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Survey for Greenland halibut in ICES Division 14B, June-July 2002

by

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Introduction

During the period 1987-1989 Japan Marine Fishery Resources Research Center (JAMARC) and Greenland Institute of Natural Resources jointly conducted 3 bottom trawl surveys at East Greenland as part of a joint venture agreement on fisheries development and fisheries research in Greenland waters (Jørgensen and Akimoto 1990; Yatsu and Jørgensen 1988abc; Yatsu and Jørgensen 1989). The surveys were primarily aimed at Greenland halibut (*Reinhardtius hippoglossoides*) and redfish (*Sebastes* spp.) and covered various areas between Cape Farewell and 72°N at depths down to 1500 m. During the period 1989-1996 Greenland Institute of Natural Resources conducted annual shrimp trawl surveys with R/V PAAMIUT at East Greenland (Anon. 1997), but the surveys only covered depths down to 600 m with a poor coverage of depths > 400 m. In 1998 Greenland Institute of Natural Resources started a bottom trawl surveys series with R/V PAAMIUT, which has been rigged for deep sea trawling. There has unfortunately not been any comparative trawling between the Japanese research vessel R/V SHINKAI MARU and R/V PAAMIUT making comparisons between the surveys difficult, and there is very little overlap in the depth range between the shrimp trawl survey and the present survey. There was no survey at East Greenland in 2001.

Materials and methods

The survey took place in the period 20/6-26/6 2002.

Stratification
The survey was planned to covered ICES Area 14B from 61°45N to 67°N between the 3-nm line and the 200-nm line or the midline to Iceland at depths from 400 to 1500 m. The survey area was stratified in 5 Subareas Q1-Q5. The commercial fishery mainly takes place in Q1, Q2, and Q5. Q3 is dominated by depths < 800 m, and Q4 is dominated by a steep continental slope. Q4 is not surveyed due to very rough bottom. Each subarea was further subdivided in 6 depth strata: 401-600, 601-800, 801-1000, 1001-1200, 1201-1400 and 1401-1500 m. The depth stratification was mainly based on 50 m depth contour maps. The area of each stratum was measured using "MapInfo Version 4.0"(Table 1). The stratum Q6 off Southeast Greenland has been included in previous years plans, but it has never been possible to make any hauls in the area due to ice, and Q6 has been excluded from the survey area in 2002.

The survey was planned as a Stratified Random Bottom Trawl Survey with in total 72 hauls. Basically hauls were allocated proportional to stratum area. All strata with an area >1% of the total survey area were allocated at least 2 hauls. However, the strata 601-800 m, 801-1000 and 1001-1201 in Q5 were allocated 2 hauls each, despite that they occupied < than 1% of the total survey area, and stratum 601-800 m and 801-1000 m in Q1 and Q2 were allocated extra hauls, because they all are important commercial fishing areas. The positions of the hauls were selected at random within each stratum by means of "The Spline Survey Designer Software System".

Vessel and gear

The survey was conducted by the 722 GRT trawler PAAMIUT, 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 2400 kg mounted with extra 20 kg. Figures of rigging and bobbins chain together with further information about the gear are given in Jørgensen (1998). 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 1998).

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. Trawling took place in 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 comprised always 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.

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

Otoliths were sampled for age determination of Greenland halibut (n=491). The otoliths 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 40 successful hauls were made (Table 1 and 2, Fig 1) and 69 different species or groups of species were recorded (Appendix 1). Q1, Q3 and Q5 were only covered partly due to ice and the coverage of the shallow strata (401-600 m) was very poor (Table 1, Fig. 1). In strata with one haul only, SD is estimated as: SD= biomass or abundance. This causes high S.E of the overall biomass and abundance of especially *Sebastes mentella* and roughhead grenadier because of large catches in the large depth stratum Q1, 401-600 m.

Greenland halibut (*Reinhardtius hippoglossoides*)
Greenland halibut was caught in 38 of the 40 hauls and the catches ranged between 0.1 kg and 595.8 kg taken at 907 m in Q5 (Fig. 1, Table 2).

The total biomass of Greenland halibut at depths between 401-1500 m was estimated at 14661.3 tons (S.E. 2605.6) which is a statistically insignificant (95 % level) decrease compared to 23144.4 tons (S.E. 3225.1) in 2000.

	1998	1999	2000	2002
Biomass	21122.6	15141.1	23144.4	14661.3
S.E	3081.7	2110.7	3225.1	2605.6

The decrease in biomass from 2000 to 2002 was almost exclusively caused by decrease in biomass in Q1 401-600 m (1000 tons) and Q3 601-800 m (3500 tons), both strata covered by one haul only in 2002, together with the lack of coverage of Q3 801-1000 (4300 tons) in 2002. In the other strata only minor changes in the biomass were observed (Jørgensen 2001). The highest density (7.8 tons per km^2) was found at 801-1000 m in Q5, as in 2000, while the largest biomass was found in Q5 1201-1400 m (Table 3).

The total abundance was estimated at $9.9016*10^6$ (S.E. $2.411*10^6$) compared to $19.056*10^6$ (S.E. $3.064*10^6$) in 2000 (Table 4)

	1998	1999	2000	2002
Abundance	$15.442*10^6$	$10.308*10^6$	$19.056*10^6$	$9.9016*10^6$
S.E	$2.204*10^6$	$1.634*10^6$	$3.064*10^6$	$2.411*10^6$

The decrease in abundance was mainly seen in the same three strata as mentioned above.
The highest density (8524 fish per km^2) was seen in Q5 801-1000 m and the largest number ($1.688*10^6$) was observed in Q3 401-600 (Table 4).

Age 7 was the most abundant in 2002 as in 1999 while age 6 was most abundant in1998 and 2000 (Table 5).

The length ranged from 27 cm to 115 cm. Generally the length distributions in the different depth strata were dominated by one – few modes (Fig. 2). A number of modes were seen in the overall length distribution of which the two around 48 and 53 cm were the most dominant (Fig. 2 and 3).

The most dominate mode use to be around 48 cm. The shift in mode can be caused by the decrease in number of fish in shallow water, which traditionally is dominated by smaller fish.

The age ranged from 1 to 18 years and the age was generally increasing by depth (Fig. 4). The overall age distribution (weighted by stratum area) was monomodal with a mode around age 7 while it was around age 6 in 2000 (Fig. 5). Mean weight- and length at age is given in Table 6.

Females started maturing at age 5 and M50 was reached at age 8. 100% maturity was reached at age 13 (Table 7). This pattern is somewhat different compared to previous years where M_{50} first was reached at age 12 and 100% maturity not was observed at all (Jørgensen 1997, 1998, 1999, 2000, 2001).

Deep-sea redfish (*Sebastes mentella*)
Deep-sea redfish was caught in 30 of the 40 hauls with catches raging from 0.1 kg to 346.7 kg taken at 683 m in Q2 (Fig. 6, Table 2).

The total biomass of deep-sea redfish was estimated at 16149.0 tons (S.E. 7173.2) which is a slight increase compared to 13178.5 tons (S.E. 2457.8) in 2000. The biomass increased in Q1 401-600 m (6000 tons) and Q2 601-800 (2000 tons) while it decreased in Q3 401-600 m (5000 tons) compared to 2000. Almost all the biomass was found at depths < 600 m (Table 8). The highest density (1.7 tons/km^2) was found in depth stratum 401-600 m in Q2 as in 2000.

	1998	1999	2000	2002
Biomass	2878.9	24093.9	13178.5	16149.0
S.E	2646.5	2878.9	2457.8	7173.2

The total abundance was estimated at 54.919 10^6 (S.E. 19.114*10^6) compared to 69.973*10^6 (S.E. 14.280*10^6) in 2000 (Table 9). Depths < 400 m was not covered during the survey and both the biomass and abundance estimates are clearly underestimated.

	1998	1999	2000	2002
Abundance	76.738*10^6	141.585*10^6	69.973*10^6	54.919*10^6
S.E	8.343*10^6	19.052*10^6	14.280*10^6	19.114*10^6

The overall length distribution ranged from 11 to 64 cm and the length seems generally to increase both by depth (Fig. 7). The overall length was dominated by a mode around 23 cm and the length distribution was generally dominated by larger fish compared to previous years (Fig. 8).

Golden redfish (*Sebastes marinus)*
Golden redfish was caught in only 3 of the 40 hauls and the largest catch was 6.2 kg (Table 2).
The catch of golden redfish has also been very low in previous years (Jørgensen 1999, 2000, 2001).

Roughhead grenadier (*Macrourus berglax*)
Roughhead grenadier was caught in 38 of the 40 hauls and catches ranged from 0.1 kg to 72.5 kg.
The species was found in all strata except at 601-800 m in Q3 (Fig.9, Table 2 and 10).

The total biomass of roughhead grenadier was estimated at 4631.2 tons (S.E. 1537.8), which is at the same level as in previous years. The highest density was observed at 1201-1400 in Q1 (0.6 tons/km^2) and the highest biomass at 401-600 m in Q1 (1448.8 tons (based on one haul only)) (Table 10).

	1998	1999	2000	2002
Biomass	3508.6	5437.0	3538.8	4631.2
S.E	550.9	859.7	370.2	1537.8

The abundance was estimated at 5.492 *10^6 (S.E. 2.143*10^6), which is at the same level as in previous years (Table 11).

	1998	1999	2000	2002
Abundance	4.029*10^6	6.262*10^6	3.985*10^6	5.492 *10^6
S.E	0.638*10^6	1.108*10^6	0.380*10^6	2.143*10^6

Pre anal fin length ranged from 2.0 to cm 44 cm. The length distributions in the three subareas Q1, Q2, and Q5 and the over all length distribution were all dominated by modes around 20 cm (Fig. 10) and Fig. 11).

Roundnose grenadier (*Coryphaenoides rupestris*)

Roundnose grenadier was caught in 22 of the 40 hauls and catches were generally low, ranging from < 0.1 kg to 246.8 at 1302 m in Q5 (Fig. 12, Table 2).

The biomass of roundnose grenadier was estimated at 1791.3 (S.E. 1229.1), which is at the same level as in previous surveys. Most of the biomass was found in Q5 at depths > 1200 m (Table 12).

	1998	1999	2000	2002
Biomass	2919.1	1328.4	2452.6	1791.3
S.E	1376.1	552.4	1328.4	1229.1

The abundance was estimated at 7.264 *10^6 (S.E. 4.564*10^6), which is at the same level as the previous years. The highest abundance was found in Q5 at depths > 1200 m both in terms of density and numbers (Table 13).

	1998	1999	2000	2002
Abundance	6.418*10^6	10.052*10^6	6.027*10^6	7.264 *10^6
S.E	2.846*10^6	1.158*10^6	2.660*10^6	4.564*10^6

Pre anal fin length ranged from 1.5 to cm 19 cm. In Q1 the length distribution was dominated by a mode around 10 cm, while a dominant mode around 3 cm was seen in Q2 and Q5 (Fig. 13). The overall length distribution was dominated by a mode around 3 cm and a broader mode at 10 cm (Fig. 14).

Temperature

The bottom temperature ranged from 0.6 to 5.6°C, while the average bottom temperature by stratum ranged from 1.0 °C in depth stratum 1401-1500 m in Q1 to 5.6 °C in depth stratum 401-600 m in Q1. In all Subareas the temperature decreased by depth. Further, the temperature generally increased at depths >801 from north to south at the same depth stratum (Table 14) as seen in previous years surveys.

