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INVESTIGATIONS OF DEMERSAL FISH IN THE SVALBARD AREA IN THE AUTUMN 2002, WITH SPECIAL ATTENTION ON JUVENILE GREENLAND HALIBUT

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PREFACE

In 1989 the ICES Advisory Committee on Fishery Management stated that actions should be taken to rebuild the spawning stock of the northeast Arctic Greenland halibut (ICES 1990). The following observations of the stock and fishery then led to actions taken in 1992 when strong regulations was enforced to reduce the total landings. Trawl catches were limited to by-catch only and the limited coastal fishery was restricted by seasonal closure.

During the end of the 1980s the year class abundance indices for Northeast Arctic Greenland halibut decreased. These indices were generated by the yearly 0-group and juvenile surveys in the Barents Sea, and it was uncertain if the decrease actually reflected the status of the stock or if there were changes in the distribution area of the young fish during this period. Russian investigations around Franz Josef Land in the period 1978-1980 (Borkin 1983) together with sporadic registrations by the Norwegian surveys early in the 1990s indicated that the area north of Spitsbergen and Franz Josef Land could be important nursery grounds. Based on these indications and a pilot survey in 1993, the Institute of Marine Research started in 1996 a program to investigate to what degree Greenland halibut's nursery grounds extended into the Arctic waters and to establish a time series of recruitment indices for these areas.

The Norwegian survey was conducted in August-September each year when the ice coverage in the area was assumed to be on its yearly minimum. The survey area has been increased several times and in 2000 it was determined to expand the survey further east into the Frans Josef area and make it a joint survey between Russian and Norwegian vessels.

This report presents the results from the survey in 2002.

SUMMARY

Institute of Marine Research in Bergen started in 1996 a program to investigate to what degree Greenland halibut's nursery grounds extended to the north and east of Spitsbergen, and Norwegian vessels executed this survey until 1999 with coverage with some stations into the Russian EEZ in 1998 and 1999. The annual meeting between Russian and Norwegian scientists decided to extend this survey to a joint survey, and the first year with joint effort with a Russian and a Norwegian vessel was year 2000. The survey was conducted as a traditional bottom trawl survey with main focus on Greenland halibut, but also analyses were carried out for cod, redfish and long rough dab.

The main results in 2002 were:

- Ice condition was much worse than in 2001 and similar to that in 2000.
- Water temperature north of Spitsbergen was higher than in 2001, but in the east, in the large area between Spitsbergen and Franz Josef Land, it was lower than in 2001.
- The highest estimations of young Greenland halibut abundance for the whole period of observations since 1996 were obtained.
- Abundance of Greenland halibut year classes continues to increase. The year class of 2001 is the highest on record.
- Growth rate slowdown of halibut young age groups was registered.
- Cod abundance in the area of research increased compared to the year of 2001 owing to individuals 20-34 cm long (2-3 year-olds).
- Abundance of red fishes is at the low level and decreased significantly compared to that in 2001.
- Abundance of long rough dab, especially of the smallest individuals, has been decreasing since the year of 2000.

1. INTRODUCTION

Greenland halibut (*Reinhardtius hippoglossoides* Walbaum) is distributed in the Arctic and boreal waters in the North Atlantic and in the North Pacific (Fedorov 1971; Godø & Haug 1989; Bowering & Brodie 1995; Bowering & Nedreaas 2000). In the northeastern Atlantic the distribution is more or less continuous along the continental slope from the Faeroe Islands and Shetland to north of Spitsbergen (Whitehead *et al.* 1986; Godø & Haug 1989), with the highest concentrations from 500 to 800 m depth between Norway and Bear Island, which is also regarded as the main spawning area (Godø & Haug 1987; Albert *et al.* 2001b). Peak of spawning occurs in December in the main spawning area, but also in nearby localities during summer (Albert *et al.* 2001b). Eggs and larvae drift northwards and the juveniles are distributed in the deeper parts of the Barents Sea and to the north and east of Spitsbergen, to the waters around Franz Josef Land (Borkin 1983; Godø & Haug 1987; Godø & Haug 1989; Albert *et al.* 2001a).

Tantsura (1958), Loeng (1989) and Strømberg (1989) have mapped the currents in the Barents Sea and the areas around Svalbard. Important currents in this area are the two main branches of warm water, the North Cape Current flowing into the Barents Sea and West Spitsbergen Current, which flows north along the slope of the continental shelf. A branch of the latter current swings eastwards north of Svalbard and this results in bottom temperatures between 1-2°C north of Svalbard and eastward towards Franz Josef Land. In the entire area the warm water is gradually mixed with cold water from the Polar basin. Ice covers the area north of Spitsbergen most of the year, but during the short summer the ice recedes towards the northeast. During some warm summers only ice drifts through the area transported by the southwestern Transpolar Current. The ice conditions change from year to year, but the period August/ September is usually the best for survey activity.

During the end of the 1980s the year class abundance indices for Northeast Arctic Greenland halibut decreased. These indices were generated by the Norwegian yearly 0-group surveys for juvenile fish in the Barents Sea, and it was uncertain if the decrease actually reflected the status of the stock or if there were changes in the distribution area of the young fish during this period. Russian investigations around Franz Josef Land in the period 1978-1980 (Borkin 1983) together with sporadic registrations by the Norwegian surveys early in the 1990s indicated that the area north of Spitsbergen and Franz Josef Land could be important nursery grounds. Based on these indications and a pilot survey in 1993, the IMR started in 1996 a program to investigate to what degree Greenland halibut's nursery grounds extended into the Arctic waters and to establish a time series of recruitment indices for these areas.

The main goal of the program was to establish a time series of recruitment indices for Greenland halibut, and also an additional goal was to look closely at the population structure (age, size, growth, survival, etc) in the different areas and depths. Further, information on other species, in particular to determine their distribution and abundance in relation to Greenland halibut, became an important task as well.

Norwegian vessels executed this survey until 1999 with coverage with some stations into the Russian EEZ in 1998 and 1999. The annual meeting between Russian and Norwegian scientists decided to extend this survey to a joint survey, and the first year with joint effort was year 2000 (Høines & Smirnov 2002). The result of this joint effort is a much better geographical coverage of the assumed distribution area of juvenile Greenland halibut.

2. METHODS

2.1. Sampling of catch

The catches were mainly sorted to species but in some cases it was difficult to determine the species, and for these cases only family was determined. The entire catch was sorted but for the most numerous species usually a representative sub-sample was taken. Greenland halibut was prioritised during sampling. Next in importance were polar cod, then cod, redfish, Long rough dab and lastly, capelin. Other species were counted and weighed.

Stratified age samples of Greenland halibut were taken in each area. Usually 10-15 otoliths per sex per 5 cm length group were selected and the smallest length group was commonly 10-14 cm. For each stratified sample, length, weight, sex and maturity status were recorded. Degree of maturation was determined according to the general scale for demersal fish given by (Fotland *et al.* 2000). In addition for female Greenland halibut, a special scale modified after (Nielsen & Boje 1995) was used.

2.2. Swept area analysis

Length based indices for each sub area was estimated using the method of (Jakobsen *et al.* 1997). For each trawl station and length, fish density was estimated by:

$$P_{s,l} = \frac{f_{s,l}}{a_{s,l}},$$

where:

$P_{s,l}$ is the number of fish/n.m.^{2} observed at station s (length l)

$f_{s,l}$ is the estimated frequency of length l

$a_{s,l}$ is swept area given by

$$a_{s,l} = \frac{d_s * EW_l}{1852}$$

d_s is towed distance (n.m.)

and

EW_l is the length dependent effective swept width.

For Greenland halibut, there is no available estimate of the length dependent effective swept width, so it was set to 25 m, independent of fish length and trawl depth.

