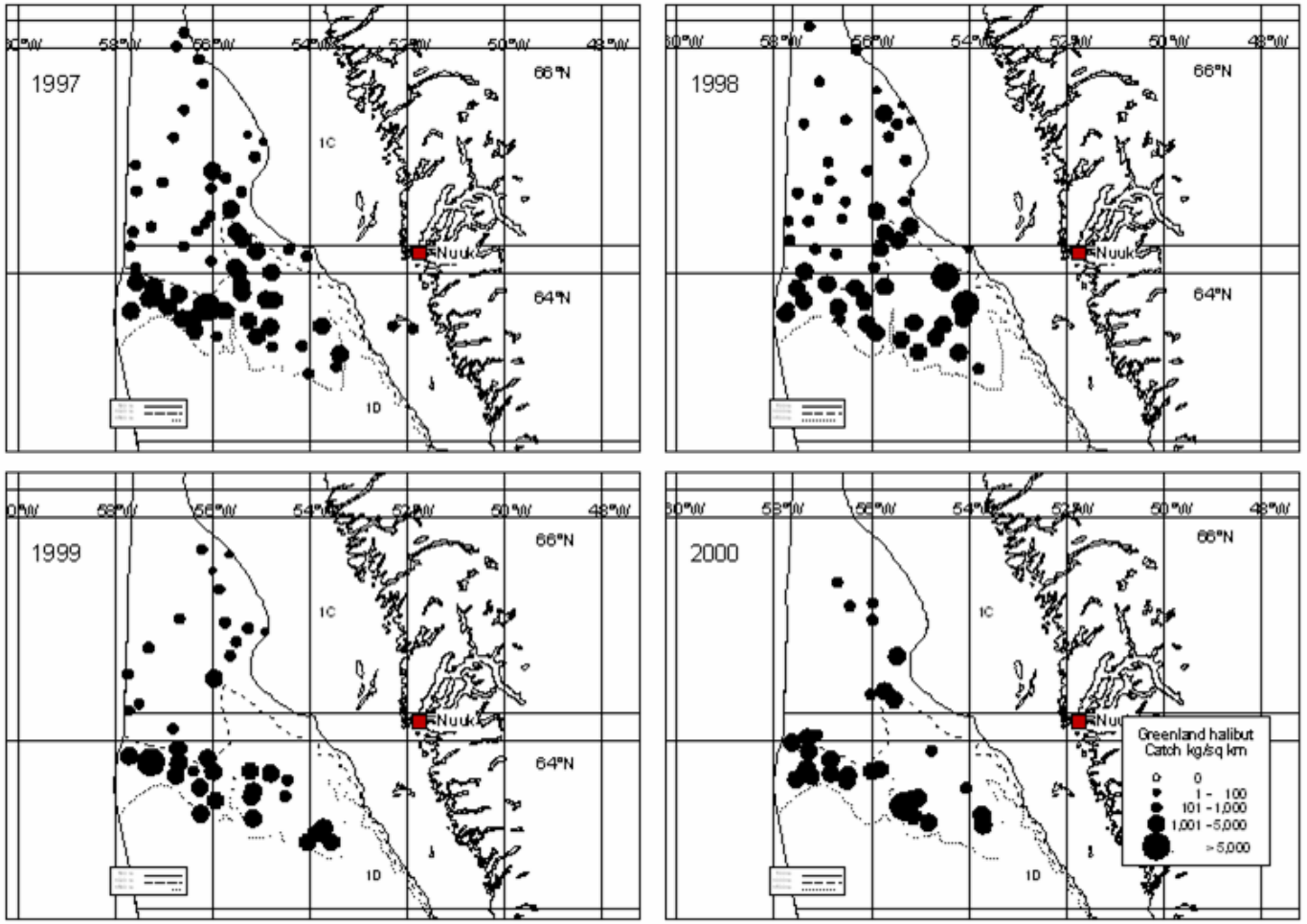

Fig. 1 Distribution of catches of Greenland halibut during 1997-2000 in kg km^{-2}.

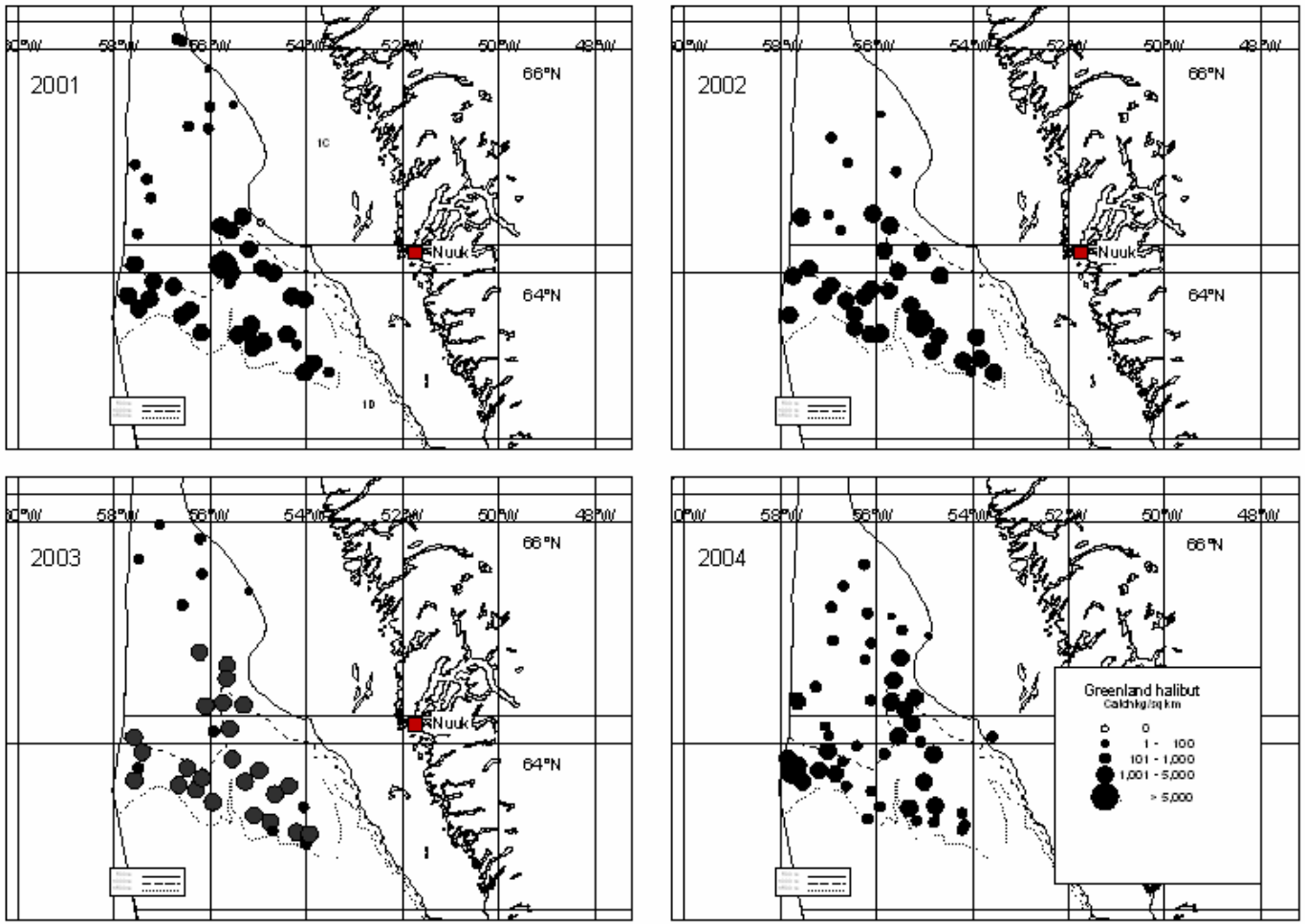

Fig. 1 (cont). Distribution of catches of Greenland halibut in 2001 - 2004 in kg km^{-2}