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Table. 1. Areas (km^2) distributed on strata and depth strata (m), the percentage distribution of the areas, number of hauls and planned number of hauls ().

	Area					
Depth Stratum	Q1	Q2	Q3	Q4	Q5	sum
401 – 600	7444.1	777	9830.2	2053.6	1819.4	21924.3
601 – 800	622	853.4	3788.1	665.7	257.1	6186.3
801-1000	652.3	1336	755.4	336.2	106.7	3186.6
1001-1200	881.8	1699.3	191.1	549.9	148.9	3471
1201-1400	741.4	1742	213.3	1147	985.5	4829.2
1401-1500	462.3	1162.6	312.9	940.5	614.5	3492.8
Sum	10803.9	7570.3	15091	5692.9	3932.1	43090.2
	% Distribution					
Depth Stratum	Q1	Q2	Q3	Q4	Q5	sum
401 - 600	17.3	1.8	22.8	4.8	4.2	50.9
601 - 800	1.4	2.0	8.8	1.5	0.6	14.4
801-1000	1.5	3.1	1.8	0.8	0.2	7.4
1001-1200	2.0	3.9	0.4	1.3	0.3	8.1
1201-1400	1.7	4.0	0.5	2.7	2.3	11.2
1401-1500	1.1	2.7	0.7	2.2	1.4	8.1
Sum	25.1	17.6	35.0	13.2	9.1	100.0
	Distribution of hauls					
Depth Stratum	Q1	Q2	Q3	Q4	Q5	sum
401 - 600	1 (9)	2 (2)	3 (12)	0	0 (3)	6 (26)
601 - 800	3 (3)	3 (3)	1 (6)	0	2 (2)	9 (14)
801-1000	2 (3)	4 (4)	0 (2)	0	2 (2)	8 (11)
1001-1200	2 (2)	2 (3)	0	0	2 (2)	6 (7)
1201-1400	2 (2)	0 (3)	0	0	3 (3)	5 (8)
1401-1500	2 (2)	2 (2)	0	0	2 (2)	6 (6)
Sum	12 (21)	13 (17)	4 (20)	0	11(14)	40 (72)

Table 2. Catch weight and number (not standardised to kg/km^2) of Greenland halibut, *Sebastes mentella, S. marinus*, roundnose and roughhead grenadier by haul. Depth in m, swept area in km^2 and bottom temperature in °C. Note that haul 22 has been excluded.

								Gre. halibut		Roundnose gre		Roughhead gre		S.mentella		S.marinus	
stnr	month	day	depth	swarea	div.	dpt.str	temp	weight	number	weight	number	weight	number	weight	number	weight	number
1	6	20	687.5	0.07904	Q1	8	3.7	133.3	103	0	0	21.7	37	22.9	44	0	0
2	6	20	851.0	0.06241	Q1	10	3.1	56.7	28	0	1	8.9	12	19.4	24	0	0
3	6	20	725.0	0.10207	Q1	8	4.5	214.3	216	0	0	16.6	26	42.1	64	0	0
4	6	20	547.5	0.07861	Q1	6	5.6	17.6	12	0	0	15.3	22	71	177	0	0
5	6	20	688.0	0.07116	Q1	8	5.0	118.9	76	0	0	23.1	34	128.8	192	0	0
6	6	20	1095.5	0.07323	Q1	12	1.2	2.0	2	0	0	1.4	2	26.2	37	0	0
7	6	21	1280.0	0.05641	Q1	14		12.4	6	4.9	13	43.9	32	0	0	0	0
8	6	21	1413.5	0.06083	Q1	15	0.6	1.7	2	0.7	2	4.1	6	0	0	0	0
9	6	21	1436.5	0.04421	Q1	15	1.3	4.8	2	3	10	12.8	12	8.6	12	0	0
10	6	21	1260.5	0.07395	Q1	14	1.6	10.3	2	0	3	27	15	0	0	0	0
11	6	21	1096.5	0.08729	Q1	12	1.7	6.0	3	0	0	32.1	21	0	0	0	0
12	6	21	940.5	0.08511	Q1	10	2.0	80.9	25	0	0	72.5	76	8.6	14	0	0
13	6	21	1056.5	0.0737	Q2	12	3.2	19.0	5	0	1	29	24	0	0	0	0
14	6	21	1433.5	0.04175	Q2	15	2.0	0.0	0	0	0	9.9	7	0	0	0	0
15	6	22	946.0	0.05331	Q2	10	2.0	36.2	10	0.1	22	64.4	70	10	15	0	0
16	6	22	682.5	0.05162	Q2	8	3.6	53.0	36	0	1	18.4	22	346.7	738	0	0
17	6	22	512.0	0.04954	Q2	6	3.8	100.1	82	0	0	8.9	14	107.1	397	0	0
18	6	22	763.0	0.07182	Q2	8	3.5	173.1	97	0	0	14.1	22	18.6	26	0	0
19	6	22	856.0	0.07337	Q2	10	3.5	51.2	17	0	0	17.6	21	6.8	12	0	0
20	6	22	1087.5	0.07324	Q2	12	1.5	11.3	3	0	8	16.8	13	0.9	1	0	0
21	6	22	1444.0	0.08532	Q2	15	0.9	0.0	0	2	4	5	8	1.55	2	0	0
23	6	23	943.5	0.07337	Q2	10	3.3	47.0	9	0	0	6.2	11	0.7	2	0	0
24	6	23	976.0	0.06916	Q2	10	2.9	31.6	8	0	3	36.1	32	1.2	2	0	0
25	6	23	691.0	0.07253	Q2	8	4.2	50.2	23	0	0	4.8	7	156.3	306	0	0
26	6	23	455.0	0.07153	Q2	6	4.1	74.6	49	0	0	1.6	3	83	384	0	0
27	6	23	557.0	0.08848	Q3	6	3.4	45.2	38	0	0	1.5	2	44	265	0	0
28	6	23	487.5	0.06079	Q3	6	3.9	6.1	3	0	0	0.3	1	6.5	44	0	0
29	6	24	661.5	0.08335	Q3	8	3.5	16.4	12	0	0	0	0	31.4	125	0	0
30	6	24	475.5	0.08228	Q3	6	3.4	1.3	3	0	0	0	0	20.5	168	0	0
31	6	25	646.5	0.06403	Q5	8	4.5	6.9	11	0	4	5.6	12	58.5	174	4.5	1
32	6	25	878.0	0.07506	Q5	10	3.7	410.9	448	16.7	303	12.8	28	2.7	6	0	0
33	6	25	656.5	0.07408	Q5	8	4.8	40.0	46	1.7	59	15	25	106.9	349	6	1
34	6	25	906.5	0.05876	Q5	10	4.0	595.8	651	48.1	545	15.3	31	30.2	71	6.2	2
35	6	25	1302.0	0.06054	Q5	14	3.3	252.0	160	246.8	894.9	8.5	15	0.1	1	0	0
36	6	25	1030.5	0.05997	Q5	12	3.7	523.7	455	11.9	68	12.2	26	0	0	0	0
37	6	25	1132.5	0.07004	Q5	12	3.4	128.0	104	7.1	124	12.8	27	0	0	0	0
38	6	26	1454.5	0.06573	Q5	15	1.8	20.4	5	3.1	13	20	18	0	0	0	0
39	6	26	1282.0	0.07257	Q5	14	2.7	160.7	36	22.4	52	9.333	27	0	1	0	1
40	6	26	1304.0	0.07484	Q5	14	2.0	141.3	66	28.1	88	2.6	7	0	0	0	0
41	6	26	1449.5	0.06978	Q5	15	2.3	44.5	29	15.3	53	1.4	3	0	0	0	0

Table 3. Biomass (tons) of Greenland halibut by area and depth stratum.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Biomass	SE
Q1	401-600	7444.1	1	0.2239	1666.6	.
	601-800	622	3	1.8189	1131.4	87.3
	801-1000	652.3	2	0.9295	606.3	13.7
	1001-1200	881.8	2	0.0480	42.3	18.3
	1201-1400	741.4	2	0.1796	133.1	29.9
	1401-1500	462.3	2	0.0683	31.6	18.6
Q2	401-600	777	2	1.5317	1190.2	379.8
	601-800	853.4	3	1.3764	1174.6	448.8
	801-1000	1336	4	0.6186	826.4	73.7
	1001-1200	1699.3	2	0.2060	350.1	87.9
	1401-1500	1162.6	2	0.0000	0.0	0.0
Q3	401-600	9830.2	3	0.2090	2054.5	1502.9
	601-800	3788.1	1	0.1968	745.4	.
Q5	601-800	257.1	2	0.3238	83.3	55.6
	801-1000	106.7	2	7.8071	833.0	248.9
	1001-1200	148.9	2	5.2803	786.2	514.1
	1201-1400	985.5	3	2.7549	2714.9	699.8
	1401-1500	614.5	2	0.4740	291.3	100.6
All				0.4530	14661.3	2605.6

Table 4. Abundance of Greenland halibut by area and depth stratum.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Abundace	SE
Q1	401-600	7444.1	1	152.6	1136332.6	.
	601-800	622	3	1495.7	930349.2	197505.0
	801-1000	652.3	2	371.2	242127.5	50533.7
	1001-1200	881.8	2	30.8	27194.8	3111.0
	1201-1400	741.4	2	66.7	49456.2	29403.7
	1401-1500	462.3	2	39.1	18056.3	2856.7
Q2	401-600	777	2	1170.1	909180.4	376915.5
	601-800	853.4	3	788.4	672827.9	257563.8
	801-1000	1336	4	164.4	219647.7	36956.2
	1001-1200	1699.3	2	54.4	92444.4	22835.1
	1401-1500	1162.6	2	0.0	0.0	0.0
Q3	401-600	9830.2	3	171.8	1688433.5	1267198.9
	601-800	3788.1	1	144.0	545406.4	.
Q5	601-800	257.1	2	396.4	101902.9	57733.0
	801-1000	106.7	2	8524.0	909509.7	272677.8
	1001-1200	148.9	2	4536.2	675440.5	454345.9
	1201-1400	985.5	3	1340.2	1320797.5	651164.6
	1401-1500	614.5	2	245.8	151056.7	104312.2
All				299.4	9690164.1	2041142.2

Table 5. Estimated abundance at age of Greenland halibut at East Greenland in 1998-2002.

AGE	1998	1999	2000	2002
	Number	Number	Number	Number
1	15443		152448	0
2	92657	30924	222326	0
3	679481	144314	651487	469004
4	1775917	1061736	2091091	383730
5	2424513	1566834	3521873	709320
6	3134880	2092548	4643204	2163814
7	3011338	2226554	3086024	2571770
8	1853131	1041120	1523718	1288792
9	571382	484482	1037809	498074
10	633153	597871	503841	258727
11	339741	329860	580522	455438
12	478725	195854	426378	359505
13	138985	226779	191208	136631
14	108099	103081	135526	156012
15	92657	103081	103646	130817
16	30886	61849	80435	72676
17	30886	10308	76758	15504
18	4633	10308	27726	19380
19		10308	0	0
20		3092	0	0
21		3092	0	0
TOTALS	15442757	10308120	19056000	9690164
CHECK	15416504	10303997	19056019	9689195

Table 6. Mean weight- and length at age and SE for Greenland halibut.