Based on (Dickson 1993a; Dickson 1993b), length dependent effective fishing width for cod was included in the calculations where EW was:

$$EW_l = \alpha * l^{\beta} \quad \text{for} \quad l_{\min} < l < l_{\max}$$

$$EW_l = EW_{l_{\min}} = \alpha * l_{\min}^{\beta} \quad \text{for} \quad l \le l_{\min}$$

$$EW_l = EW_{l_{\max}} = \alpha * l_{\max}^{\beta} \quad \text{for} \quad l \ge l_{\max}$$

The parameters used for cod were:

α: 5.91

β: 0.43

l_{min}: 15 cm

l_{max}: 62 cm

Point observations for fish density based on length (l) was summed up in 5 cm length groups denoted by $p_{s,l}$. Stratified abundance indices for each length group and strata were generated using

$$L_{p,l} = \frac{A_p}{S_p} * \sum P_{s,l}$$

where:

$L_{p,l}$ is the index for stratum p, length group l

A_p area (n.m.^{2}) of stratum p

S_p is the number of stations in stratum p

For each sub area, the total number of fish in each 5cm length group was estimated by summing over all strata in the sub area, and the total number of fish in each age group in the area was estimated using an age/length key. Finally, the total index for each length and age class is the sum of the values for all sub areas.

For each year, an age/length key was estimated for each stratum. All age samples for a stratum were used. Age samples from a length group was weighted by the index of the number of fish in the 5 cm length group within a stratum divided by the number of age samples in the length group:

$$w_{p,l} = \frac{L_{p,l}}{n_{p,l}} ,$$

where $n_{p,l}$ is the number of age samples in stratum p and length group l.

The proportion of age a at length l was estimated using

$$P_a^{(l)} = \frac{\sum_p n_{p,a,l} * w_{p,l}}{\sum_p n_{p,l} * w_{p,l}}$$

where $P_a^{(l)}$ is the weighted proportion of age a in length group l in stratum p,

and $n_{p,a,l}$ is the number of age samples of age a in length group l.

The sum of the weighted factors in a sub area is the abundance index for the total number of fish in the sub area. The number of fish at age was estimated by:

$$N_a = \sum_p \sum_l L_{p,l} * P_a^{(l)}$$

Average length and weight at age was estimated using (only shown for weight):

$$W_a = \frac{\sum_p \sum_l \sum_j W_{p,a,l,j} * w_{p,l}}{\sum_p \sum_l \sum_j w_{p,l}},$$

where $W_{p,a,l,,j}$ is the weight for sample j in length group l in stratum p and age a.

3. SURVEY OPERATION

The survey area was divided into seven sub areas (Fig. 3.1), and each of these sub areas was divided into three depth strata, 100-300m, 300-500m, and >500m (Table 3.1). Some trawl hauls were also taken outside this area, but these were excluded from the swept area analyses. The survey was conducted using the research vessel "Jan Mayen" in the period from 25 August to 10 September 2002 and the Russian vessel R/V "Nerey" in the period 8 September to 25 September 2002. In the previous years (the years 1996-2001) the Norwegian survey was conducted using hired vessels in the period August/September (Table 3.2). From the Norwegian side the numbers of stations in each stratum in each year have been fairly constant, with exception of subarea D (Kvitøya) and E (Russian EEZ).

The trawlers were equipped with the same type of trawl that is used by the IMR's research vessels in the Barents Sea, a Campelen 1800 standard shrimp trawl equipped with rockhopper gear with a trawl bag (22 mm stretched meshes; (Engås & Godø 1989)). The sweeps were 40 m and strapping was used to stabilize the opening of the trawl. Vaco trawl doors were employed (6m^2, 1500 kg) and the standard trawling time was 30 min at 3 knots. The trawls were equipped with ScanMar (Jan Mayen) or Simrad FS-900/FS-925 (Nerey) sensors, which measured the distance between the doors, the trawl's vertical opening and contact with the bottom. The trawls were also equipped with a calibrated temperature recorder from ScanMar. From 2000 the Norwegian vessel also was equipped with a CTD-probe causing a better coverage of the hydrographical conditions in the survey area.

In 2002 the vessels had worse coverage of the total area than in 2001 (Table 3.2, 3.3).

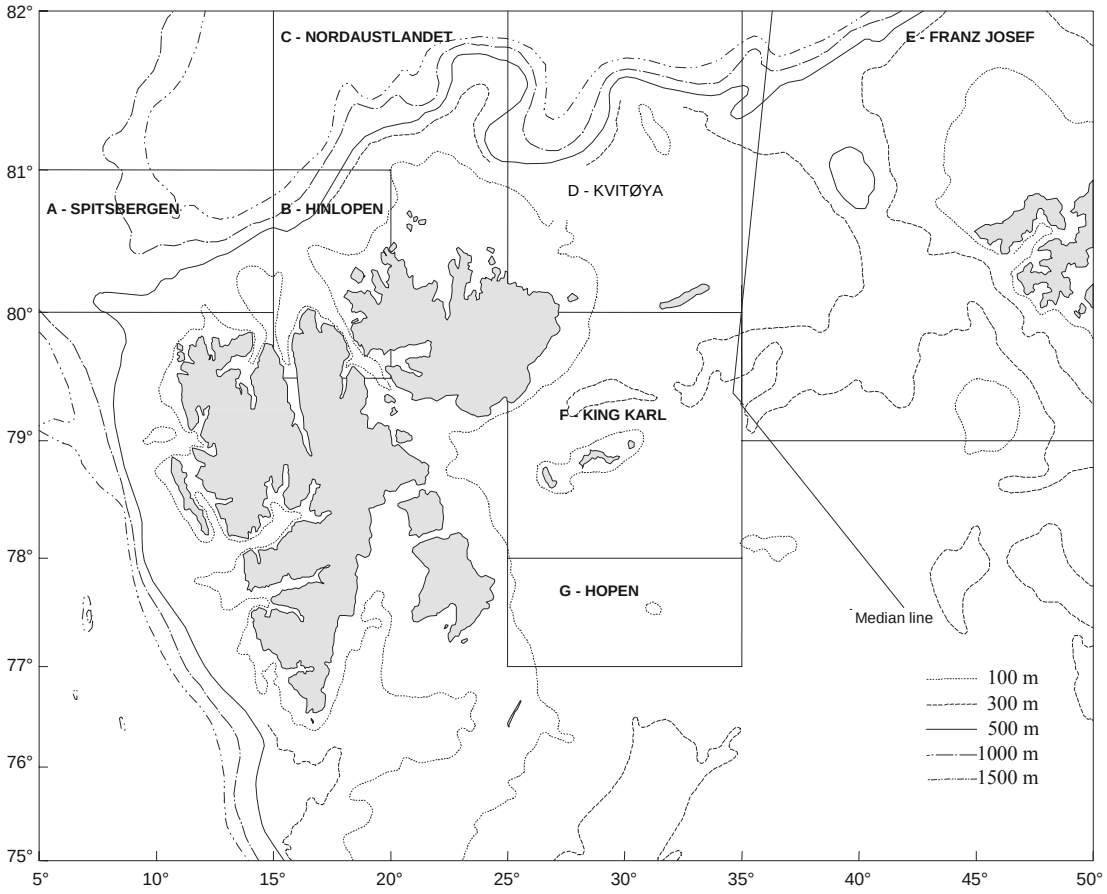

Figure 3.1. Map of the survey area with sub areas marked

Table 3.1. Area and depth intervals for each strata

Strata nr.	Area	Depth	Area (nm^2)
1	A	100-300 m	848
2	A	300-500 m	304
3	A	> 500 m	4373
4	B	100-300 m	915
5	B	300-500 m	324
6	B	> 500 m	299
7	C	100-300 m	438
8	C	300-500 m	818
9	C	> 500 m	1444
10	D	100-300 m	5560
11	D	300-500 m	707
12	D	> 500 m	1600
13	E	100-300 m	11577
14	E	300-500 m	8006
15	E	> 500 m	1058
16	F	100-300 m	10204
17	F	300-500 m	1485
18	F	> 500 m	-
19	G	100-300 m	7373
20	G	300-500 m	-
21	G	> 500 m	-