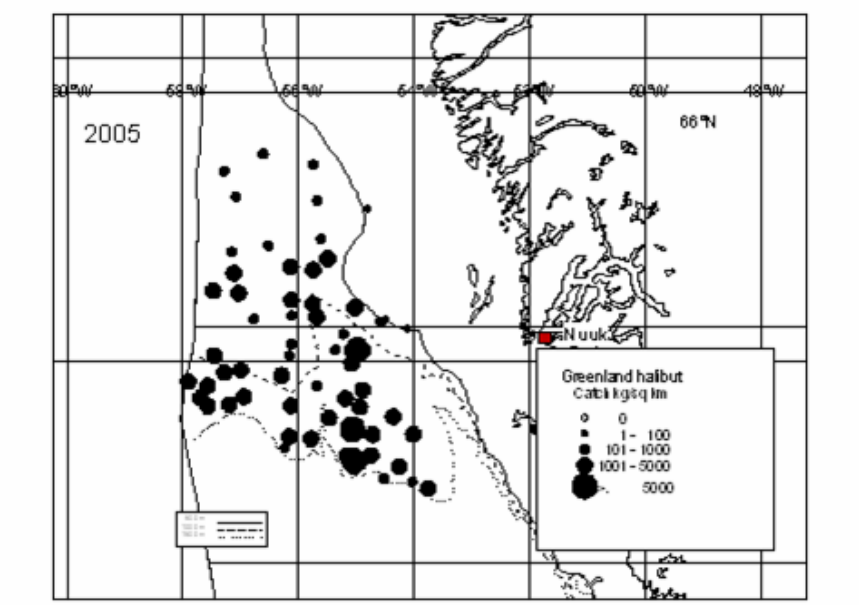

Fig. 1 cont. Distribution of catches of Greenland halibut (kg per sq km) in 2005

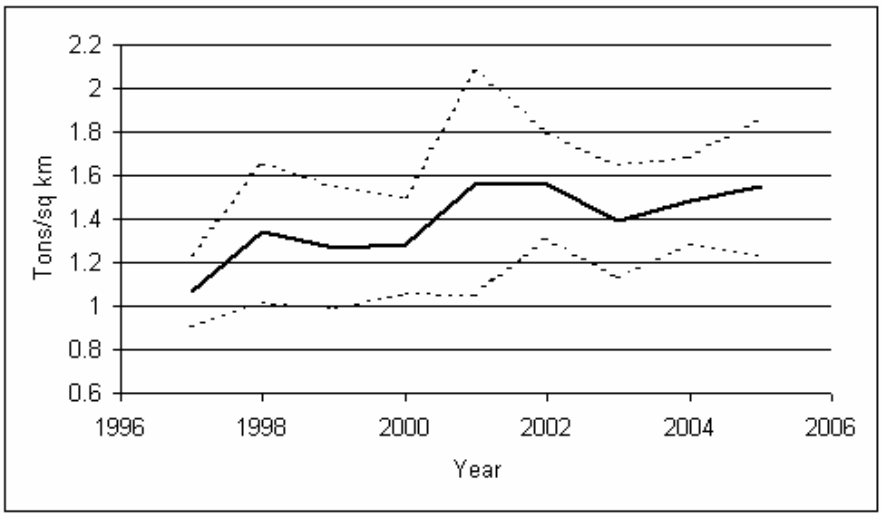

Fig. 2. Mean catch of Greenland halibut per sq. km (tons) standardized by stratum area with 2* +/- S.E.

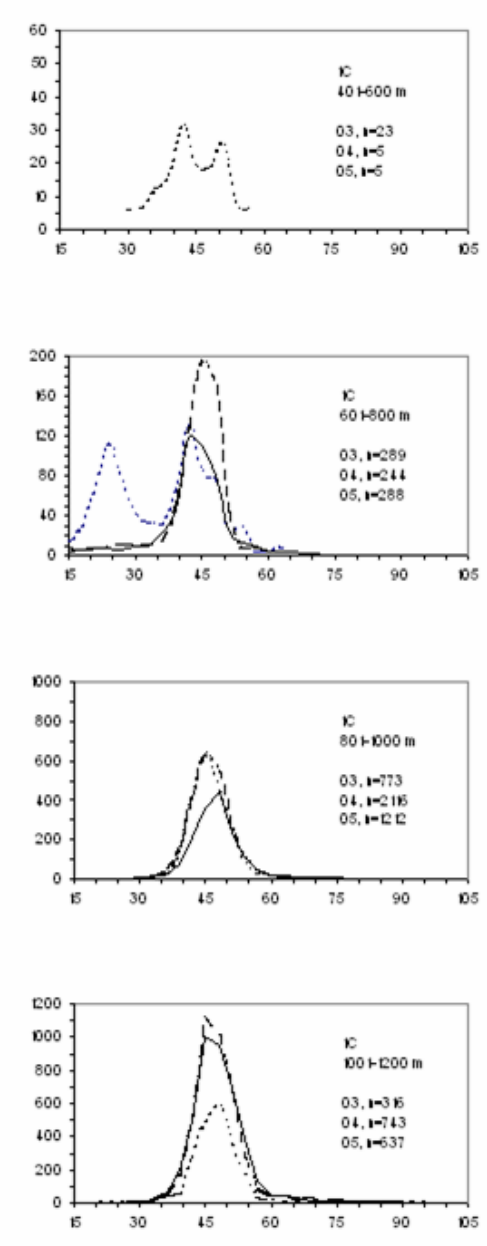

Fig. 3. Length distribution in numbers/km^2 of Greenland halibut (3 cm groups) by year, and depth stratum in Div. 1C. Note different scales on y-axis.. 2003. Dotted line 2004: Dashed line. 2005: Solid line

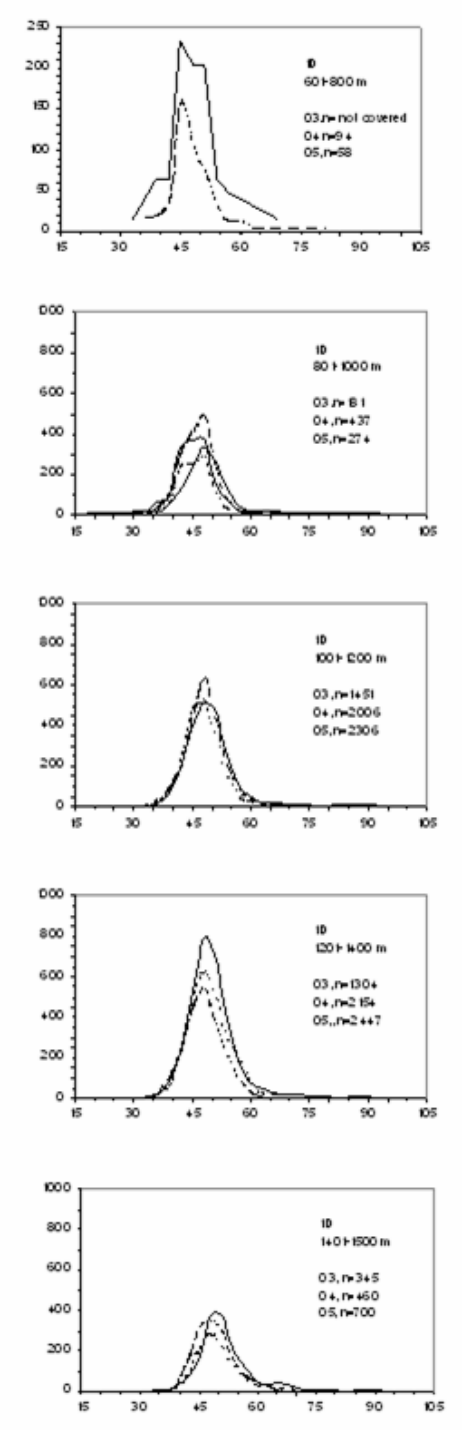

Fig. 3. (cont'd) Length distribution in numbers/km^2 of Greenland halibut (3 cm groups) by year, and depth stratum in Div. 1D. Note different scales on y-axis. 2002: Solid line. 2003. Dotted line. 2004: Dashed line.