Obs	AGE	WGTMEAN	SEW	LENMEAN	SEL	N
1	3	224.17	16.67	29.750	0.57899	12
2	4	357.62	13.11	35.143	0.36701	21
3	5	607.61	15.00	41.935	0.26631	46
4	6	902.12	23.78	47.242	0.19319	66
5	7	1263.95	27.56	52.329	0.19230	76
6	8	1648.77	37.17	57.077	0.22924	65
7	9	2063.75	60.12	60.469	0.35635	32
8	10	2299.52	74.72	62.810	0.36916	21
9	11	2630.68	58.81	65.341	0.29788	44
10	12	3311.25	109.87	70.150	0.43933	40
11	13	3792.22	171.66	72.667	0.76696	18
12	14	4858.89	200.45	77.222	0.70736	18
13	15	6808.33	329.62	85.444	0.95391	18
14	16	7511.00	396.76	88.000	1.24722	10
15	17	9140.00	.	92.000	.	1
16	18	13733.33	1565.87	105.000	5.00000	3

Table 7. Maturity (MAT) at age in percent, Greenland halibut females, East Greenland, 2002. Maturity:1=immature 2=maturing.

	MAT	
	1	2

AGE	PctN	PctN	N
3	100.00	.	3.00
4	100.00	.	6.00
5	83.33	16.67	12.00
6	95.65	4.35	23.00
7	72.73	27.27	22.00
8	50.00	50.00	16.00
9	35.00	65.00	20.00
10	44.44	55.56	9.00
11	15.00	85.00	20.00
12	18.18	81.82	22.00
13	.	100.00	14.00
14	.	100.00	18.00
15	.	100.00	18.00
16	.	100.00	7.00
17	.	100.00	1.00
18	.	100.00	3.00

Table 8. Biomass (tons) of *Sebastes mentella* distributed on area and depth stratum.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Biomass	SE
Q1	401-600	7444.1	1	0.9032	6723.3	.
	601-800	622	3	0.8374	520.8	303.3
	801-1000	652.3	2	0.2059	134.3	68.4
	1001-1200	881.8	2	0.1789	157.7	157.7
	1201-1400	741.4	2	0.0000	0.0	0.0
	1401-1500	462.3	2	0.0973	45.0	45.0
Q2	401-600	777	2	1.6611	1290.7	389.1
	601-800	853.4	3	3.0435	2597.4	1635.4
	801-1000	1336	4	0.0768	102.6	55.3
	1001-1200	1699.3	2	0.0061	10.4	10.4
	1401-1500	1162.6	2	0.0091	10.6	10.6
Q3	401-600	9830.2	3	0.2845	2796.2	1121.2
	601-800	3788.1	1	0.3767	1427.1	.
Q5	601-800	257.1	2	1.1783	302.9	68.0
	801-1000	106.7	2	0.2750	29.3	25.5
	1001-1200	148.9	2	0.0000	0.0	0.0
	1201-1400	985.5	3	0.0006	0.5	0.5
	1401-1500	614.5	2	0.0000	0.0	0.0
All				0.4990	16149.0	7173.2

Table 9. Abundance of *Sebastes mentella* distributed on area and depth stratum.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Abundace	SE
Q1	401-600	7444.1	1	2251.6	16760905.6	.
	601-800	622	3	1279.9	796072.5	428138.8
	801-1000	652.3	2	274.5	179072.5	71779.9
	1001-1200	881.8	2	252.6	222775.7	222775.7
	1201-1400	741.4	2	0.0	0.0	0.0
	1401-1500	462.3	2	135.7	62738.9	62738.9
Q2	401-600	777	2	6691.0	5198902.7	1027683.5
	601-800	853.4	3	6294.6	5371827.8	3547613.2
	801-1000	1336	4	125.3	167369.8	81561.8
	1001-1200	1699.3	2	6.8	11601.6	11601.6
	1401-1500	1162.6	2	11.7	13626.7	13626.7
Q3	401-600	9830.2	3	1920.8	18881949.9	6473356.8
	601-800	3788.1	1	1499.8	5681316.7	.
Q5	601-800	257.1	2	3714.2	954919.5	256231.5
	801-1000	106.7	2	644.2	68730.9	60201.9
	1001-1200	148.9	2	0.0	0.0	0.0
	1201-1400	985.5	3	10.1	9952.4	5036.8
	1401-1500	614.5	2	0.0	0.0	0.0
All				1680.4	54381763.3	19211185.7

Table 10. Biomass (tons) of roughhead grenadier distributed on area and depth stratum.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Biomass	SE
Q1	401-600	7444.1	1	0.1946	1448.8	.
	601-800	622	3	0.2539	157.9	29.8
	801-1000	652.3	2	0.4972	324.3	231.3
	1001-1200	881.8	2	0.1934	170.6	153.7
	1201-1400	741.4	2	0.5717	423.8	153.1
	1401-1500	462.3	2	0.1785	82.5	51.3
Q2	401-600	777	2	0.1010	78.5	61.1
	601-800	853.4	3	0.2063	176.1	71.6
	801-1000	1336	4	0.5136	686.2	332.1
	1001-1200	1699.3	2	0.3114	529.2	139.4
	1401-1500	1162.6	2	0.1479	171.9	103.8
Q3	401-600	9830.2	3	0.0073	71.7	49.5
	601-800	3788.1	1	0.0000	0.0	.
Q5	601-800	257.1	2	0.1450	37.3	14.8
	801-1000	106.7	2	0.2155	23.0	4.8
	1001-1200	148.9	2	0.1931	28.8	1.5
	1201-1400	985.5	3	0.1227	120.9	45.8
	1401-1500	614.5	2	0.1622	99.7	87.3
All				0.1431	4631.2	1537.8

Table 11. Abundance of roughhead grenadier distributed on area and depth stratum.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Abundace	SE
Q1	401-600	7444.1	1	279.9	2083276.4	.
	601-800	622	3	400.2	248925.9	45278.8
	801-1000	652.3	2	542.6	353935.7	228509.5
	1001-1200	881.8	2	133.9	118112.1	94028.3
	1201-1400	741.4	2	385.1	285489.7	135096.0
	1401-1500	462.3	2	185.0	85538.2	39939.6
Q2	401-600	777	2	162.3	126082.5	93494.8
	601-800	853.4	3	276.4	235839.1	82220.9
	801-1000	1336	4	553.0	738791.3	349138.6
	1001-1200	1699.3	2	251.6	427491.0	125850.5
	1401-1500	1162.6	2	130.7	151972.5	42959.1
Q3	401-600	9830.2	3	13.0	127965.9	66323.7
	601-800	3788.1	1	0.0	0.0	.
Q5	601-800	257.1	2	262.4	67472.0	19286.6
	801-1000	106.7	2	450.3	48048.3	8246.3
	1001-1200	148.9	2	409.5	60979.4	3579.8
	1201-1400	985.5	3	237.8	234326.5	79383.7
	1401-1500	614.5	2	158.4	97348.8	70931.3
All				169.7	5491595.3	2143423.1

Table 12. Biomass of roundnose grenadier distributed on area and depth stratum.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Biomass	SE
Q1	401-600	7444.1	1	0.0000	0.0	.
	601-800	622	3	0.0000	0.0	0.0
	801-1000	652.3	2	0.0000	0.0	0.0
	1001-1200	881.8	2	0.0000	0.0	0.0
	1201-1400	741.4	2	0.0434	32.2	32.2
	1401-1500	462.3	2	0.0397	18.3	13.0
Q2	401-600	777	2	0.0000	0.0	0.0
	601-800	853.4	3	0.0000	0.0	0.0
	801-1000	1336	4	0.0005	0.6	0.6
	1001-1200	1699.3	2	0.0000	0.0	0.0
	1401-1500	1162.6	2	0.0117	13.6	13.6
Q3	401-600	9830.2	3	0.0000	0.0	0.0
	601-800	3788.1	1	0.0000	0.0	.
Q5	601-800	257.1	2	0.0115	2.9	2.9
	801-1000	106.7	2	0.5206	55.5	31.8
	1001-1200	148.9	2	0.1499	22.3	7.2
	1201-1400	985.5	3	1.5869	1563.9	1226.9
	1401-1500	614.5	2	0.1332	81.9	52.9
All				0.0553	1791.3	1229.1

Table 13. Abundance of roundnose grenadier distributed on area and depth stratum.

Div.	Stratum(m)	Area	Hauls	Mean sq km	Abundace	SE
Q1	401-600	7444.1	1	0.0	0.0	.
	601-800	622	3	0.0	0.0	0.0
	801-1000	652.3	2	8.0	5226.1	5226.1
	1001-1200	881.8	2	0.0	0.0	0.0
	1201-1400	741.4	2	135.5	100470.8	70392.1
	1401-1500	462.3	2	129.5	59882.2	44682.6
Q2	401-600	777	2	0.0	0.0	0.0
	601-800	853.4	3	6.5	5510.9	5510.9
	801-1000	1336	4	114.0	152325.7	133706.7
	1001-1200	1699.3	2	61.4	104340.4	81284.5
	1401-1500	1162.6	2	23.4	27253.4	27253.4
Q3	401-600	9830.2	3	0.0	0.0	0.0
	601-800	3788.1	1	0.0	0.0	.
Q5	601-800	257.1	2	429.4	110406.1	94344.3
	801-1000	106.7	2	6656.1	710205.3	279490.8
	1001-1200	148.9	2	1452.2	216230.0	47382.8
	1201-1400	985.5	3	5558.2	5477577.4	4547031.2
	1401-1500	614.5	2	478.6	294122.2	172586.5
All				224.4	7263550.4	4563636.3

Table 14. Mean bottom temperature, S.E.and number of observations by area and depth stratum.

Area	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
Q1	5.6		1	4.4	.38	3	2.6	.55	2	1.5	.25	2	1.6		1	1.0	.35	2
Q2	4.0	.15	2	3.8	.22	3	2.9	.33	4	2.4	.85	2				1.5	.55	2
Q3	3.6	.17	3	3.5		1												
Q5				4.7	.15	2	3.9	.15	2	3.6	.15	2	2.7	.38	3	2.1	.25	2