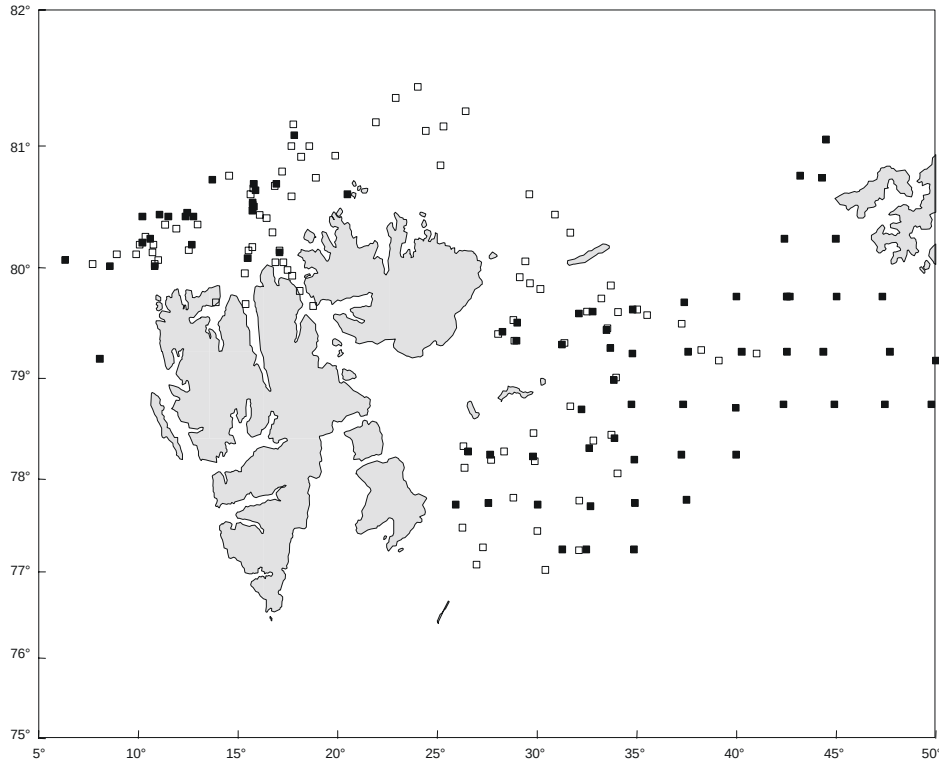

Figure 3.2. Trawl stations in the bottom trawl survey in 2002. Filled symbols are stations carried out by Nerey and open symbols are carried out by Jan Mayen

Table 3.2. Vessel and time period for each Norwegian survey and the number of approved trawl hauls (used in the estimates) for each stratum and year

Vessel	Time period	Number of hauls in each sub area and stratum																					Total
		A			B			C			D			E			F			G			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
Ftr Hopen	23/8-17/9-96	4	2	4	8	4	1	2		4	9	6					7	3		2			56
Mtr Tromsland	27/8-13/9-97	5	3	7	11	8		4	1	3	4	3					13	11		9			82
Mtr Comet	31/8-19/9-98	5	4	8	12	9	1	4	1	1	12	3		8	4		18	7		9			106
Mtr Comet	31/8-15/9-99	6	5	5	10	9		4	4	1	9	2		6	4		13	7		9			94
RV Jan Mayen	28/8-17/9-00	4	3		11	10		4	1	1	4						10	8		9			65
RV Jan Mayen	28/8-15/9-01	3	7	8	12	10		3	1	1	10	3		6	4		11	9		8			96
RV Jan Mayen	25/8-10/9-02	5	4	5	12	10		2	2	1	4	3		3	3		14	8		8			84

Table 3.3. Vessel and time period for each Russian survey and the number of approved trawl hauls (used in the estimates) for each stratum and year

Vessel	Time period	Number of hauls in each sub area and stratum																					Total
		A			B			C			D			E			F			G			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
RV Persey IV	2/9-14/9-00	1			1									10	10	2	3			6			33
RV Nerey	1/9-24/9-01	2	3	5	3	3		4	3	5	8	4	6	12	16	3	9	8		8			102
RV Nerey	8/9-25/9-02	3	2	8	3	7	1	1	1					7	11		11	8		8			71

4. HYDROGRAPHY

Measurements of temperature and salinity were recorded for the whole water column on all fixed stations on the Norwegian and Russian vessels. Figures 4.1 and 4.2 shows the temperature distributions close to surface and at bottom in 2002 (based on Norwegian data).

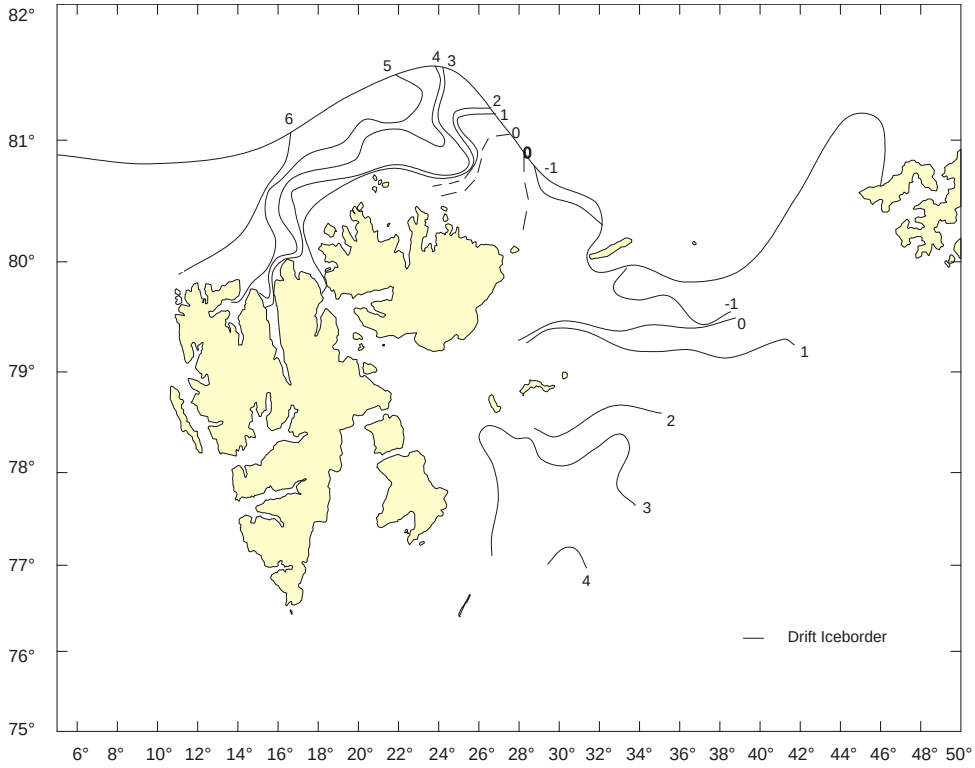

Figure 4.1. Temperature distribution at 5 m below surface in August-September 2002

During the survey in 2002, ice condition was much worse than in 2001 because of the wind regime. In 2001, the surveyed area to the northeast of Spitsbergen and near the Franz Josef Land was completely open; but in 2002, the edge of drifting ice was much to the south reaching 80° N near Kvitøya and Victoria Island (Figs. 4.1 and 4.2). This caused the significant reduction of a number of trawl stations in sub-areas D and E compared to 2001.

It can be concluded by results of oceanographic investigations conducted in September 2002 in the northern part of the Barents Sea that water temperature north of the Spitsbergen Archipelago was anomaly high compared to both long-term mean values and the similar period of the year 2001 (Figs. 4.1 and 4.2, Table 4.1). Eastwards, in the area between Spitsbergen and Franz Josef Land, the predominating winds on the northern directions caused the carry-off of both ice fields and coldwater masses of the Polar Basin. Therefore, water temperature in this area by all layers was mainly close to the long-term mean level and lower than the previous year, excluding the area north of the King Karl Land.