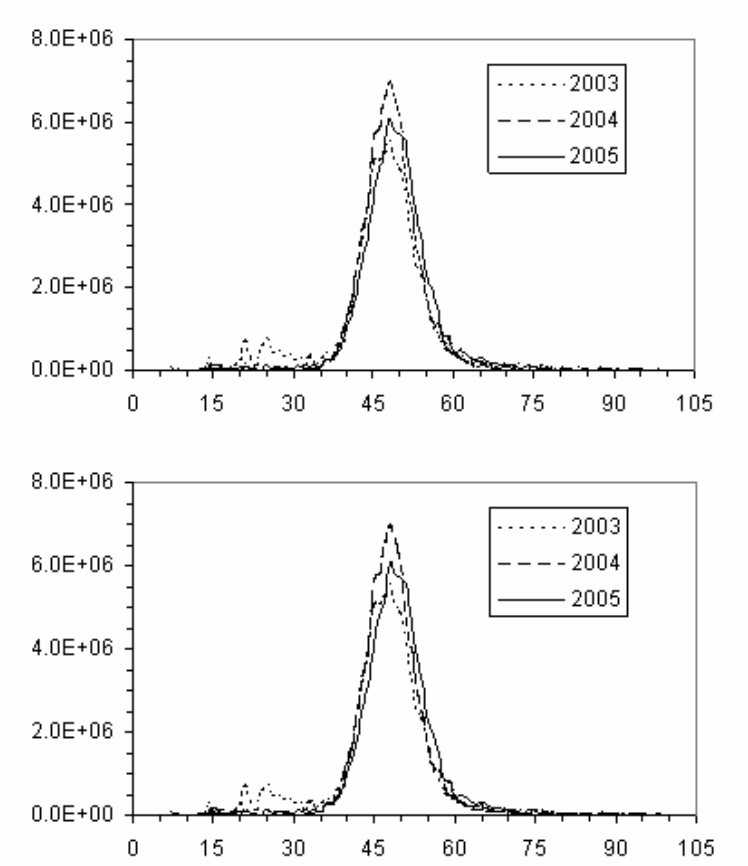

Fig. 4. Over all length distribution of Greenland halibut in numbers (weighted by stratum area) by year.

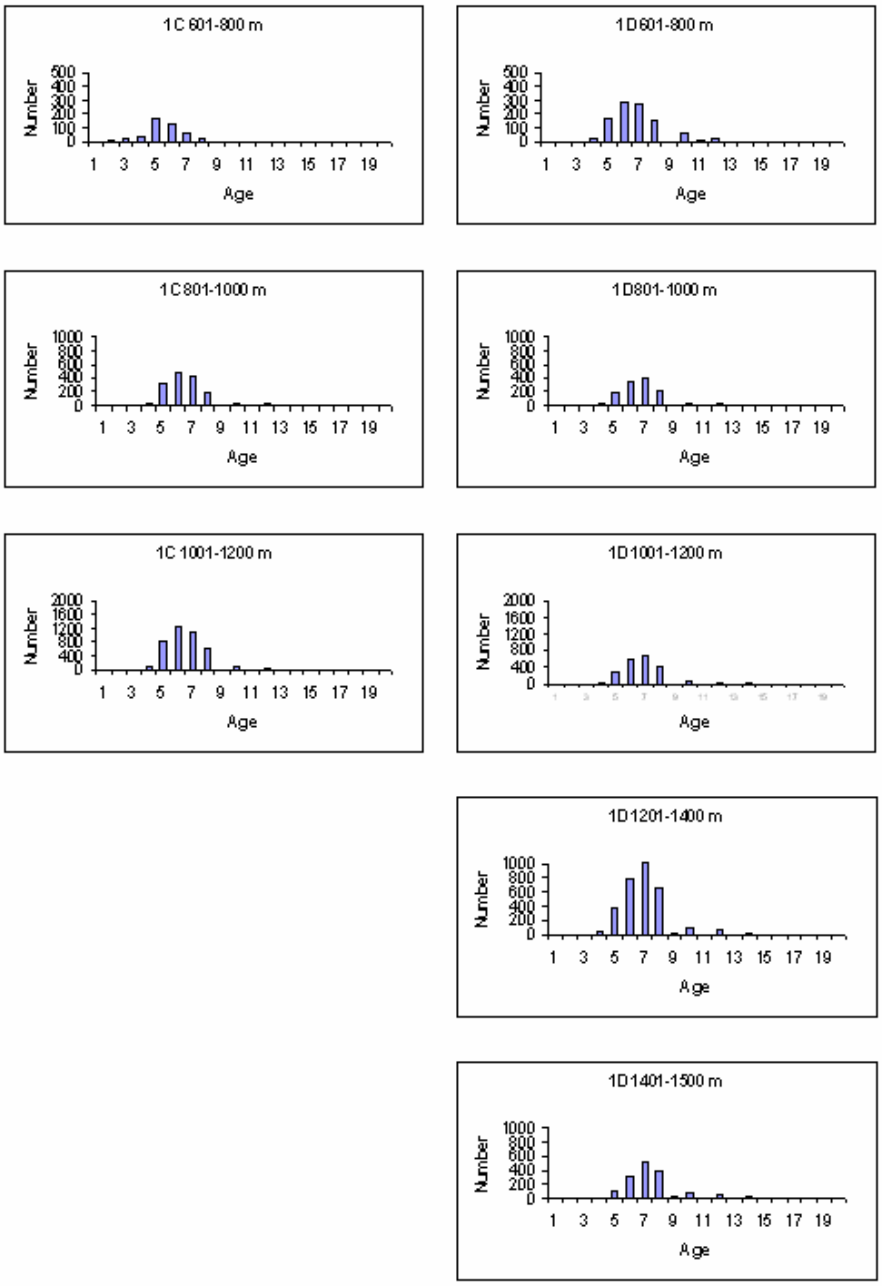

Fig. 5. Age distribution (number km^{-2}) by NAFO Division and depth stratum. Note different scales on y-axis.

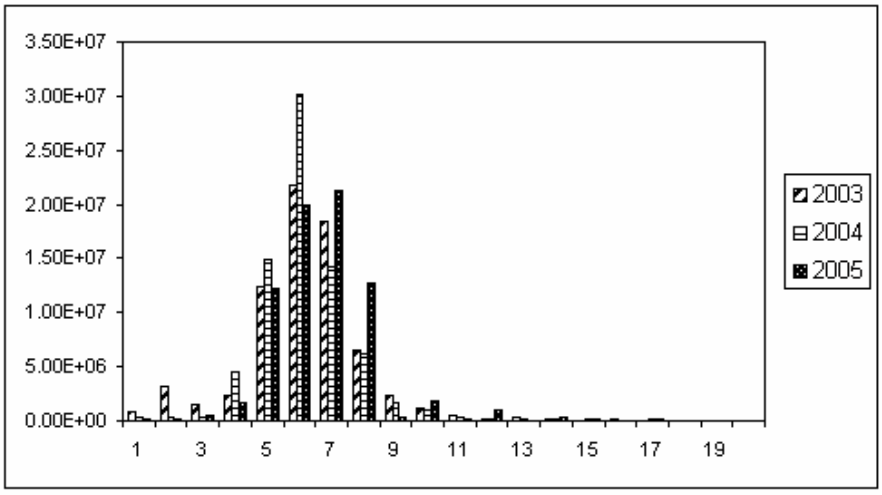

Fig. 6. Total age distribution in numbers (weighted by stratum area) of Greenland halibut in NAFO Div. 1C-1D in 2003- 2005.