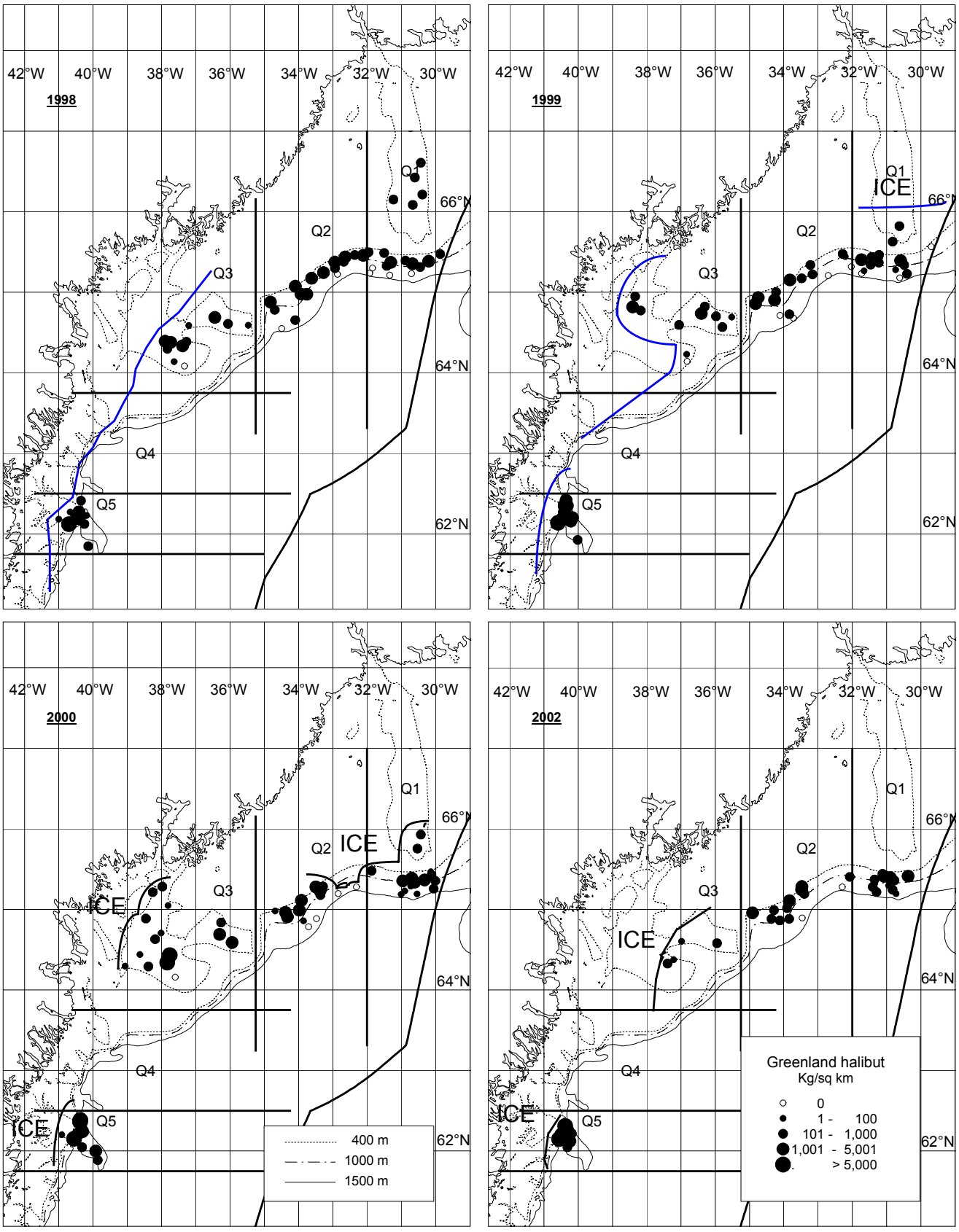


Fig. 1. Distribution of catches of Greenland halibut at East Greenland in 1998 - 2000.

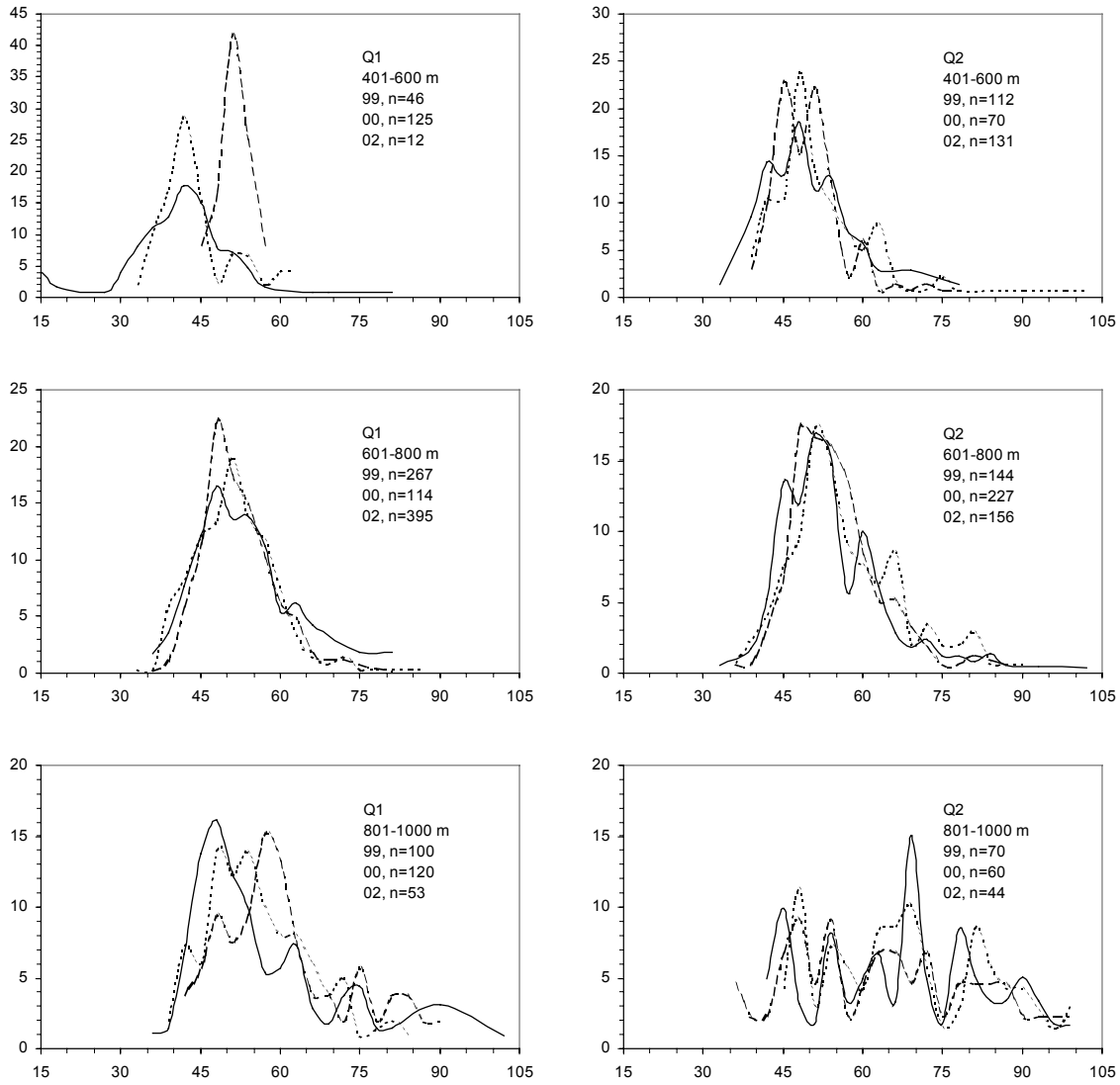


Fig. 2a. Length distribution (percent) of Greenland halibut (3 cm groups) by year, area and depth stratum. Strata with few observations are not included.. Dotted line:1999. Solid line: 2000. Dashed line 2002. n=number of fish measured. Note different scale on y-axis.

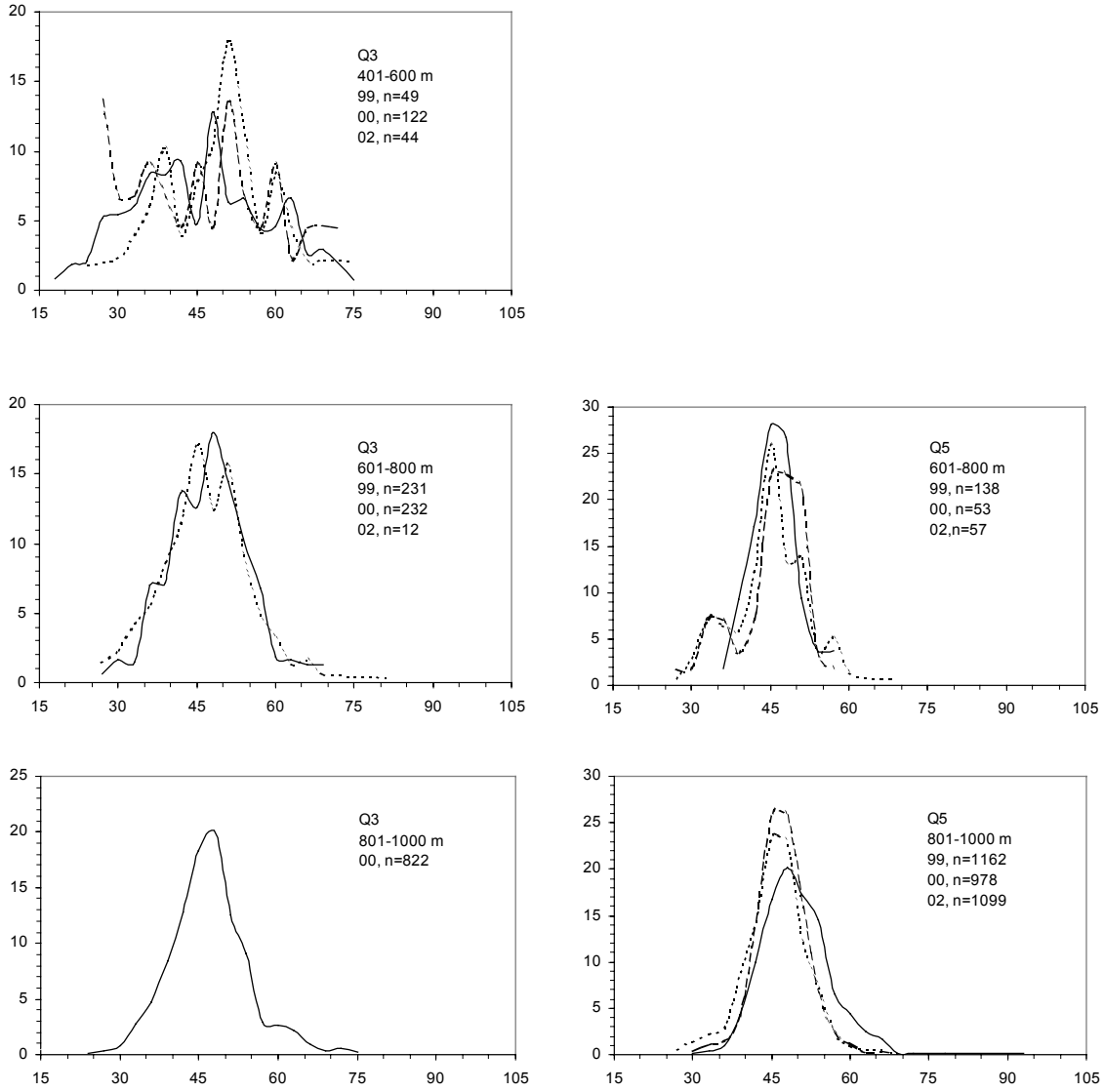


Fig. 2b. Length distribution (percent) of Greenland halibut (3-cm groups) by year, area and depth stratum. Dotted line: 1999. Solid line: 2000. Dashed line: 2002. n=number of fish measured. Note different scale on y-axis.