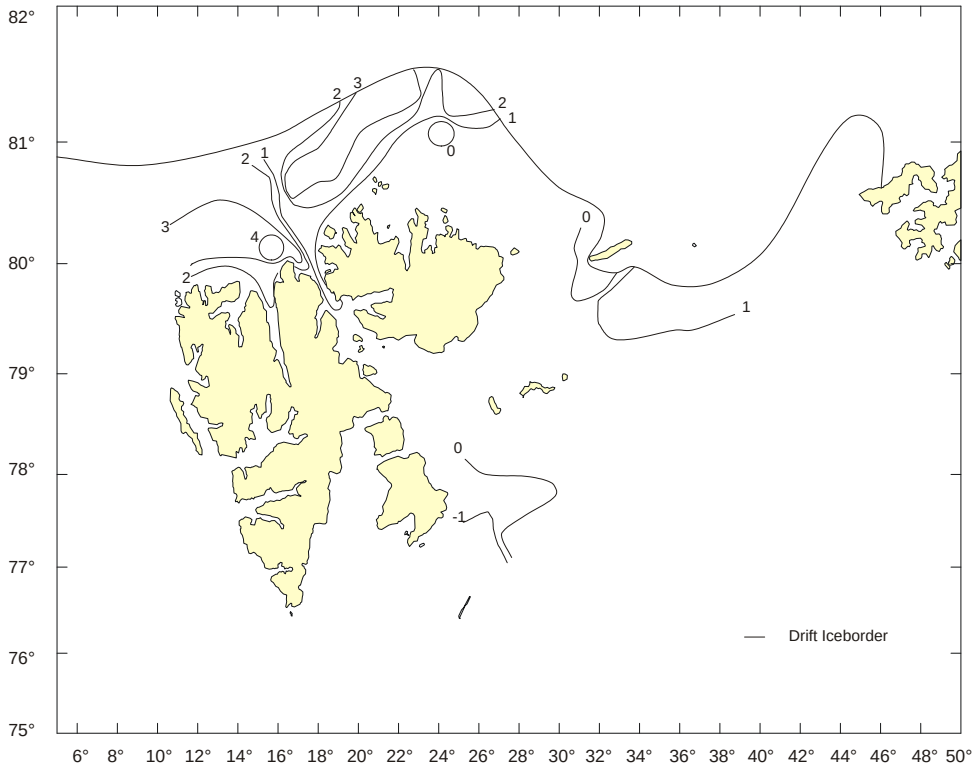

Figure 4.2. Temperature distribution at bottom in August-September 2002

Table 4.1 Mean bottom temperature (°C) in different sub areas in the period 1997-2002. Values are calculated based on mean values in strata (1-3) from Norwegian vessels where measurements are done each year

	A	B	C	D	E	F	G
1997	1.74	2.06	0.02	0.53	-	1.02	0.14
1998	1.67	1.96	-	0.32	0.65	0.70	-0.29
1999	1.38	2.62	1.58	0.55	0.27	0.24	-0.09
2000	2.65	2.09	1.84	0.33	-	0.76	0.17
2001	1.79	2.46	2.21	0.55	1.33	0.93	0.30
2002	3.31	2.51	2.02	1.09	0.61	0.69	0.01

5. DISTRIBUTION AND ABUNDANCE OF GREENLAND HALIBUT

5.1. Swept area

The geographic distribution based on bottom trawl catch rates (number of fish per 3 nautical miles, corresponding to 1 hour towing) of Greenland halibut in 2002 are shown in Figures 5.1 and 5.2.

The distribution of Greenland halibut was in general similar to that observed in the previous years. As in 2000-2001, the densest concentrations were revealed in the area south of Kvitøya. Some catches were very high, reaching 6 thousand individuals per 30-minutes trawling, which has never been observed before. Correspondingly, total abundance of Greenland halibut in the sub-area F was assessed as much as 65 mill. individuals (Table 5.1), which is 3 times more than in 2001. The extreme indices of Greenland halibut should be interpreted with caution since the hydrographical conditions have changed markedly in comparison with the last years. And these indices could be caused by re-distribution of Greenland halibut connected to the cooling of the northern and eastern parts of the surveyed area.

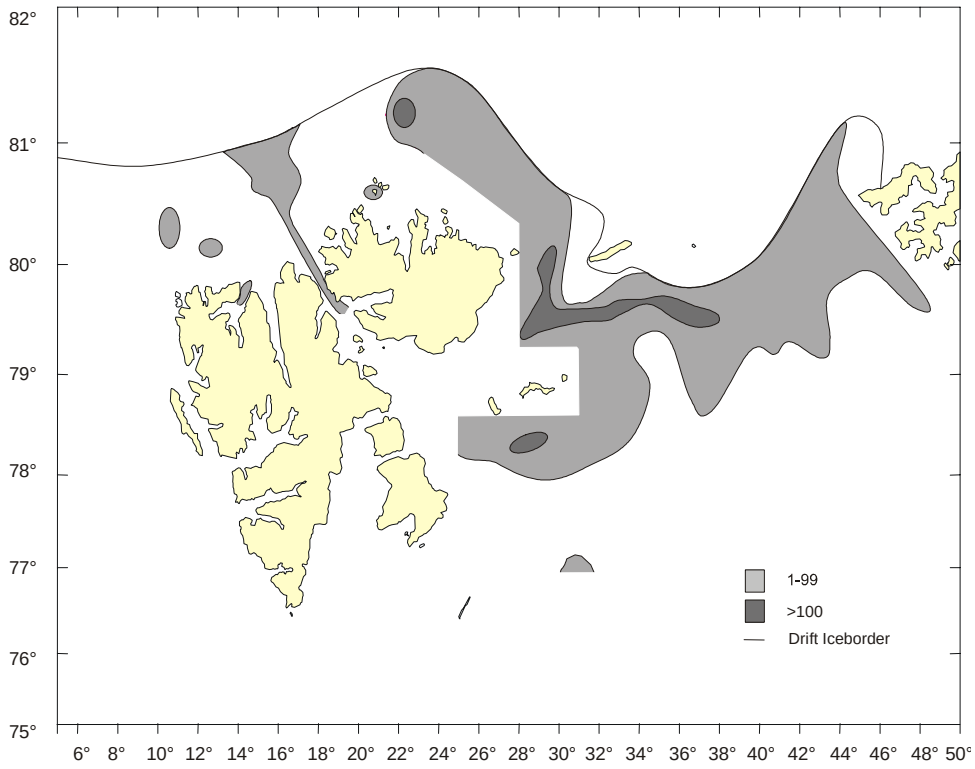

Figure 5.1. GREENLAND HALIBUT < 15 cm. Distribution in trawl catches in August-September 2002 (number per hour trawling)

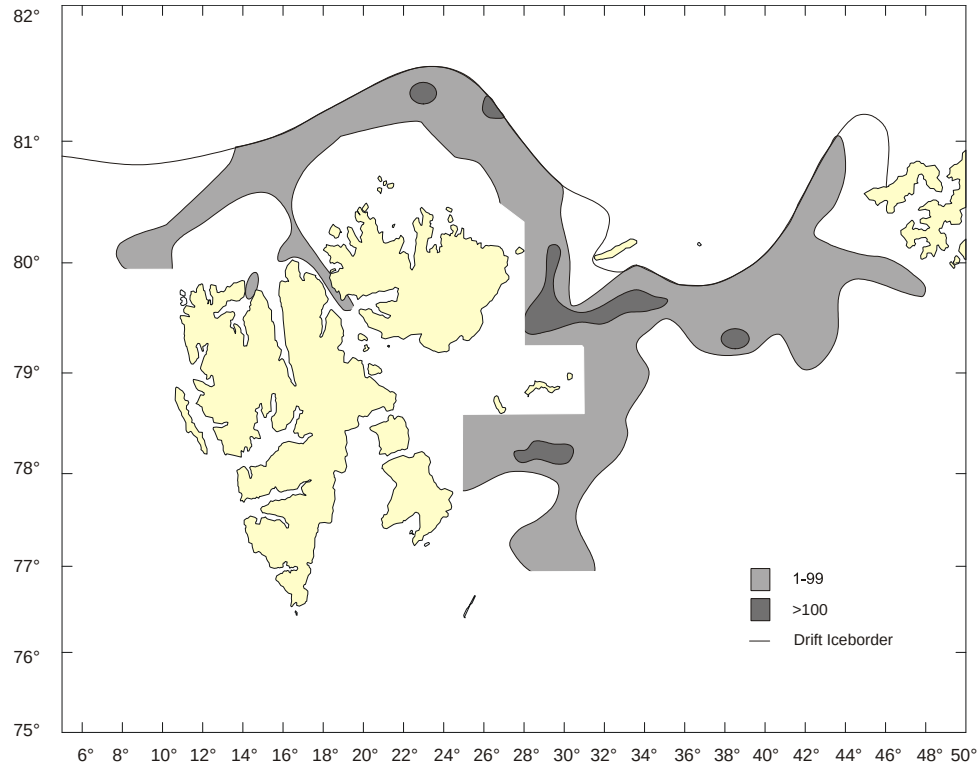

Figure 5.2. GREENLAND HALIBUT > 15 cm. Distribution in trawl catches in August-September 2002 (number per hour trawling)