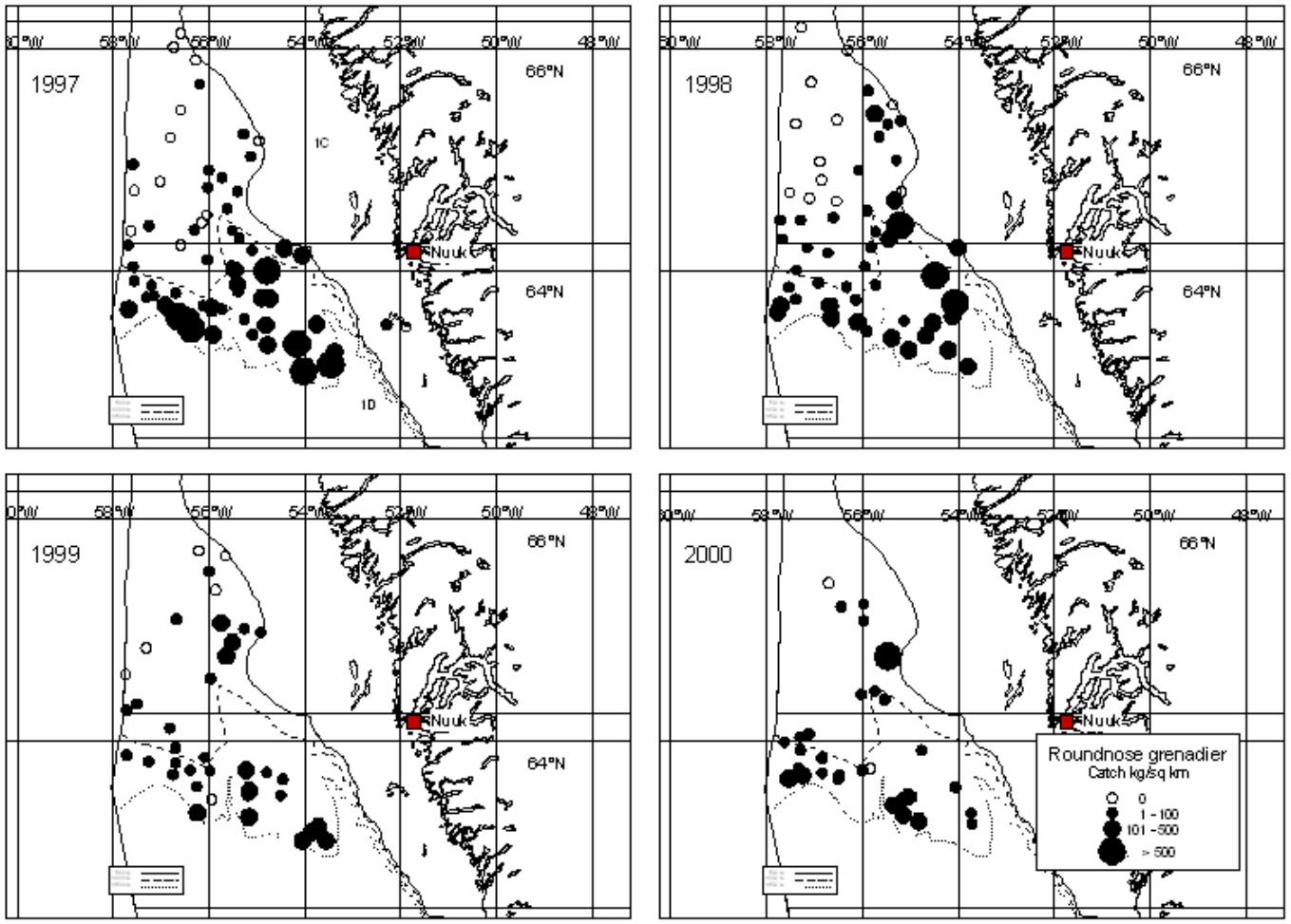

Fig. 7. Distribution of catches of roundnose grenadier in 1997-2000 in kg km^{-2}.

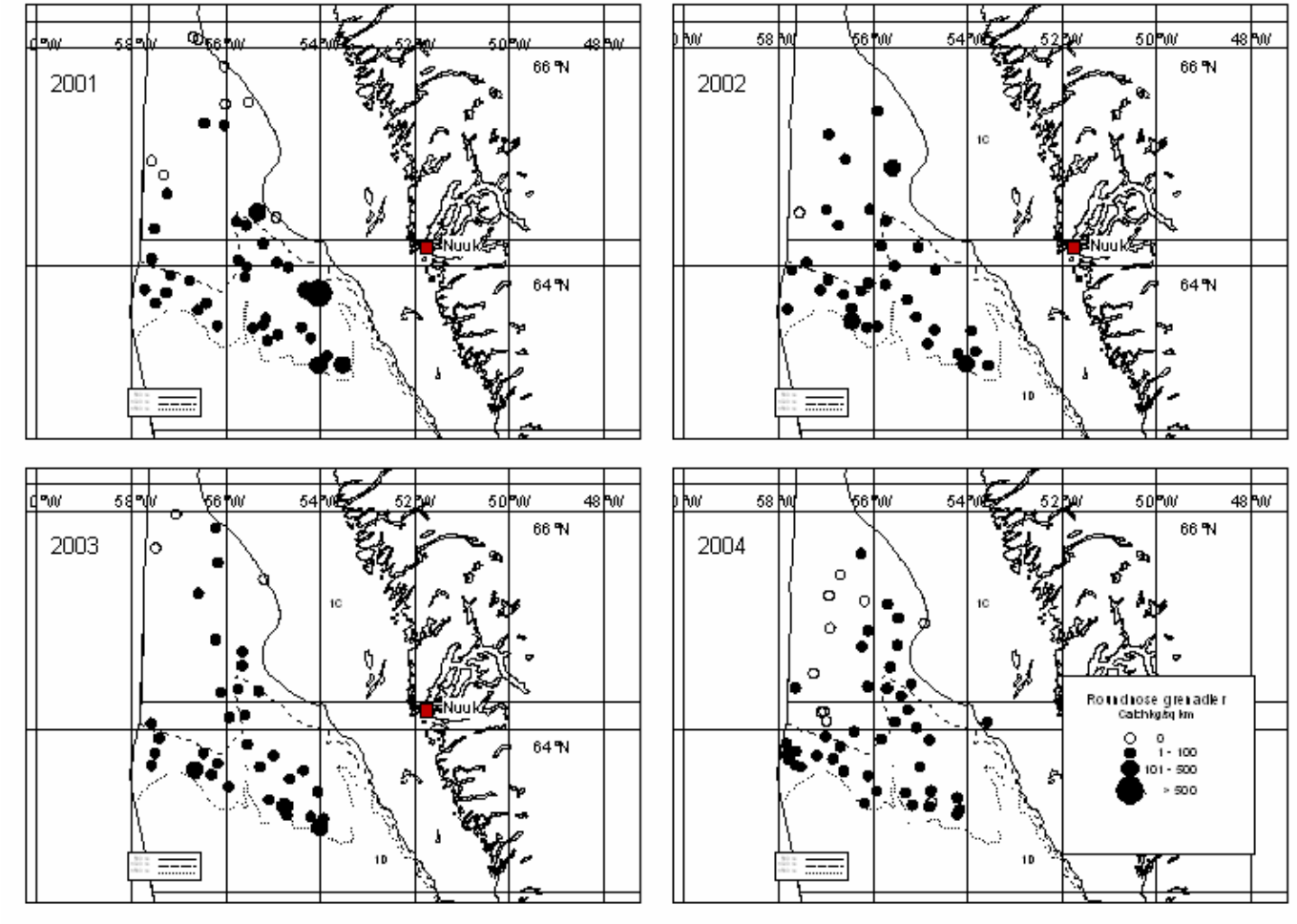

Fig. 7 cont. Distribution of catches of roundnose grenadier during 2001-2004.