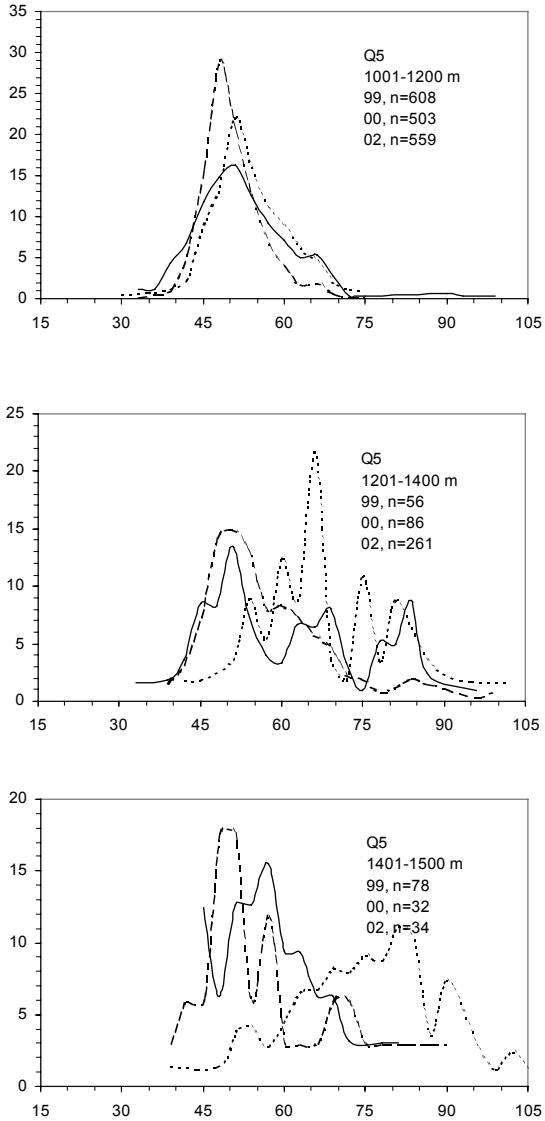


Fig. 2c. Length distribution (percent) of Greenland halibut (3-cm groups) in area Q5 continued by year and depth stratum. Dotted line: 1999. Solid line: 2000. Dashed line: 2002. n=number of fish. Note different scale on y-axis.

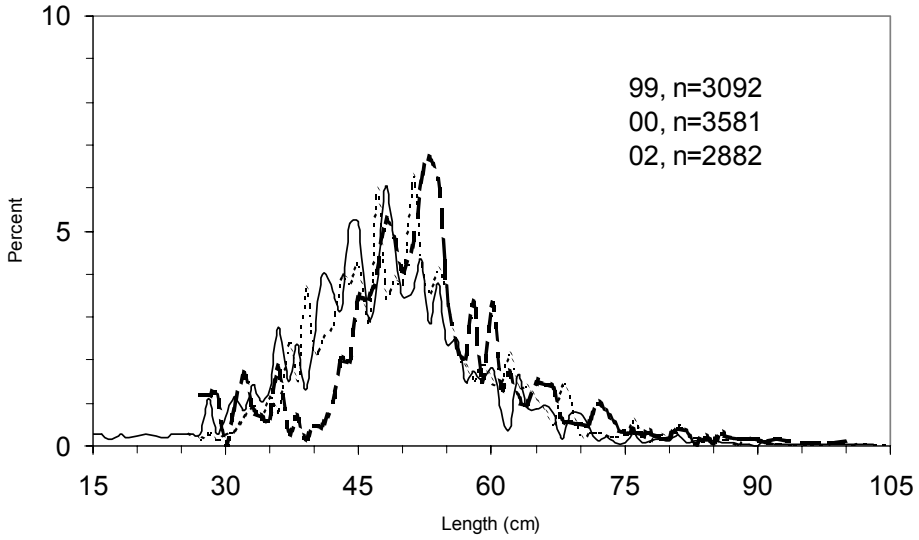


Fig. 3. Overall length distribution (percent) of Greenland halibut by year. Dotted line: 1999. Solid line:2000. Dashed bold line:2002. n=number of fish measured.

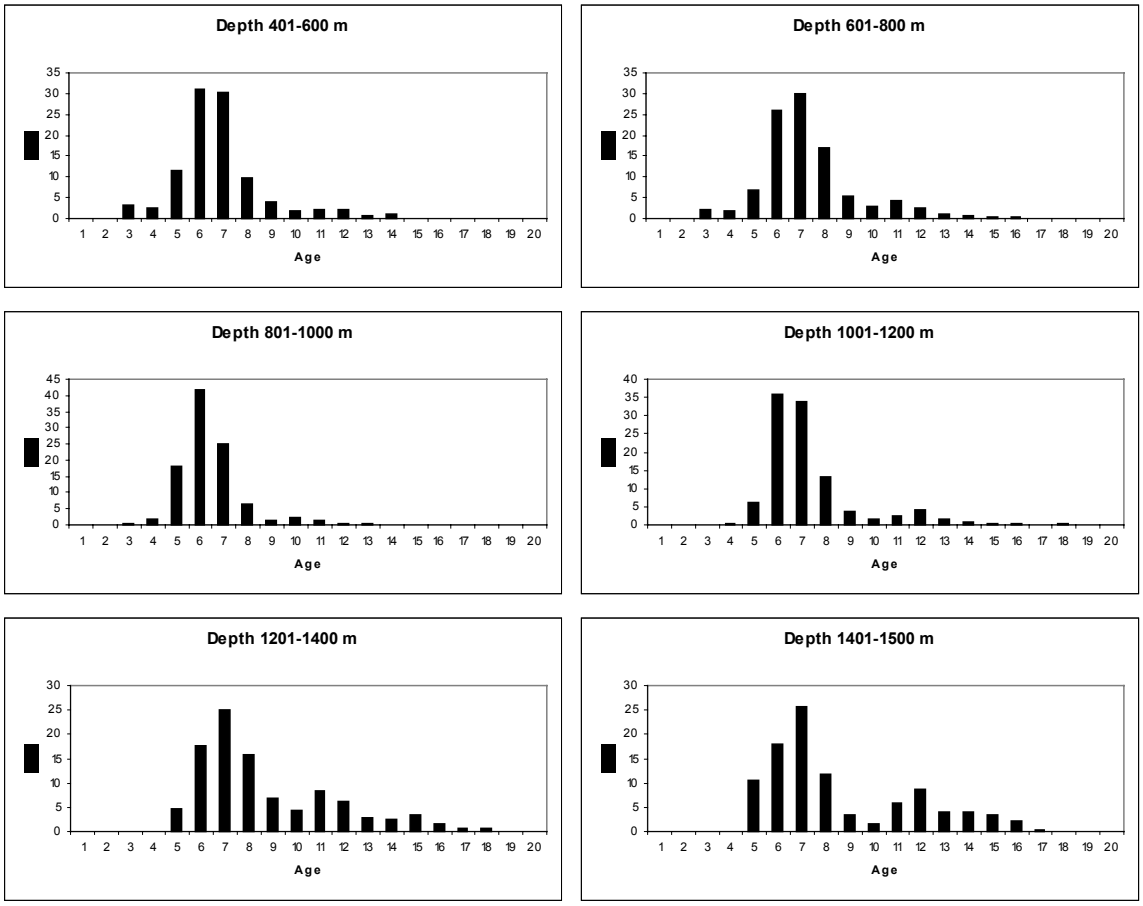


Fig. 4. Age distribution of Greenland halibut by depth.

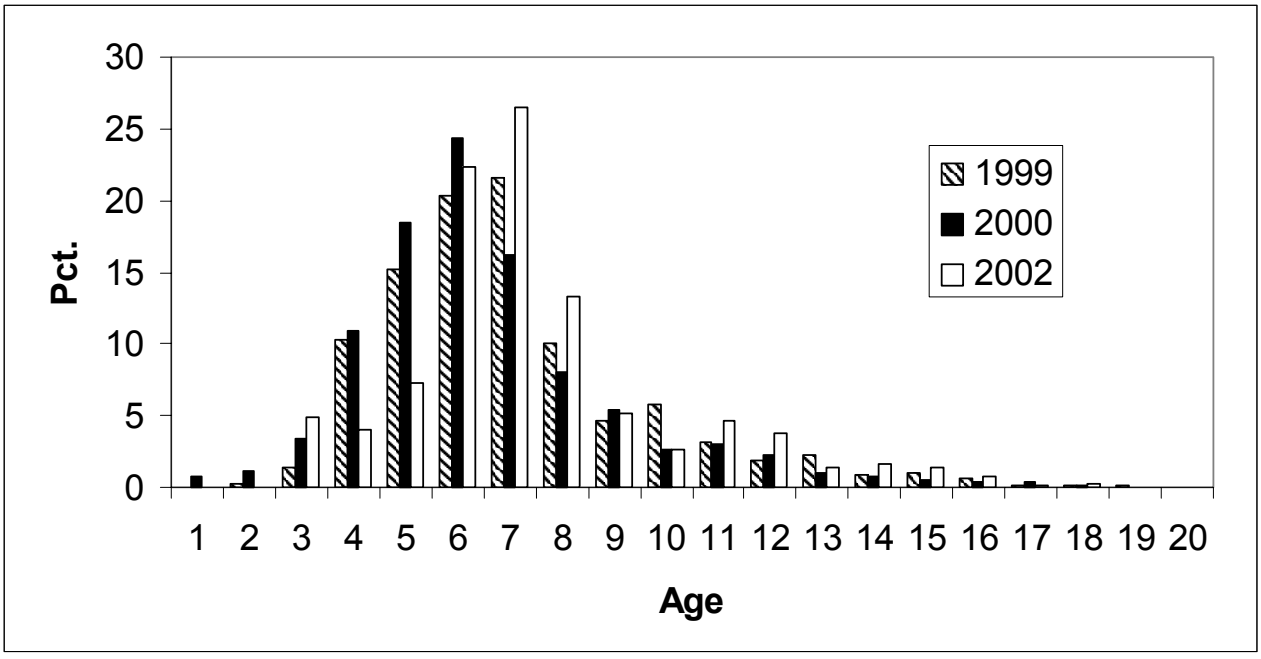


Fig 5. Total age distribution (weighted by stratum area) of Greenland halibut in 1999 - 2002.