Table 5.1 presents the abundance indices by length for each sub area. Standard error and coefficient of variation (CV) are also given. Table 5.2 shows the abundance indices by age- and length groups, and Table 5.3 presents the indices for each age group by sub areas. Fish smaller than 30 cm dominated the estimates and the highest abundance were observed in sub area F and E.

Time series (1996-2002) is presented in Table 5.4. The indices are very variable throughout the time series due to differences in area coverage and changes in survey operation. From 1996 to 1999 the survey was conducted by one Norwegian vessel only, and in the years 1996 and 1997 there were also no coverage in the Russian EEZ (Sub area E).

Abundance indices of fish at age 1, 2 and 3 as well as total indices in 2002 are the highest in the time series.

Table 5.1. ***GREENLAND HALIBUT*. Abundance indices (I) at length with standard error of the mean (S) from bottom trawl hauls for main areas north and east of Spitsbergen in August-September 2002 (numbers in thousands)**

Length (cm)	Area														Total		
	A		B		C		D		E		F		G				
	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	CV(%)
5-9	40	34	11	7	29	29	88	69	57	38	263	100	21	21	509	137	26.9
10-14	115	77	447	170	1 119	689	2 763	1 404	16 669	7 215	27 259	9 706	65	47	48 437	12 196	25.2
15-19			91	24	236	229	418	190	2 117	1 189	12 598	6 022	23	23	15 483	6 145	39.7
20-24	8	8	43	22	1 177	1 152	1 541	1 105	5 107	2 636	12 499	5 302			20 375	6 133	30.1
25-29	150	80	77	43	486	379	867	740	3 253	1 387	6 877	2 310			11 709	2 821	24.1
30-34	374	161	133	50	269	43	495	372	2 326	846	3 998	1 362			7 595	1 655	21.8
35-39	606	336	140	61	155	83	210	132	335	136	1 226	463			2672	612	22.9
40-44	564	214	28	11	323	21	12	12	111	49	465	188	43	29	1 546	291	18.8
45-49	152	61	4	2	97	13	23	23			72	38	23	23	371	80	21.5
50-54	100	68			71										171	68	39.5
55-59	58	40	15		12	12									85	42	49.0
60-64	50	34													50	34	67.7
65-69											14	14			14	14	100
70-74							12	12							12	12	100
75-79																	
80-84																	
>85																	
Sum	2217		989		3 973		6 427		29 976		65 271		175		109 027		

Table 5.2. ***GREENLAND HALIBUT*. Abundance indices at length and age (0-group excluded) from bottom trawl survey north and east of Spitsbergen in August-September 2002 (numbers in thousands)**

Length (cm)	Age (year-class)						Sum
	1 (01)	2 (00)	3 (99)	4 (98)	5 (97)	6+	
5-9	385						385
10-14	48 437						48 437
15-19	4 215	11 268					15 483
20-24		19 645	730				20 375
25-29		1 658	10 051				11 709
30-34			6 575	1 020			7 595
35-39			45	2 619	7		2 671
40-44				273	1 261	12	1 546
45-49					119	252	371
50-54						171	171
55-59						85	85
60-64						50	50
65-69						14	14
70-74						12	12
75-79							
80-84							
>85							
Sum	53 037	32 571	17 402	3 912	1 386	596	108 904

Table 5.3. *GREENLAND HALIBUT*. Abundance indices by age (0-group excluded) and sub areas in August-September 2002 (numbers in thousands) n = number of valid hauls in each sub area

Sub area	Age (year-class)						Total	n
	1 (01)	2 (00)	3 (99)	4 (98)	5 (97)	6+		
A	140	8	299	831	565	360	2 203	27
B	471	110	150	210	33	14	988	33
C	1 148	1 121	958	328	302	117	3 974	7
D	2 990	1 943	1 176	271	23	23	6 426	7
E	17 519	6 775	5 008	562	111	0	29 975	24
F	30 701	22 595	9 809	1 711	309	60	65 185	41
G	68	20	0	0	43	23	154	16
Total	53 037	32 572	17 400	3 913	1 386	597	108 905	155

Table 5.4. *GREENLAND HALIBUT*. Abundance indices from bottom trawl surveys north and east of Spitsbergen in August-September 1996-2002 (numbers in thousands). Indices in 1996-1999 based on Norwegian surveys only

Year	Age						Total
	1	2	3	4	5	6+	
1996*	15 655	14 510	10 025	3 487	1 593	3 349	48 619
1997*	3 415	15 271	14 140	2 803	403	434	36 466
1998	10 210	28 020	17 186	6 380	1 551	932	64 279
1999	7 514	16 159	8 045	3 067	2 401	954	38 140
2000	17 087	10 320	7 460	5 855	1 629	476	42 827
2001	24 603	19 302	5 444	3 497	1 440	786	55 072
2002	53 037	32 571	17 402	3 912	1 386	596	108 904

* No coverage in Russian EEZ.

5.2. Growth

Table 5.5 presents the time series for mean length (A) and mean weight (B) by age for the entire investigated area. The annual growth increment is shown in Table 5.6 and for all age groups in the surveys the annual growth has been low from 1997-1998.

Mean length and weight of individuals in 2002, excluding age group 3, differed much from those observed in 2001. Length and weight of young age groups, especially of group 1, decreased, whereas those of the elder groups, especially of groups 6-7, on the contrary, significantly increased. In the period between investigations of 2001 and 2002, the rate of growth of the youngest age groups (younger than 2 year old) was slowed, and that of fish older than 3 year old was speeded up compared to the period of 2000-2001. It is difficult to find the explanation to this contradiction.

Table 5.5. ***GREENLAND HALIBUT*. Mean length (A) and mean weight (B) of Greenland halibut, all areas and strata pooled. Standard deviation of length in brackets**

A	Age							N
	1	2	3	4	5	6	7	
1996	14.7 (1.80)	22.3 (1.96)	27.3 (2.48)	34.6 (1.90)	41.6 (3.16)	47.1 (2.27)	50.6 (2.26)	300
1997	13.0 (1.34)	23.9 (2.81)	32.9 (3.25)	39.6 (2.68)	45.7 (3.39)	51.4 (2.24)	54.0 (-)	376
1998	14.7 (0.65)	21.3 (1.78)	30.7 (2.42)	36.5 (2.62)	42.3 (2.07)	47.8 (2.25)	52.6 (2.28)	366
1999	13.9 (1.53)	22.3 (1.90)	28.9 (2.36)	36.1 (2.74)	40.1 (3.32)	46.0 (1.48)	50.5 (4.42)	491
2000	15.6 (2.59)*	23.2 (1.36)	29.2 (2.20)	34.5 (2.87)	42.2 (2.40)	46.8 (1.80)	53.9 (0.38)	615
2001	15.6 (2.59)	22.6 (1.51)	28.5 (2.06)	34.1 (2.79)	40.2 (2.10)	45.7 (2.14)	52.7 (1.88)	564
2002	12.8 (1.46)	21.0 (2.55)	28.8 (2.56)	35.9 (2.38)	42.2 (1.70)	48.1 (1.77)	55.0 (-)	453
B	Age							
	1	2	3	4	5	6	7	N
1996	24	91	183	386	684	946	1 239	300
1997	18	113	305	581	935	1 142	1 480	376
1998	18	71	243	431	692	973	1 348	366
1999	49	88	208	458	585	891	1 336	491
2000	28*	94	201	346	690	943	1 582	615
2001	28	92	199	369	631	841	1 330	564
2002	14	73	204	419	753	1 029	1 613	453

*No samples of 1-group in 2000, used mean length and mean weight as in 2001.