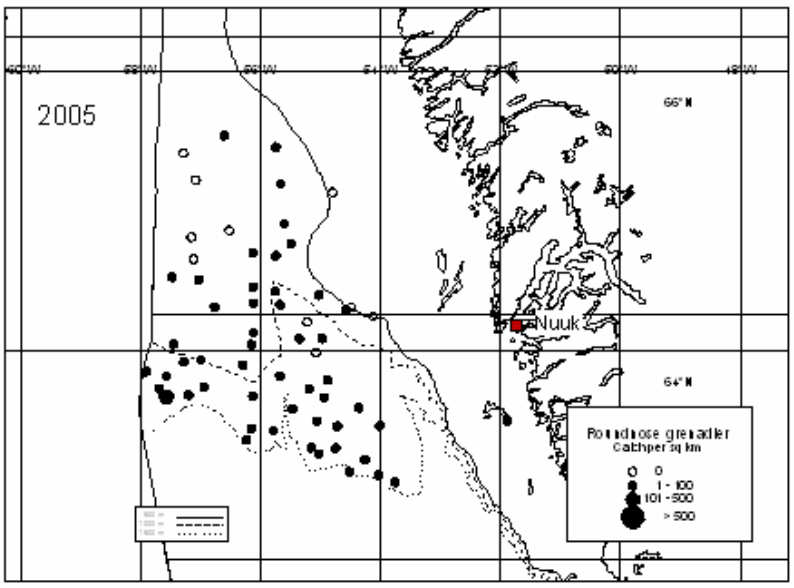

Fig. 7 cont. Catches of roundnose grenadier (kg per km) in 2005.

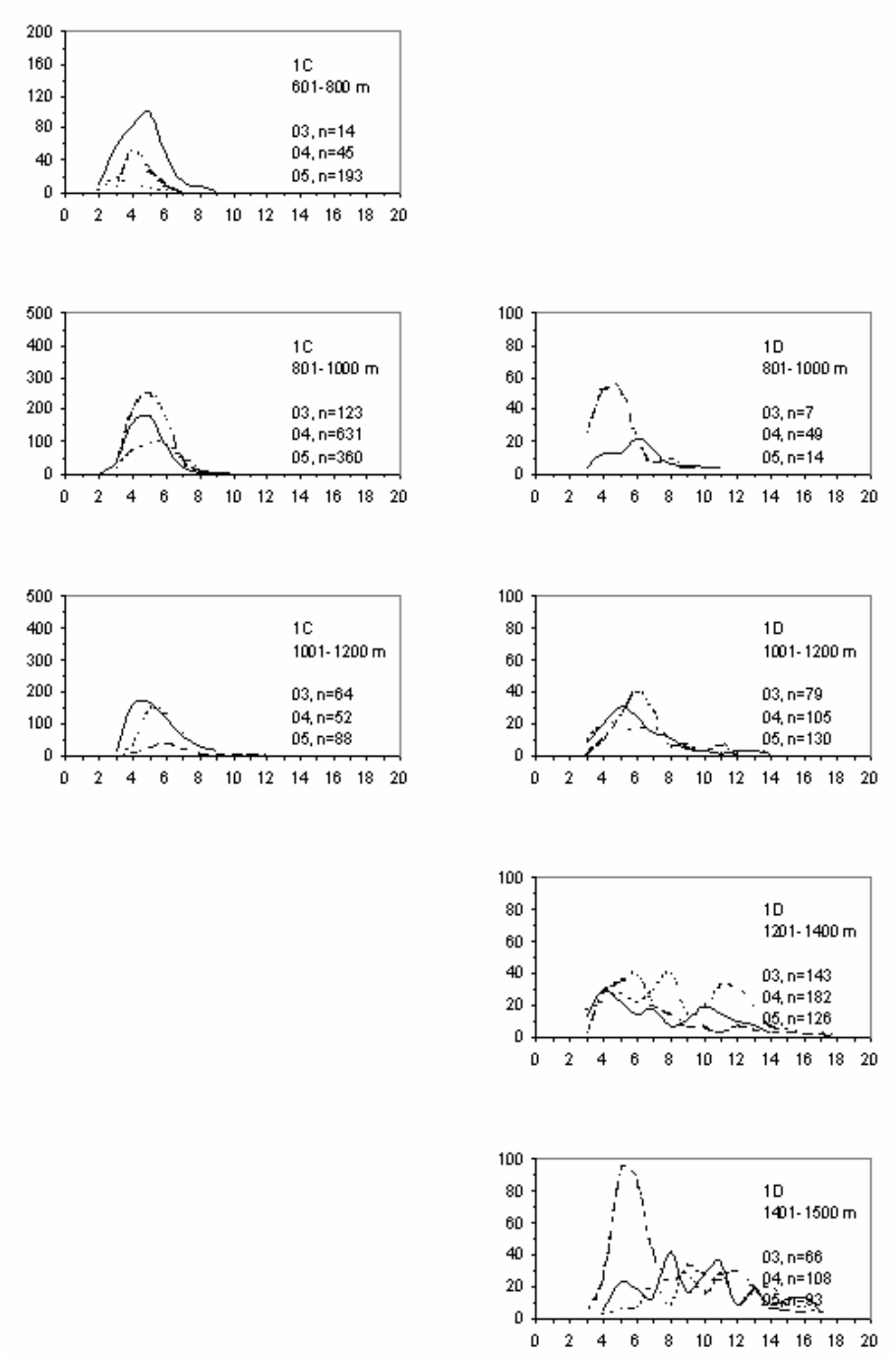

Fig. 8. Length distribution (pre anal fin length) of roundnose grenadier in numbers/km^2 by year and depth strata. Dotted line: 2003. Dashed line: 2004. Solid line: 2005

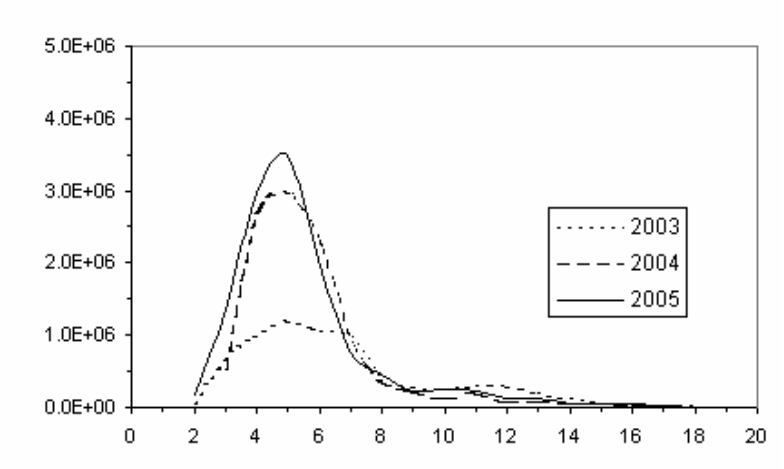

Fig. 9. Overall length distribution of roundnose grenadier (pre anal fin length) in numbers (weighted by stratum area) by year.