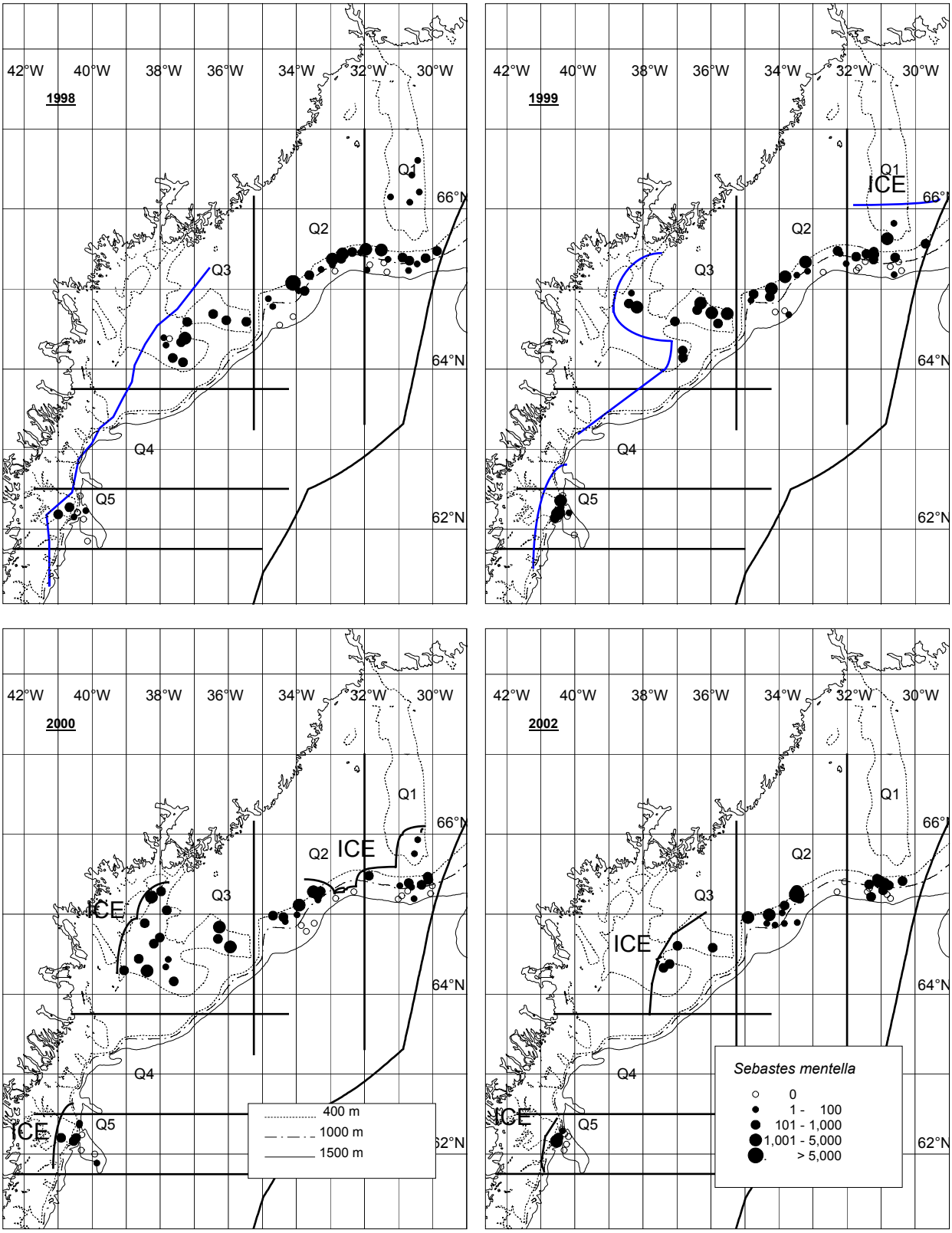


Fig. 6. Distribution of catches of *Sebastes mentella* at East Greenland in 1998 - 2002.

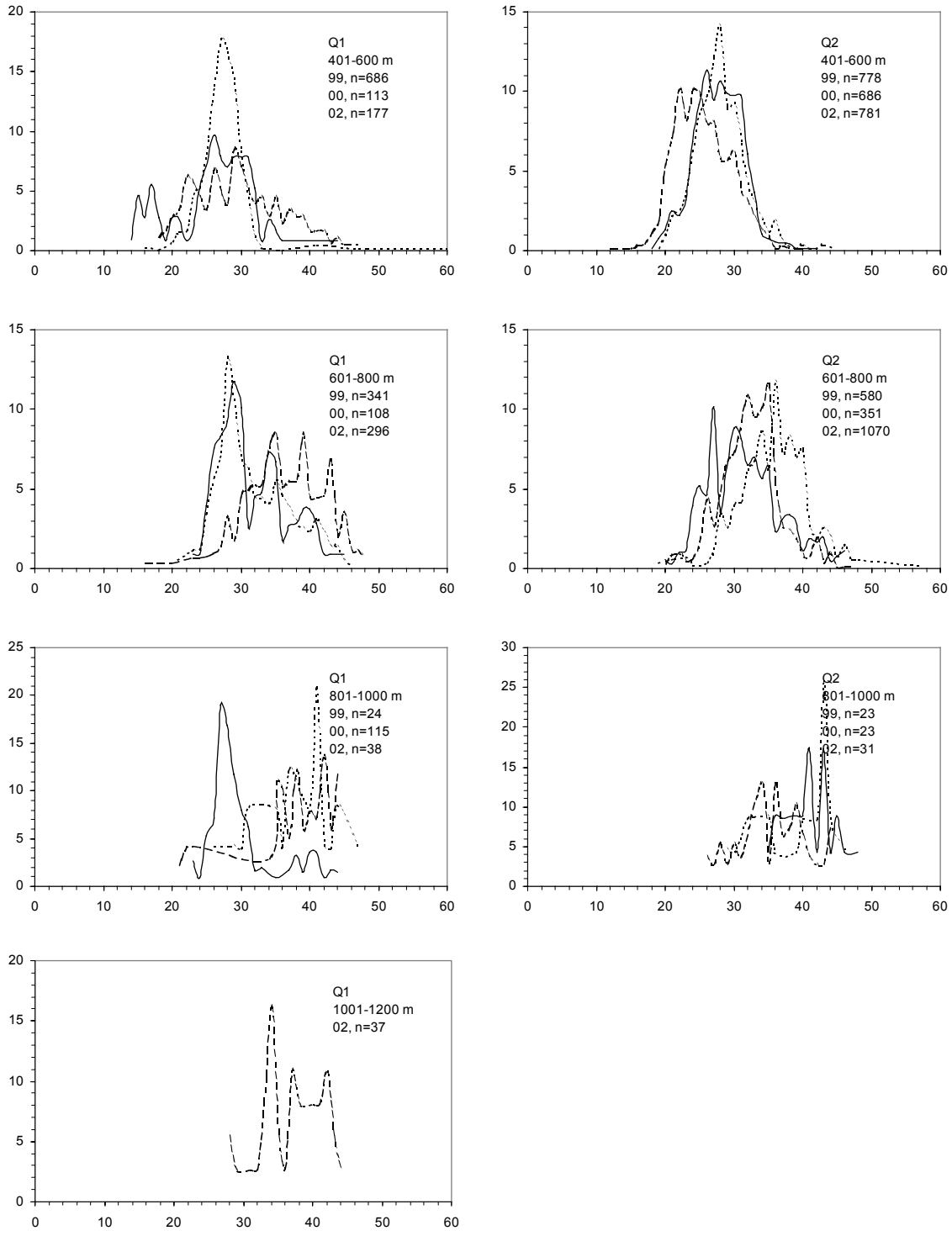


Fig. 7a. Length distribution (percent) of *Sebastes mentella* by year, area and depth strata. Only strata with more than 20 observations are included. Dotted line: 1999. Solid line: 2000. Dashed line: 2002. n=number of fish meaured.

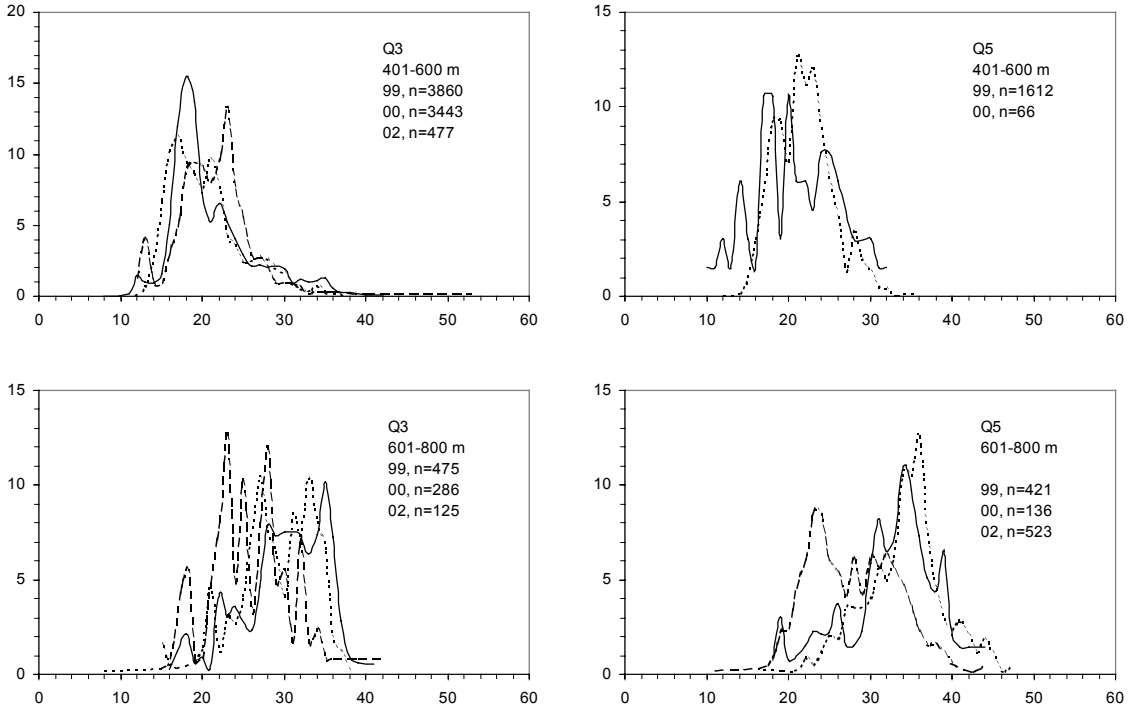
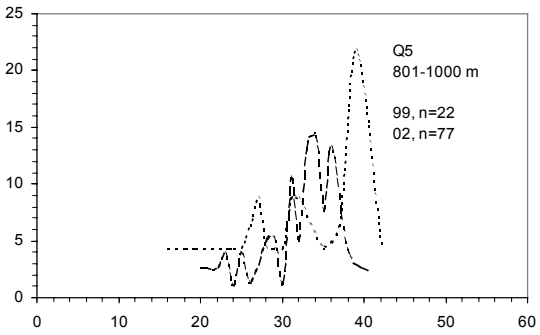


Fig. 7b. Length distribution (percent) of *Sebastes mentella* by year, area and depth strata. Only strata with more than 20 observations are included. Dotted line:1999. Solid line: 2000. Dashed line:2002. n=number of fish



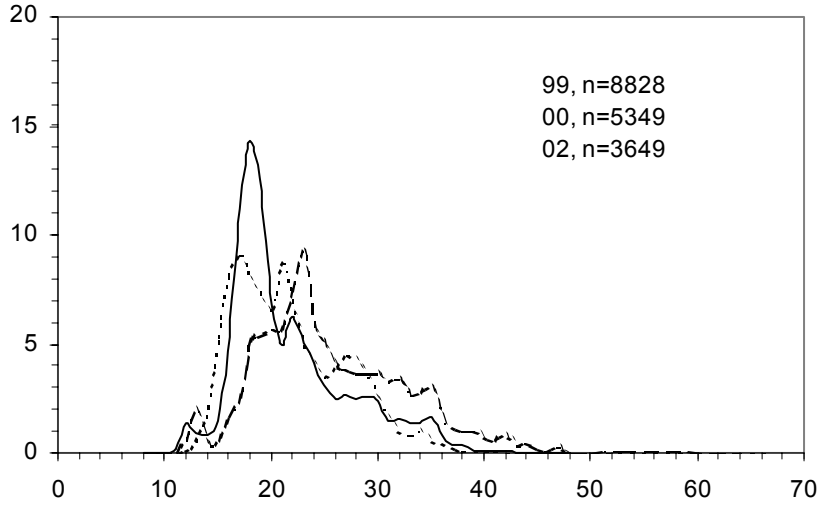


Fig. 8. Overall length distribution of *Sebastes mentella* (percent). Dottet line:1999. Solid line: 2000. Dashed line 2002.