Table 5.6. ***GREENLAND HALIBUT*. Annual growth increment (g) from the surveys north and east of Spitsbergen in the period 1996-2002**

Year	Age				
	1-2	2-3	3-4	4-5	5-6
1996-1997	89	214	398	549	458
1997-1998	53	130	126	111	38
1998-1999	70	137	215	154	199
1999-2000	45	113	138	232	358
2000-2001	64	105	168	285	151
2001-2002	45	112	220	384	398

5.3. Considerations and conclusions

When using the abundance indices for stock assessment it is important to be aware of all the technical changes introduced during the time series. The Norwegian survey, which was started in 1996, has undergone changes during the whole period with respect to area coverage and also in using different vessels. After 2000 this survey became a joint survey between Russian and Norwegian vessels and the area coverage again changed. The survey area was extended further to the east and the area around Franz Josef Land was included in the geographical coverage. The analyses are also influenced by using data from two different vessels combined into one estimate. The between vessel factors was looked into in chapter 9, and for future use of this time series it is probably most correct to only use data after 2000.

Assessments of Greenland halibut abundance in 2002 very much exceeds those obtained before, but this result should be interpreted with caution since the area covered was reduced

due to the ice conditions. Abundance increased owing to individuals at the age of 1-3 (year classes of 1999-2001). Apparently, these year classes are comparatively abundant. The tendency of increasing indices of the youngest fish in the recent years probably reflects an improved spawning stock of Greenland halibut. However, it is necessary to remember that variations of the hydrographical regime and cooling of the marginal habitat could have an impact on the increase of young fish concentrations.

6. DISTRIBUTION AND ABUNDANCE OF COD

6.1. Swept area

The geographic distribution based on bottom trawl catch rates (number of fish per 3 nautical miles, corresponding to 1 hour towing) of cod in 2002 is shown in Figures 6.1 – 6.2. The survey area is in the outer boundary of the natural distribution for cod and the figures reflect this.

A character of cod distribution, both for individuals less than 20 cm and for larger fish, was in 2002 practically the same as in 2001. The difference was that because of the lower water temperature in the area between Spitsbergen and Franz Josef Land the relatively dense concentrations (100 and more ind./1 trawling hour) were not observed in 2002 north of 77°30'N.

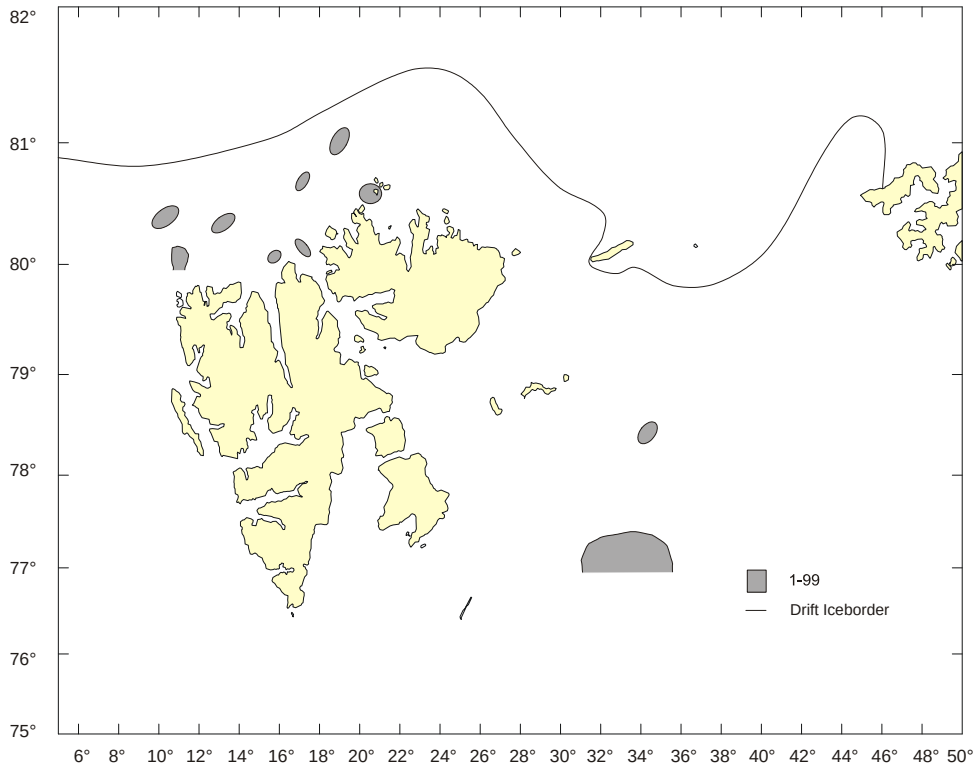

Figure 6.1. COD < 20 cm. Distribution in trawl catches in August-September 2002 (number per hour trawling)

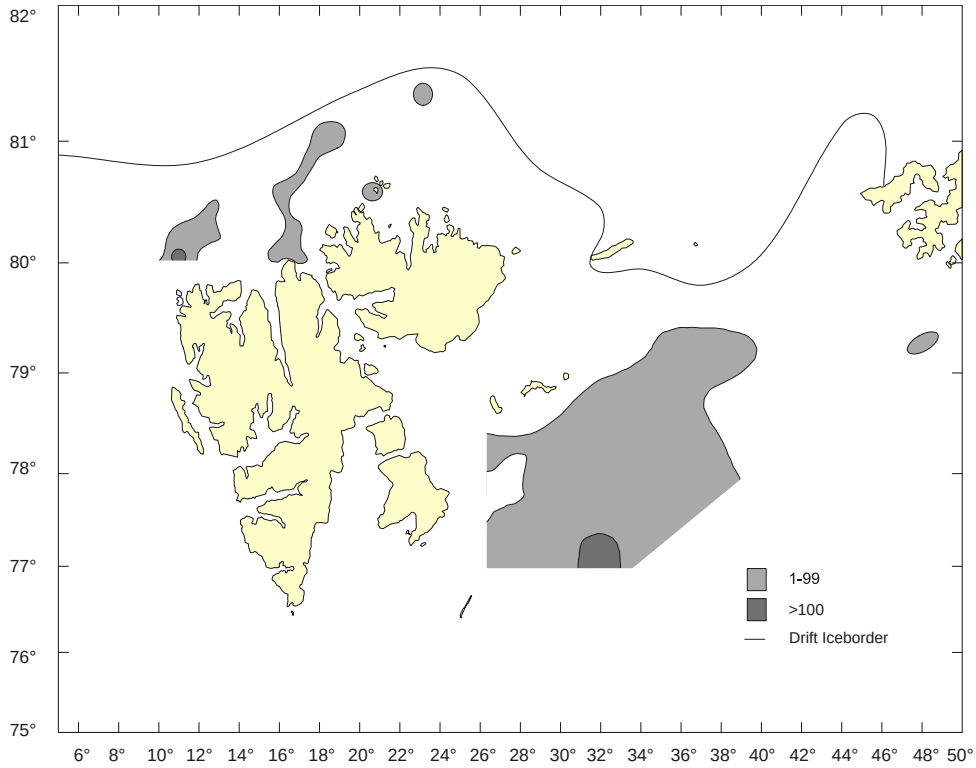

Figure 6.2. COD > 20 cm. Distribution in trawl catches in August-September 2002 (number per hour trawling)

Table 6.1 presents the abundance indices by length in 2002, for each sub area with standard error in addition to the coefficient of variation for the total. The CV's were relatively high for most of the length groups and only the estimate for fish in length group 50-79 cm showed a CV less than 30 %. The length groups 20-34 cm were most abundant. The length group 25-29 cm contributed more than 32 % of the total estimate.