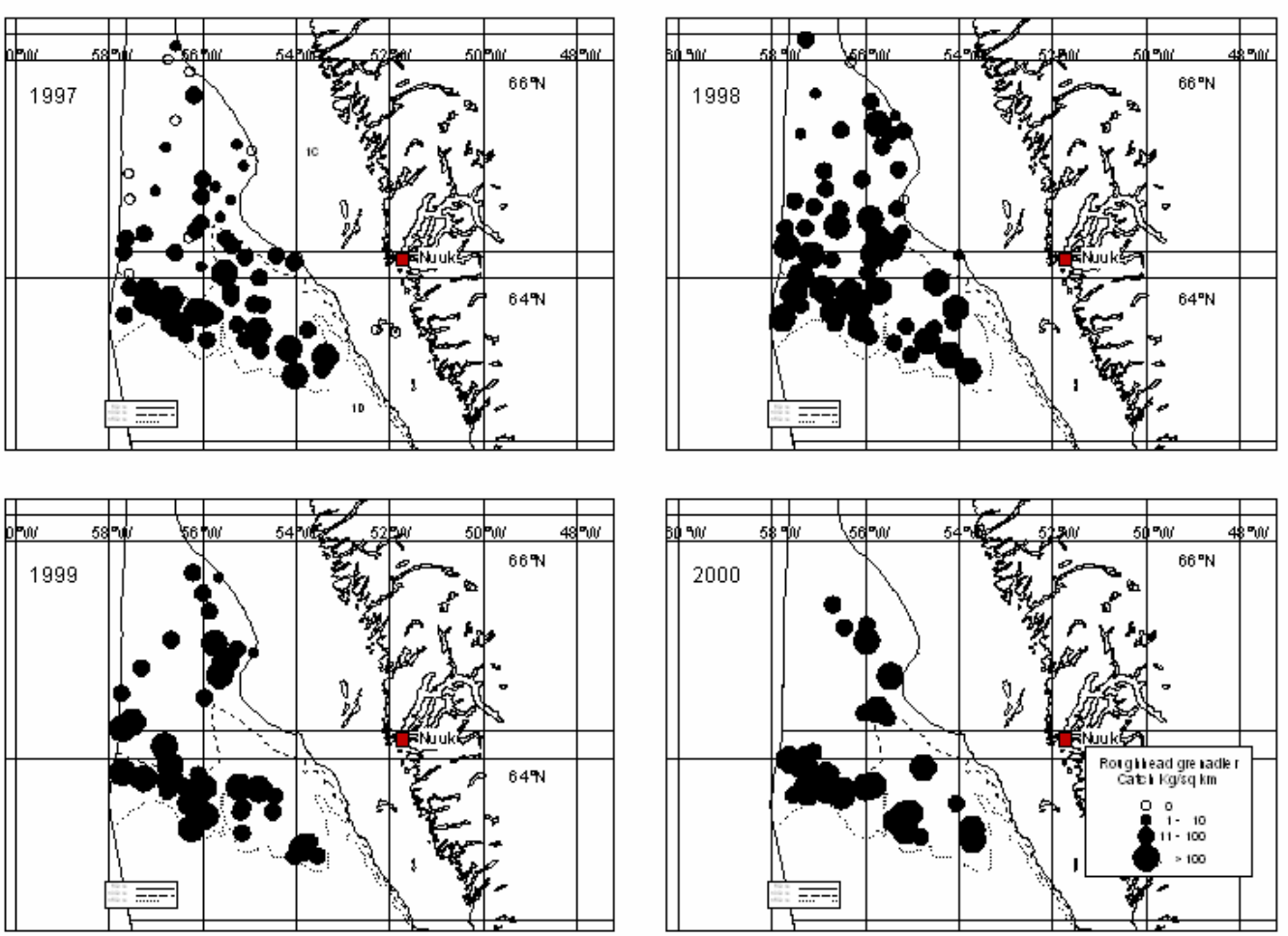

Fig. 10. Distribution of catches of roughhead grenadier in 1997-2000 in kg km^{-2}.

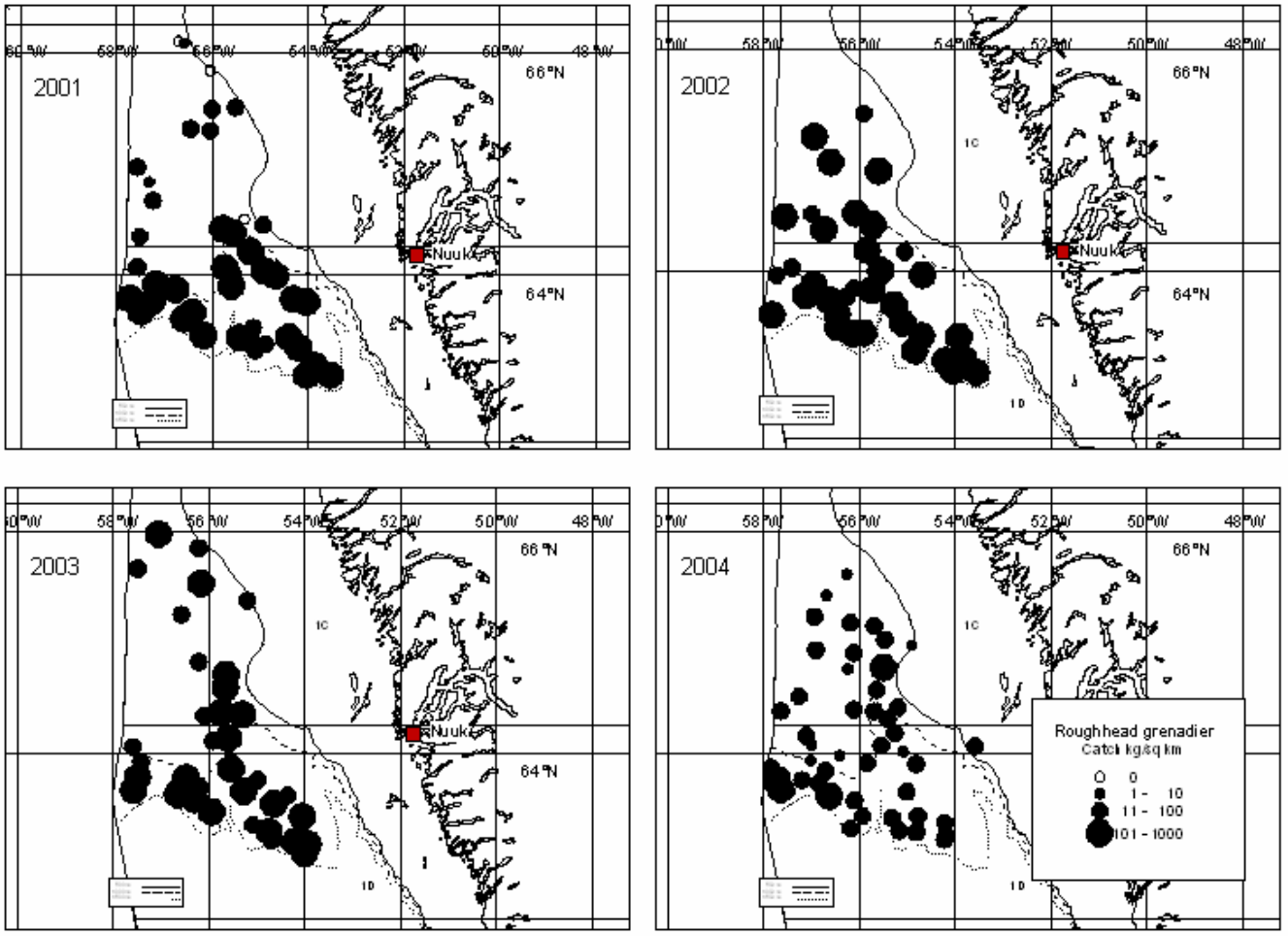

Fig. 10 cont.. Distribution of catches of roughhead grenadier during 2001-2004.