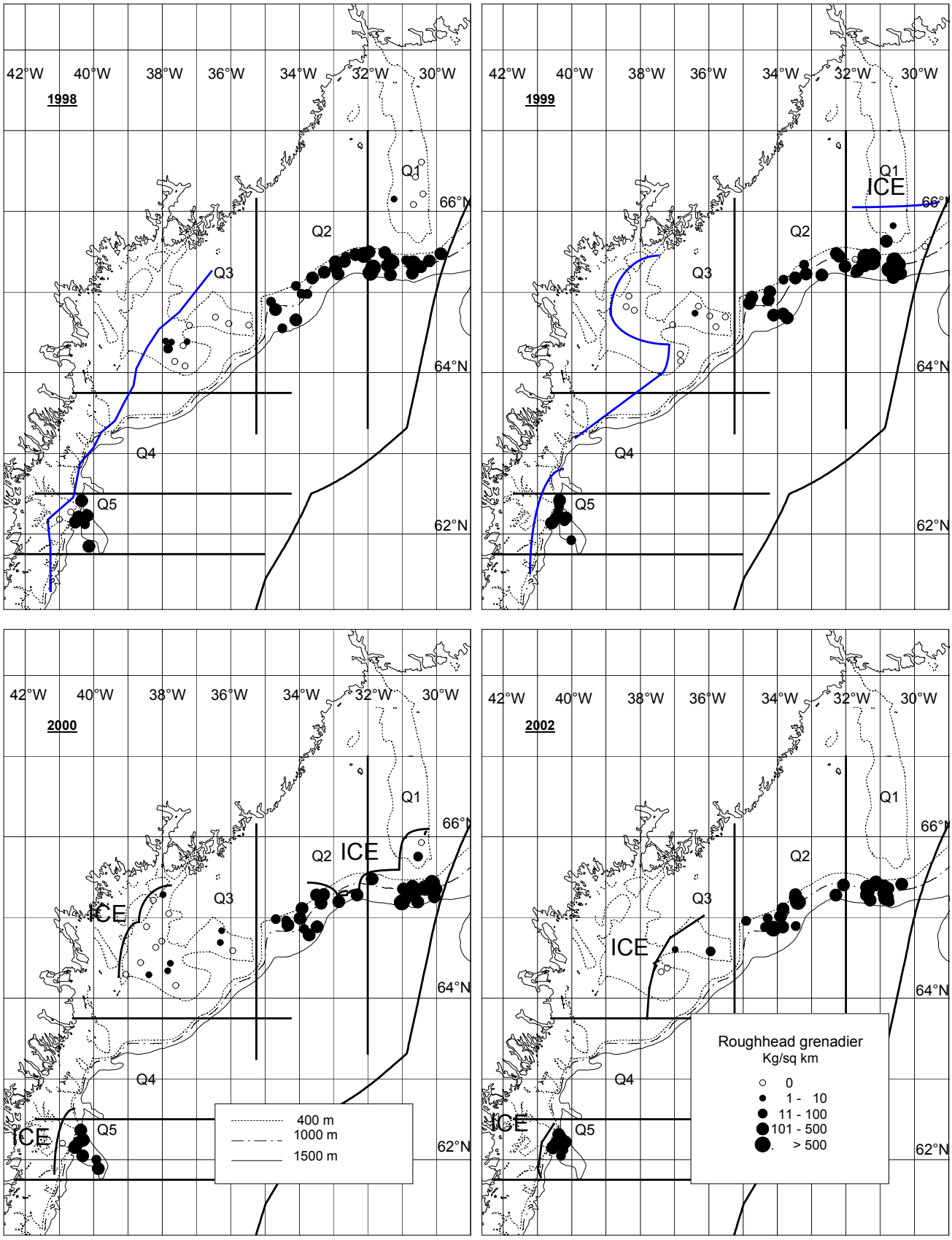


Fig. 9. Distribution of catches of roughhead grenadier at East Greenland in 1998 - 2002.

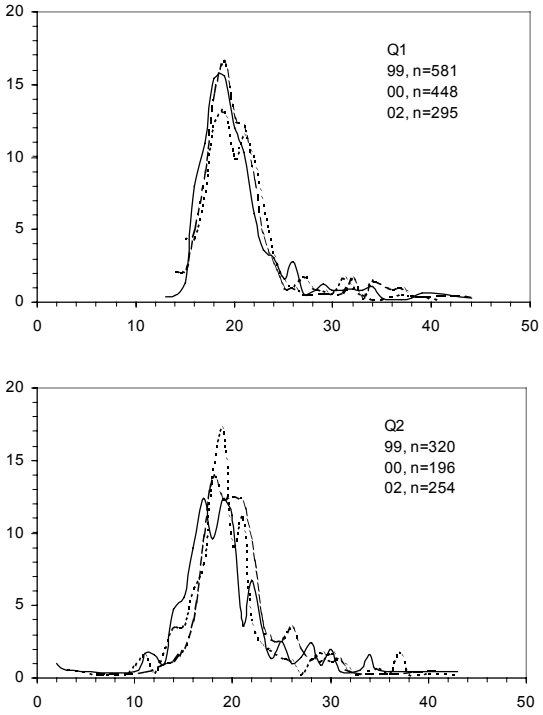


Fig. 10. Length (pre anal fin length (cm)) distributions (percent) of roughhead grenadier by year and area. Only areas with more than 20 observations are included. Dottet line:1999. Solid line: 2000. Dashed line 2002. Note different scales on y-axis.

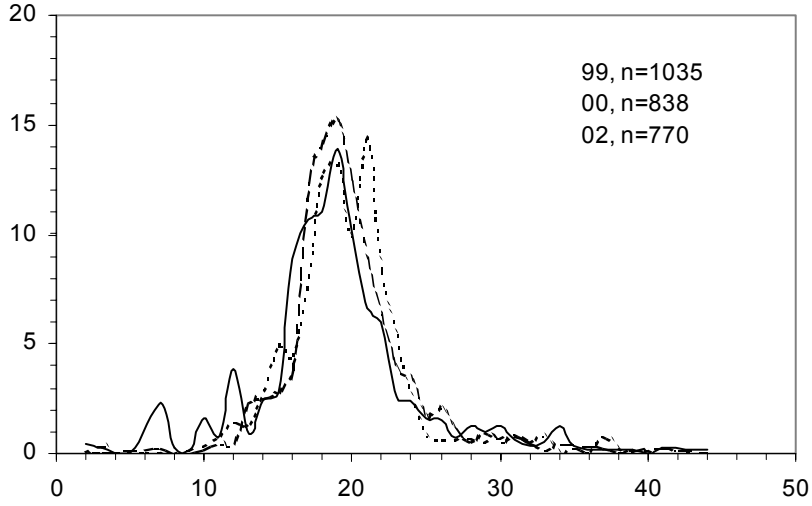


Fig. 11. Overall length distributions (percent) of roughhead grenadier by year. Dottet line:1999. Solid line: 2000. Dashed line: 2002.

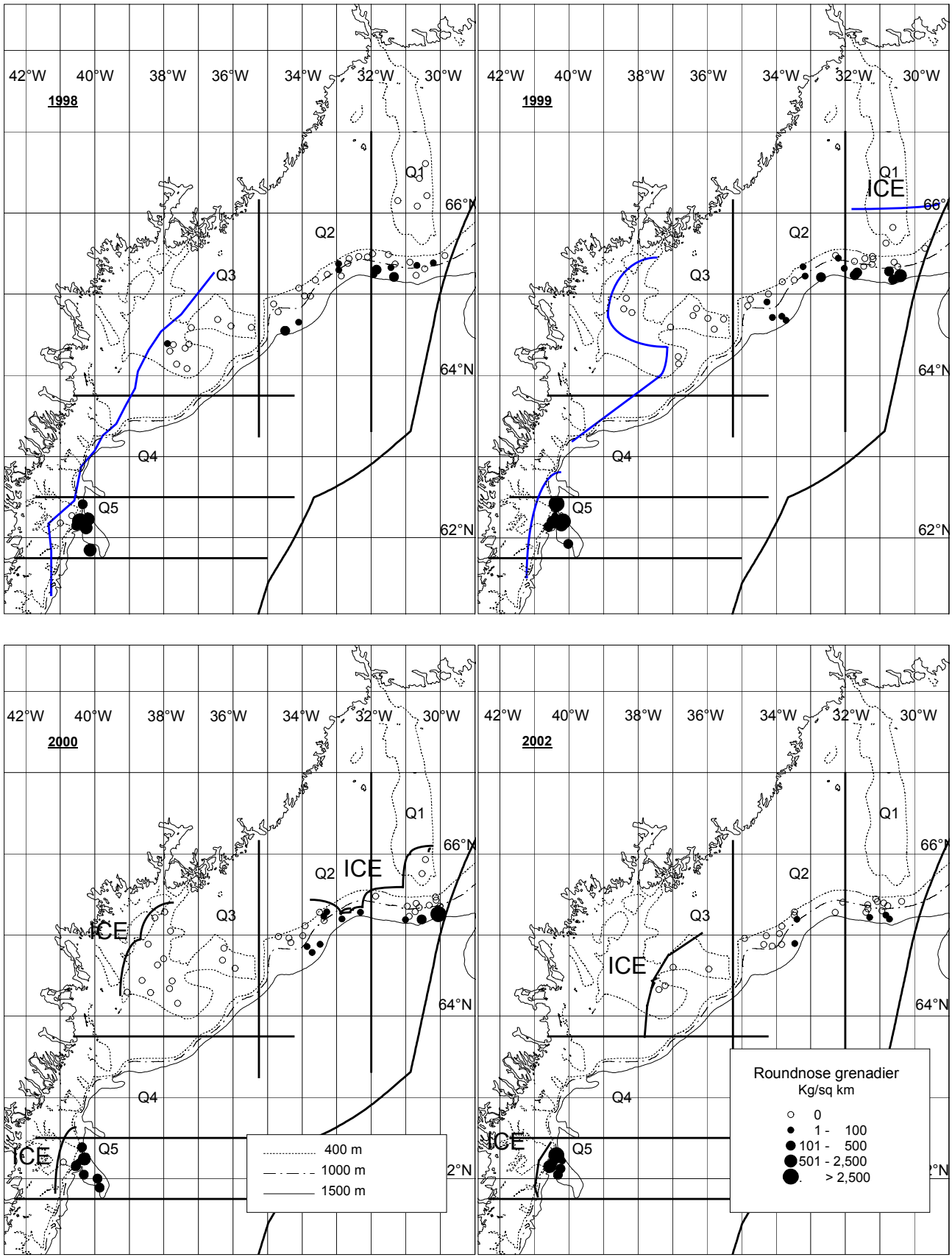


Fig. 12. Distribution of catches of roundnose grenadier at East Greenland in 1998 - 2002.

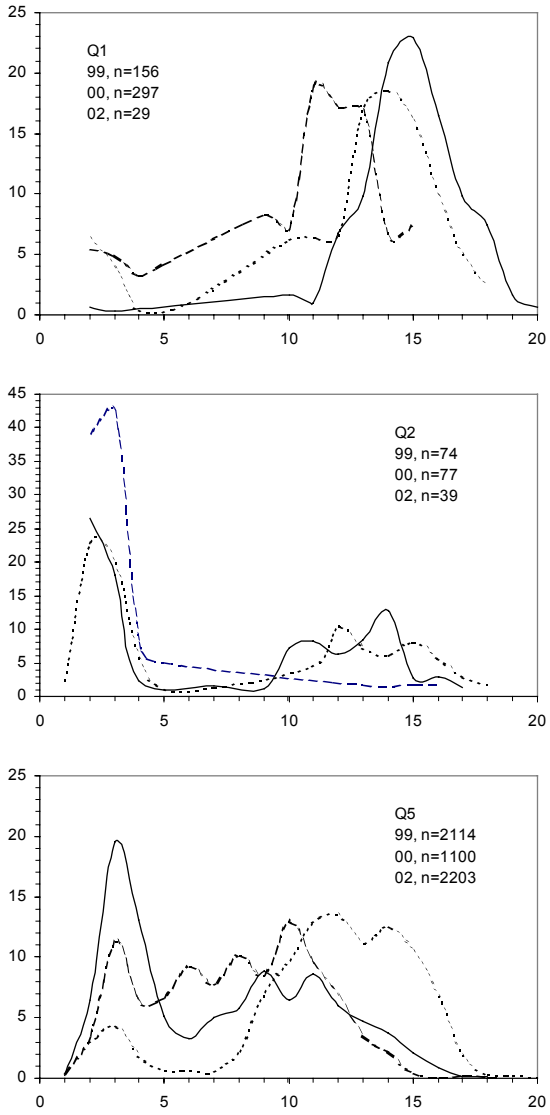


Fig 13. Lengt (pre anal fin length (cm) distribution (percent) of roundnose grenadier by area and year. Dottet line:1999. Solid line: 2000. Dashed line: 2002. Only areas with more than 20 observations are included.