Time series (1996-2002) is presented in Table 6.2. The highest index was estimated in 1996 when the length group 15-19 cm contributed with 61 % of the total estimate. The lowest estimate in the time series was in 1998 with only 4 mill individuals and this is also the year with the lowest observed mean bottom temperature in sub area G (Table 4.1). In 1999-2001 the total estimate has fluctuated around 20 mill individuals with relatively low numbers of fish smaller than 25 cm.

In 2002 the total estimate is the second highest in the time series, and this is caused by a marked increase in the abundance of fish between 20 and 34 cm.

Table 6.1 ***COD*. Abundance indices (I) at length with standard error of the mean (S) from bottom trawl hauls for main areas north and east of Spitsbergen in August-September 2002 (numbers in thousands)**

Length (cm)	Area														Total		
	A		B		C		D		E		F		G				
	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	CV (%)
5-9	226	127	19	12	162	162							300	223	708	304	42.9
10-14	7	7			10	10							391	275	407	275	67.6
15-19	17	12	4	4	10	10					27	27	478	390	535	391	73.0
20-24	333	281	51	29	24	24					47	33	2 542	2 459	2 997	2 476	82.6
25-29	229	72	47	22	22	16					248	103	8 869	8 403	9 415	8 404	89.3
30-34	61	27	3	3					56	56	103	49	4 685	3 961	4 908	3 962	80.7
35-39	49	25	7	6							37	37	528	339	621	342	55.0
40-44	15	8	3	3							18	18	441	249	476	250	52.4
45-49	14	14											402	259	416	260	62.5
50-54	24	14	2	2	11	11					256	142	804	259	1 098	296	26.9
55-59	35	21									543	210	800	284	1 378	354	25.7
60-64	12	9									869	352	947	281	1 828	451	24.6
65-69	35	21							60	45	910	358	750	196	1 755	411	23.4
70-74	19	13	1	1					19	19	621	196	420	130	1 080	237	21.9
75-79									39	27	551	188	225	88	815	209	25.7
80-84									39	27	239	104	81	39	359	114	31.8
85-89											141	58	65	29	206	65	31.7
90-94																	
>95											15	15			15	15	100.0
Sum	1 110		136		237		0		214		4 621		22 730		29 048		

Table 6.2 ***COD*. Abundance indices from bottom trawl surveys north and east of Spitsbergen in August-September 1996-2002 (numbers in thousands)**

Year	Length group (cm)																			Total
	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	>95	
1996*	1490	3 002	35 732	6 927	2 107	2 386	2 525	1 257	274	6	0	0	1 300	520	781	0	130	0	0	58 437
1997*	51	517	2 673	3 344	2 751	527	219	429	89	60	0	88	87	116	60	116	0	29	0	11 156
1998	36	1 099	722	516	391	215	167	211	132	22	117	131	109	168	133	106	17	0	0	4 291
1999	6	353	2 324	2 288	3 685	3 732	2 281	1 397	1 478	1 995	1 395	860	685	442	490	304	151	114	42	24 022
2000	103	78	600	443	1 801	2 078	2 780	1 555	948	1 146	2 184	2 337	1 110	849	392	229	82	33	0	18 747
2001	0	135	873	942	1 161	1 427	1 895	1 369	1 509	2 093	2 393	1 620	1 751	1 333	483	151	73	47	3	19 259
2002	708	407	535	2 997	9 415	4 908	621	476	416	1 098	1 378	1 828	1 755	1 080	815	359	206		15	29 048

* No coverage in Russian EEZ.

6.2. Considerations and conclusions

The cod distribution is very dependent of the bottom temperature conditions in this area, and since the polar front is variable from year to year in the survey area it is expected that also this will influence the total estimate. If the polar front extends far south the distribution of cod will be limited in the survey area and the estimate will be reduced. Variation in the cod estimate will then not necessarily reflect variation in cod abundance, but variation in suitable living conditions for cod. It is not possible to make conclusions about stock status on cod based on this survey alone, but the results are important as supplement to other investigations done every year for mapping the cod stock.

7. DISTRIBUTION AND ABUNDANCE OF REDFISH

7.1. Swept area

7.1.1. Sebastes marinus

Figure 7.1 show the horizontal distribution of *Sebastes marinus* in 2002. The general picture was that the abundance of *S. marinus* was very low on the survey area and the distribution was also very limited as in previous years.

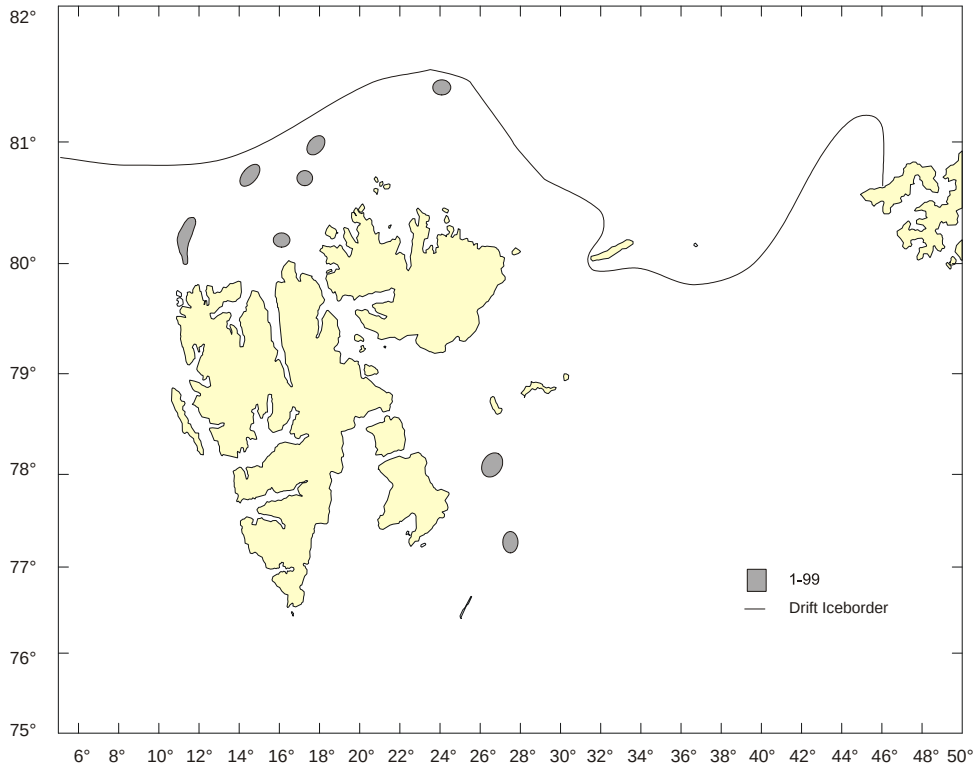

Figure 7.1. SEBASTES MARINUS. Distribution in trawl catches in August-September 2002 (number per hour trawling)

Table 7.1 presents the abundance indices by length in 2002, for each sub area with standard error in addition to the coefficient of variation for the total. The CV's were high for all the length groups and only the estimate for fish in length group 35-39 cm showed a CV less than 50 %. In 2002 this was the most abundant length group in the catches with an estimate of 58% of the total estimate.