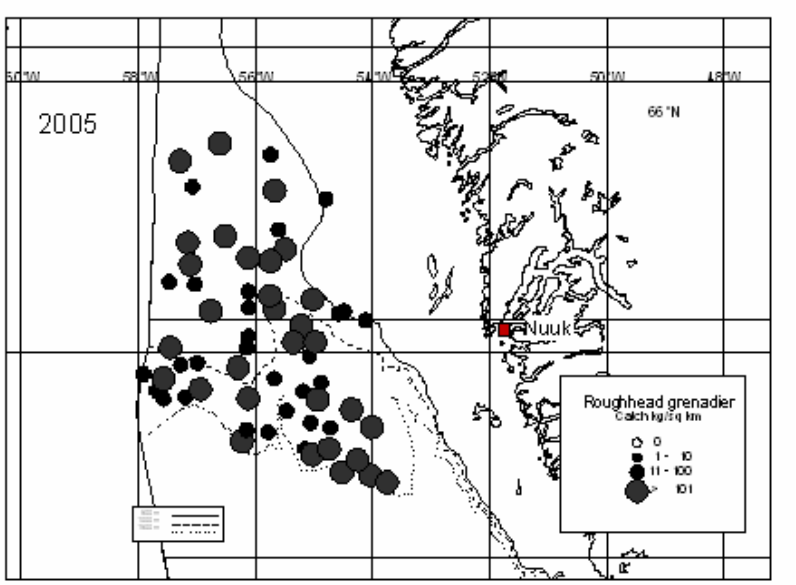

Fig 10. cont. Catches of roughhead grenadier (kg per sq km) in 2005.

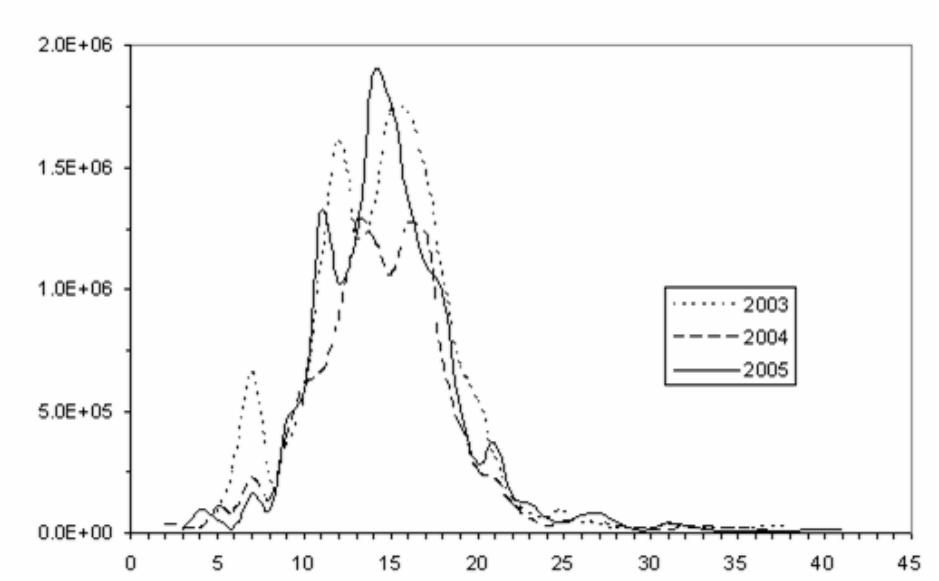

Fig. 11. Overall length distribution (pre anal fin length) of roughhead grenadier in numbers (weighted by stratum area) by year.

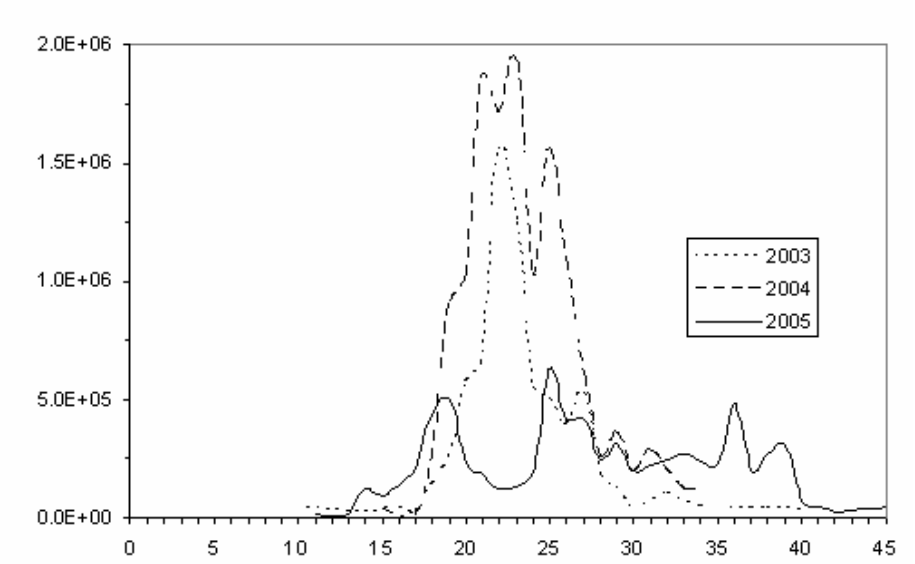

Fig. 12. Overall length distribution (pre anal fin length) of deep sea redfish in numbers (weighted by stratum area) by year .