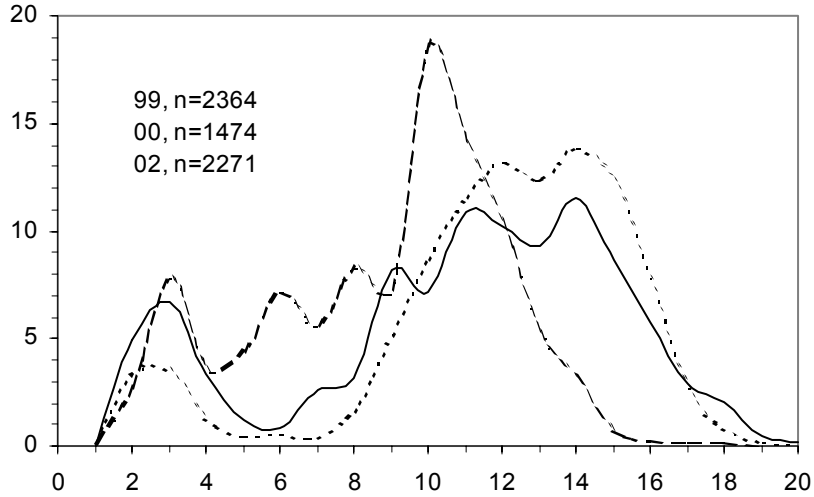


Fig. 14. Over all length distribution(percent) of roundnose grenadier by year. Dottet line:1999. Solid line: 2000. Dashed line: 2002

Appendix 1. List of species and groups of species recoded at East Greenland 2002 with observed minimum and maximum 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 < 49g is given as 0.0 kg)

Obs	ART	species	min wgt	max wgt	min no	max no	min len	max len	min dept	max dept	min temp	max temp
1	ARS	Agentina silus	0.2	1.9	1	5	28.0	42.0	455.0	946.0	2.0	4.2
2	ALA	Alepocephalus agassizzi	0.0	267.3	1	113	7.0	76.0	878.0	1454.5	0.6	4.0
3	ALE	Alepocephalus sp.	0.0	0.0	1	1	12.0	12.0	547.5	1260.5	1.6	5.6
4	CAD	Anarhichas denticulatus	1.8	77.1	1	7	54.0	121.0	455.0	1132.5	1.5	5.0
5	CAA	Anarhichas lupus	1.5	29.1	1	44	23.0	60.0	455.0	557.0	3.4	5.6
6	CAS	Anarhichas minor	0.6	22.2	1	8	33.0	110.0	455.0	946.0	2.0	5.6
7	ANT	Antimora rostrata	0.0	26.5	1	45	11.0	310.0	856.0	1454.5	0.9	4.0
8	ARZ	Arctozenius rissoi	0.0	0.1	1	1	24.0	27.0	646.5	1454.5	1.8	4.5
9	AVO	Avocettina infans	0.0	0.0	1	1	60.0	138.0	856.0	946.0	2.0	3.5
10	BAM	Bajacalifornia megalops	0.1	0.1	1	1	22.0	22.0	1449.5	1449.5	2.3	2.3
11	BAT	Bathylagus euryops	0.0	1.4	1	28	7.0	23.0	878.0	1454.5	0.6	3.7
12	BSP	Bathyraja spinicauda	0.1	32.4	1	2	25.0	157.0	547.5	1302.0	2.0	5.6
13	BEG	Benthosema glaciale	0.0	0.0	1	9	3.5	8.0	512.0	1444.0	0.6	4.8
14	POC	Boreogadus saida	0.0	1.2	1	6	10.0	27.0	455.0	943.5	2.0	4.8
15	BOA	Borostomias antarctica	0.0	0.1	1	1	13.0	24.0	1030.5	1444.0	0.9	3.7
16	USK	Brosme Brosme	0.6	0.6	2	2	26.0	35.0	547.5	547.5	5.6	5.6
17	CFB	Centroscyllium fabricii	1.2	37.4	1	30	17.0	81.0	646.5	1282.0	1.7	4.8
18	CHL	Chaenophryne longiceps	0.2	0.3	1	1	13.0	16.0	943.5	1444.0	0.9	3.3
19	CHA	Chauliodus sloani	0.0	0.1	1	3	15.0	23.0	512.0	1433.5	2.0	4.8
20	CHN	Chiasmodon niger	0.0	0.0	1	1	14.0	17.0	878.0	1444.0	0.9	3.7
21	CBB	Coryphaenoides brevibarbis	0.0	0.4	1	69	1.5	6.0	878.0	1454.5	0.9	4.0
22	CGR	Coryphaenoides guntheri	0.0	2.3	1	50	2.0	14.0	646.5	1454.5	0.9	4.5
23	RNG	Coryphaenoides rupestris	0.0	246.8	1	895	1.5	19.0	646.5	1454.5	0.6	4.8
24	COM	Cottunculus microps	0.0	0.2	1	2	5.0	18.0	487.5	656.5	3.9	4.8
25	COS	Cottunculus sadko	0.9	0.9	3	3	23.0	25.0	851.0	851.0	3.1	3.1
26	COT	Cottunculus thomsonii	0.4	0.4	1	1	28.0	28.0	1282.0	1282.0	2.7	2.7
27	CLM	Cyclothone microdon	0.0	0.0	1	17	4.0	9.0	687.5	1444.0	0.6	4.0
28	COD	Gadus morhua	1.9	1.9	1	1	62.0	62.0	455.0	455.0	4.1	4.1
29	GOB	Gonostoma bathyphilum	0.1	0.1	2	2	16.0	18.0	1304.0	1304.0	2.0	2.0
30	PLA	Hippoglossoides platessoides	0.2	18.0	1	60	22.0	40.0	455.0	725.0	3.4	5.6
31	HAL	Hippoglossus hippoglossus	14.4	86.3	1	1	105.0	185.0	455.0	763.0	3.5	4.8
32	HAF	Hydrolagus affinis	0.0	21.8	1	2	17.0	131.0	906.5	1454.5	1.8	4.0
33	LMC	Lampanyctus macdonaldi	0.0	0.3	1	18	7.0	18.0	646.5	1454.5	0.6	4.5
34	LAS	Lampedena speguligera	0.0	0.0	1	1	11.0	11.0	943.5	1260.5	1.6	3.3
35	LEP	Lepedion eques	0.0	0.3	2	8	9.0	34.0	646.5	1030.5	3.6	4.8
36	KCT	Lithodes maja	0.1	0.2	1	4	.	.	475.5	661.5	3.4	3.5
37	LYP	Lycodes pallidus	0.0	0.3	1	4	20.0	25.0	687.5	1280.0	1.2	4.5
38	LYV	Lycodes vahli	0.0	0.0	1	1	17.0	17.0	487.5	487.5	3.9	3.9
39	GRE	Macrouridae	0.0	0.0	1	4	2.5	5.0	1056.5	1087.5	1.5	3.2
40	RHG	Macrourus berglax	0.3	72.5	1	76	2.5	44.0	455.0	1454.5	0.6	5.6
41	MAA	Magnisudis atlantica	0.1	1.1	1	2	28.0	53.0	946.0	1302.0	1.6	3.3
42	MAL	Malacosteus niger	0.0	0.1	1	1	16.0	24.0	763.0	1260.5	1.6	4.0
43	CAP	Mallotus villosus	0.0	0.1	0	18	9.0	16.0	512.0	1449.5	0.9	4.2
44	MPH	Melamphaidae	0.0	0.1	0	1	.	.	691.0	976.0	2.9	4.2
45	WHB	Micromesistius poutassou	0.1	17.3	1	83	18.0	38.0	455.0	906.5	3.1	5.6
46	BLI	Molva dypterygia	0.7	6.7	1	6	42.0	93.0	455.0	906.5	3.7	5.0
47	NEM	Nemichthys scolopaceus	0.0	0.0	1	1	100.0	100.0	1260.5	1260.5	1.6	1.6
48	NOT	Notacanthus chemnitzii	0.0	7.3	1	5	18.0	106.0	682.5	1413.5	0.6	5.0
49	OCT	Octopus	0.0	6.0	1	3	.	.	557.0	1302.0	1.5	4.8
50	OND	Oneirodes sp.	0.0	0.0	1	1	.	.	1433.5	1433.5	2.0	2.0
51	ONA	Onogadus argentatus	0.0	0.5	1	5	9.0	36.0	512.0	1444.0	0.6	5.6
52	RBT	Raja bathyphila	0.1	34.6	1	5	17.0	111.0	475.5	1087.5	1.5	3.4
53	RFL	Raja fyllae	0.0	4.3	1	2	13.0	50.0	487.5	906.5	3.5	4.8
54	RRD	Raja radiata	0.4	16.0	1	20	15.0	54.0	455.0	976.0	2.0	5.6
55	RSP	Raja spinacidermis	1.0	3.1	1	2	45.0	79.0	1282.0	1449.5	2.3	2.7
56	GHL	Reinhardtius hippoglossoides	1.3	595.8	2	651	27.0	115.0	455.0	1454.5	0.6	5.6
57	SCO	Scopelosarus lepidus	0.1	0.5	1	4	28.0	39.0	1056.5	1302.0	1.6	3.3
58	REG	Sebastes marinus	4.5	6.2	1	2	49.0	64.0	646.5	906.5	4.0	4.8
59	REB	Sebastes mentella	0.1	346.7	1	738	11.0	64.0	455.0	1444.0	0.9	5.6
60	RED	Sebastes sp.	9.5	9.5	8	8	27.0	51.0	455.0	455.0	4.1	4.1
61	SEK	Serasia koefoedi	0.0	0.0	1	1	9.0	14.0	1302.0	1433.5	2.0	3.3
62	SER	Serrivomer beani	0.0	0.6	0	4	36.0	80.0	455.0	1454.5	0.6	5.6
63	GSK	Somniosus microcephalus	400.0	400.0	1	1	410.0	410.0	682.5	682.5	3.6	3.6
64	SQT	Squit	0.0	0.2	0	5	.	.	557.0	1444.0	0.6	4.8
65	STO	Stomias boa	0.0	0.1	1	2	16.0	29.0	725.0	1454.5	0.9	4.5
66	SYN	Synapobranchus kaupi	0.0	4.0	1	31	10.0	70.0	646.5	1454.5	1.6	4.8
67	TRA	Trachyrynchus murrayi	0.1	8.2	1	59	2.5	18.5	878.0	1302.0	2.9	4.0
68	TRM	Triglops murray	0.3	6.0	2	31	5.0	20.0	1132.5	1454.5	1.8	3.4
69	XEC	Xenodermichthys copei	0.0	0.0	1	1	8.0	8.0	688.0	688.0	5.0	5.0