Appendix 1. List of species and groups of species recorded in Div. 1C-D in 2005 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	wgt	no	depth range		temp range		maxpos
1	New		0.0	1	1422.0	1422.0	3.6	3.6	63.0510
2	ALA	Alepocephalus agassizzi	307.2	261	1132.0	1485.0	3.6	3.6	64.0799
3	CAD	Anarhichas denticulatus	10.8	2	794.5	1477.5	3.6	3.6	64.8113
4	CAA	Anarhichas lupus	0.0	1	422.0	423.5	4.8	4.8	65.1329
5	CAS	Anarhichas minor	18.0	4	411.5	423.5	4.8	4.8	65.1329
6	ANC	Anopologaster cornuta	0.0	1	1068.5	1422.0	3.6	3.6	63.7238
7	ANT	Antimora rostrata	32.4	71	699.5	1485.0	3.6	4.8	65.1938
8	ARZ	Arctozenius rissoi	0.0	3	417.5	1344.0	3.6	4.8	65.2224
9	BAM	Bajacalifornia megalops	1.2	1	1132.0	1342.0	3.6	3.6	64.0799
10	BAT	Bathylagus euryops	3.6	75	423.5	1485.0	3.6	4.8	65.5405
11	BBA	Bathypolypus baridii	0.0	1	699.5	818.5	3.6	4.8	65.4594
12	BSE	Bathypolypus sp.	1.2	1	423.5	1344.0	3.6	4.8	65.1329
13	BSP	Bathyraja spinicauda	18.0	1	1105.0	1162.0	3.6	3.6	63.6580
14	BEG	Benthosema glaciale	1.2	129	417.5	1446.0	2.4	4.8	65.5405
15	POC	Boreogadus saida	0.0	1	627.5	1127.5	2.4	3.6	65.4127
16	BOA	Borostomias antarctica	0.0	4	795.0	1485.0	3.6	3.6	64.7000
17	CRM	Careproctus micropus	0.0	2	699.5	843.0	3.6	3.6	64.8586
18	CAR	Careproctus reinhardti	0.0	2	685.0	826.5	3.6	4.8	65.5405
19	CFB	Centroscyllium fabricii	22.8	39	685.0	1287.5	3.6	4.8	65.5405
20	CHO	Ceratias holboelli	0.0	1	1344.0	1485.0	3.6	3.6	63.6757
21	CHL	Chaenophryne longiceps	1.2	1	890.0	890.0	3.6	3.6	64.7000
22	CHA	Chauliodus sloani	42.0	4	737.5	1477.5	3.6	4.8	65.1938
23	CHN	Chiasmodon niger	0.0	5	423.5	1239.0	3.6	4.8	65.4594
24	CRQ	Chionocetes opilio	9.6	27	417.5	417.5	4.8	4.8	63.4912
25	CBB	Coryphaenoides brevibarbis	24.0	7	1074.5	1485.0	3.6	3.6	64.3251
26	CGR	Coryphaenoides guntheri	2.4	40	905.0	1485.0	3.6	3.6	64.6775
27	RNG	Coryphaenoides rupestris	8.4	148	417.5	1485.0	2.4	4.8	65.5405
28	COM	Cottunculus microps	0.0	2	422.0	1089.5	2.4	4.8	65.4127
29	COT	Cottunculus thomsonii	1.2	2	737.5	1287.5	3.6	4.8	65.1938
30	LUM	Cyclopterus lumpus	2.4	1	423.5	1149.0	3.6	4.8	65.1329
31	CLM	Cyclothone microdon	1.2	25	699.5	1477.5	3.6	3.6	65.1938
32	EUR	Eurypharynx pelecanoides	0.0	2	1105.0	1477.5	3.6	3.6	63.8464
33	COD	Gadus morhua	25.2	57	411.5	715.0	4.8	4.8	65.1329
34	ONA	Gaidropsarus argentatus	1.2	3	627.5	1422.0	2.4	4.8	65.5405
35	ONN	Gaidropsaurus ensis	4.8	34	627.5	1485.0	2.4	4.8	65.5405
36	WIT	Glyptocephalus cynoglossus	0.0	1	863.0	863.0	3.6	3.6	64.9069
37	GOB	Gonostoma bathyphilum	0.0	3	627.5	1170.0	2.4	3.6	65.4127
38	PLA	Hippoglossoides platessoides	26.4	144	411.5	864.5	3.6	4.8	65.5405
39	HAL	Hippoglossus hippoglossus	2.4	1	715.0	715.0	4.8	4.8	64.2913
40	HOA	Holtbyrnia anomala	0.0	2	826.5	1430.5	3.6	3.6	64.5233
41	HMC	Holtbyrnia macrops	0.0	1	794.5	1120.5	3.6	3.6	64.8113
42	LMC	Lampanyctus macdonaldi	3.6	203	411.5	1485.0	3.6	4.8	65.5405
43	LAI	Lampenyctus intricarius	0.0	36	897.5	1214.0	3.6	3.6	64.4538
44	LEP	Lepedion eques	0.0	3	715.0	864.5	3.6	4.8	64.3954
45	LIF	Liparis fabricii	0.0	1	627.5	627.5	2.4	2.4	65.4127
46	KCT	Lithodes maja	2.4	2	411.5	715.0	4.8	4.8	64.3082
47	LYE	Lycodes esmarki	0.0	1	795.0	795.0	3.6	3.6	64.0389
48	LYN	Lycodes eudipleurostictus	0.0	1	653.5	653.5	3.6	3.6	65.2224
49	LPA	Lycodes paamiuti	0.0	1	627.5	627.5	2.4	2.4	65.4127
50	ELZ	Lycodes sp.	0.0	1	1239.0	1425.5	3.6	3.6	63.8127
51	LYT	Lycodes terranova	0.0	2	890.0	1342.0	3.6	3.6	64.7000
52	LYV	Lycodes vahli	2.4	27	417.5	417.5	4.8	4.8	63.4912
53	RHG	Macrourus berglax	25.2	56	411.5	1485.0	2.4	4.8	65.5405
54	MAA	Magnisudis atlantica	1.2	1	627.5	1127.5	2.4	3.6	65.4127
55	MAL	Malacosteus niger	0.0	2	801.5	1425.5	3.6	3.6	65.1938
56	MMI	Maulisa microlepis	0.0	1	1105.0	1105.0	3.6	3.6	63.5858
57	MPH	Melamphaidae	0.0	1	1127.5	1430.5	3.6	3.6	63.8464
58	MYC	Myctophidae	0.0	89	699.5	801.5	3.6	3.6	65.1938
59	MYP	Myctophum punctatum	0.0	1	1089.5	1446.0	3.6	3.6	63.9139
60	MYI	Myxine ios	0.0	1	737.5	737.5	4.8	4.8	64.3100

61	NEG	Neolithodes grimaldi	4.8	3	1068.5	1425.5	3.6	3.6	64.3251
62	NZB	Nezumia bairdi	0.0	4	794.5	1173.0	3.6	3.6	65.1938
63	NOT	Notacanthus chemnitzii	13.2	12	801.5	1477.5	3.6	3.6	65.1938
64	NOK	Notoscopelus kroeyri	0.0	2	423.5	1446.0	3.6	4.8	65.1329
65	SKP	Platytroctidae	0.0	1	1233.5	1233.5	3.6	3.6	63.4366
66	POL	Polyacanthonotus rissoanus	0.0	2	1344.0	1485.0	3.6	3.6	63.6757
67	RBT	Raja bathyphila	13.2	1	962.0	1446.0	3.6	3.6	64.0412
68	RFL	Raja fyllae	1.2	1	423.5	1359.5	3.6	4.8	65.5405
69	RRD	Raja radiata	4.8	9	417.5	423.5	4.8	4.8	65.1329
70	SKA	Raja. sp.	0.0	1	801.5	1287.5	3.6	3.6	65.1938
71	GHL	Reinhardtius hippoglossoides	925.2	792	411.5	1485.0	2.4	4.8	65.5405
72	ROM	Roulina maderensis	0.0	2	1239.0	1239.0	3.6	3.6	63.8127
73	SAL	Salmo salar	3.6	1	866.5	866.5	3.6	3.6	64.7632
74	SCB	Scopelogadus beani	0.0	2	1378.5	1378.5	3.6	3.6	63.2967
75	SCO	Scopelosarus lepidus	1.2	13	715.0	1477.5	3.6	4.8	65.1938
76	REG	Sebastes marinus	3.6	16	411.5	864.5	3.6	4.8	64.8113
77	REB	Sebastes mentella	72.0	140	411.5	1477.5	2.4	4.8	65.5405
78	RED	Sebastes sp.	0.0	1	1068.5	1244.0	3.6	3.6	63.4554
79	SSI	Serasidae	0.0	1	1127.5	1132.0	3.6	3.6	64.0799
80	SER	Serrivomer beani	0.0	8	685.0	1485.0	3.6	4.8	65.5405
81	STO	Stomias boa	0.0	9	685.0	1485.0	3.6	4.8	65.5405
82	SYN	Synapobranchus kaupi	7.2	46	423.5	1485.0	3.6	4.8	65.5405
83	TRA	Trachyrynchus murrayi	0.0	1	795.0	905.0	3.6	3.6	64.0389
84	XEC	Xenodermichthys copei	0.0	1	715.0	1105.0	3.6	4.8	64.8113