Table 7.1 *SEBASTES MARINUS*. Abundance indices (I) at length with standard error of the mean (S) from bottom trawl hauls for main areas north and east of Spitsbergen in August-September 2002 (numbers in thousands)

Length (cm)	Area														Total		
	A		B		C		D		E		F		G				
	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	CV(%)
5-9			3	3											3	3	100.0
10-14			9	9											9	9	100.0
15-19			3	3											3	3	100.0
20-24																	
25-29	8	5	3	3											10	6	53.5
30-34	20	11													20	11	56.2
35-39	11	8	1	1	12	12					20	20	21	21	66	33	49.8
40-44	4	4													4	4	100.0
45-49																	
50-54																	
55-59																	
> 60																	
Sum	42		18		12						20		21		113		

Time series (1997-2002) is presented in Table 7.2. In 1996 the redfish was not separated in the two species and the indices for *S. marinus* is included in the result for *S. mentella*. The indices were generally low with exception of 1999 when the length groups between 10 and 19 cm were good represented. In 2000 and 2001 these length groups were again very low or absent from the survey area. It is important to notify that the estimate for 1999 is not due to one or two very rich catches, but it is caused by several moderate catches. Since 1999 the indices has decreased and in 2002 the estimate was the second lowest observed in the time series.

7.1.2. Sebastes mentella

Figure 7.2 shows the horizontal distribution of *Sebastes mentella* in 2002.

Sebastes mentella were distributed quite widely as far as the Franz Josef Land. A character of distribution was similar to that observed in 2001. Redfish were mainly found in areas with depths more that 300 m. No dense concentrations were formed in the area between Spitsbergen and Franz Josef Land. The largest catches (upto 162 ind./30 min. trawling) were registered to the northwest of Spitsbergen.

Table 7.3 presents the abundance indices by length in 2002, for each sub area with standard error in addition to the coefficient of variation for the total. The CV's were generally lower than for *S. marinus* and all length groups smaller than 35 cm showed a CV less than 50 %. In

2002 as well as in previous years the most abundant length group in the catches was the smallest one (5-14 cm), which contributed with approx. 2/3 of the total estimate.

Time series (1996-2002) is presented in Table 7.4. In 1996 the redfish was not separated in the two species and the indices for *S. marinus* is included in the result for *S. mentella*. In 2002, a very low abundance estimate, only 50% of the index of 2001, was obtained. It was probably connected with underestimation, since in 2002 there was no possibility to observe the area of the continental slope to the northeast of Spitsbergen, where in 2001 high catches were taken.

Table 7.2 *SEBASTES MARINUS*. Abundance indices from bottom trawl surveys north and east of Spitsbergen in August-September 1996-2002 (numbers in thousands)

Year	Length group (cm)												Total
	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	> 60	
1996*	All redfish determined only to family – included in the chapter of *S. mentella*												
1997*	0	0	54	154	123	0	0	5	0	0	0	0	336
1998	0	0	0	0	5	5	29	0	0	0	0	0	39
1999	26	2 027	4 219	447	72	32	10	15	0	0	0	0	6 848
2000	0	0	4	41	181	179	23	86	0	2	0	0	515
2001	0	0	53	30	110	44	48	14	0	15	0	0	314
2002	3	9	3	0	10	20	66	4	0	0	0	0	113

*No coverage in Russian EEZ.

Table 7.3 *SEBASTES MENTELLA*. Abundance indices (I) at length with standard error of the mean (S) from bottom trawl hauls for main areas north and east of Spitsbergen in August-September 2002 (numbers in thousands)

Length (cm)	Area														Total		
	A		B		C		D		E		F		G				
	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	CV(%)
5-9	81	70	172	109			1 079	814	228	128	536	170			2 096	851	40.6
10-14	586	357	463	388			218	102	170	104	536	235			1 973	596	30.2
15-19	386	136	27	8	256	16	208	193			25	21			901	238	26.4
20-24	641	162	6	5	162	85	35	35			54	42	23	23	921	192	20.9
25-29	114	35			134	32	23	23			20	20			292	57	19.5
30-34	33	18			49	31	12	12							94	38	40.2
35-39	8	5			12	12	12	12							31	17	55.7
40-44	3	3													3	3	100.0
45-49																	
50-54																	
55-59																	
>60																	
Sum	1 850		669		613		1 586		398		1 170		23		6 309		

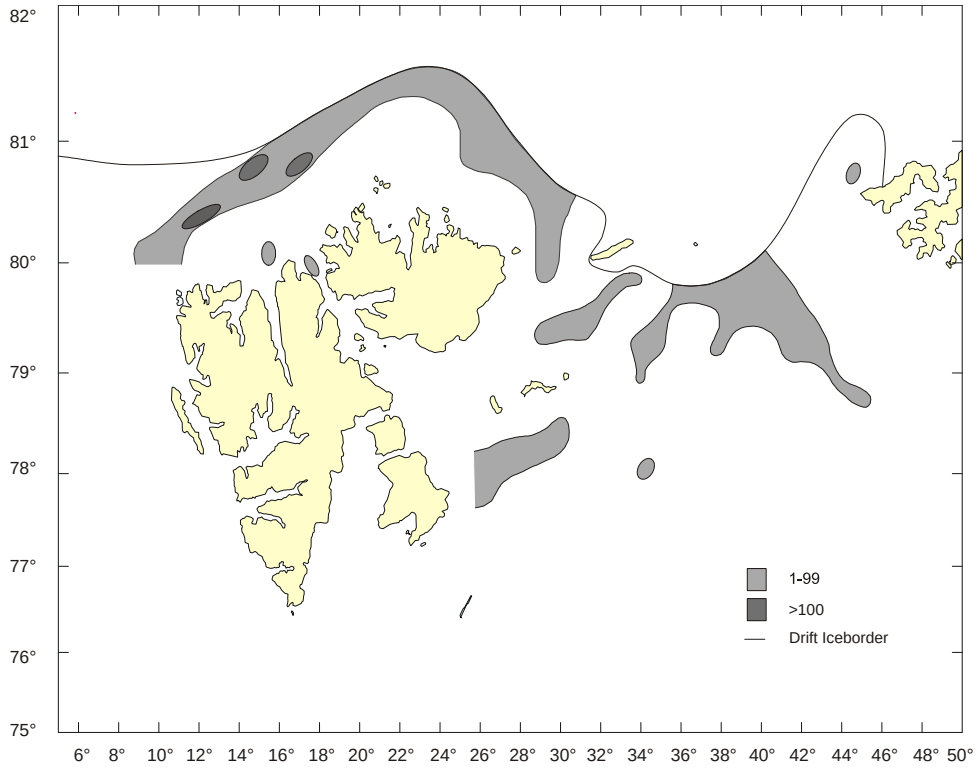

Figure 7.2. SEBASTES MENTELLA. Distribution in trawl catches in August-September 2002 (number per hour trawling)

Table 7.4 *SEBASTES MENTELLA*. Abundance indices from bottom trawl surveys north and east of Spitsbergen in August-September 1996-2002 (numbers in thousands)

Year	Length group (cm)												Total
	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	> 60	
1996*	258 032	76 682	16 267	7 666	368	443	43	23	0	0	0	0	359 523
1997*	13 483	53 681	10 670	7 408	4 216	567	0	0	0	0	0	0	90 025
1998	26	58 210	9 038	2 848	663	101	29	0	29	0	0	0	70 943
1999	0	2 040	3 077	500	37	8	0	0	0	0	0	0	5 662
2000	88	552	6 141	986	145	153	2	0	0	0	2	0	8 068
2001	7 325	390	2 113	1 392	220	9	102	17	16	0	0	0	11 583
2002	2 096	1 973	901	921	292	94	31	3	0	0	0	0	6 309

* No coverage in Russian EEZ, 1996 also includes *Sebastes marinus.*

7.2. Considerations and conclusions

Both *S. marinus* and *S. mentella* showed very low abundance and horizontal distribution in the survey area. The low abundance of the recruiting length groups confirms that the stocks of these species remain at a very low level.

8. DISTRIBUTION AND ABUNDANCE OF LONG ROUGH DAB

8.1. Swept area

Figure 8.1 shows the horizontal distribution of long rough dab in 2002. Long rough dab showed the widest distribution of the species included in this report. Highest catches, more than 1000 individuals per 3 nautical miles, were found in the southern part of sub-area G (Hopen).

It should be mentioned that because of the reduction of water temperature, the eastern border of the continuous distribution of long rough dab was far to the west compared to that in 2001.

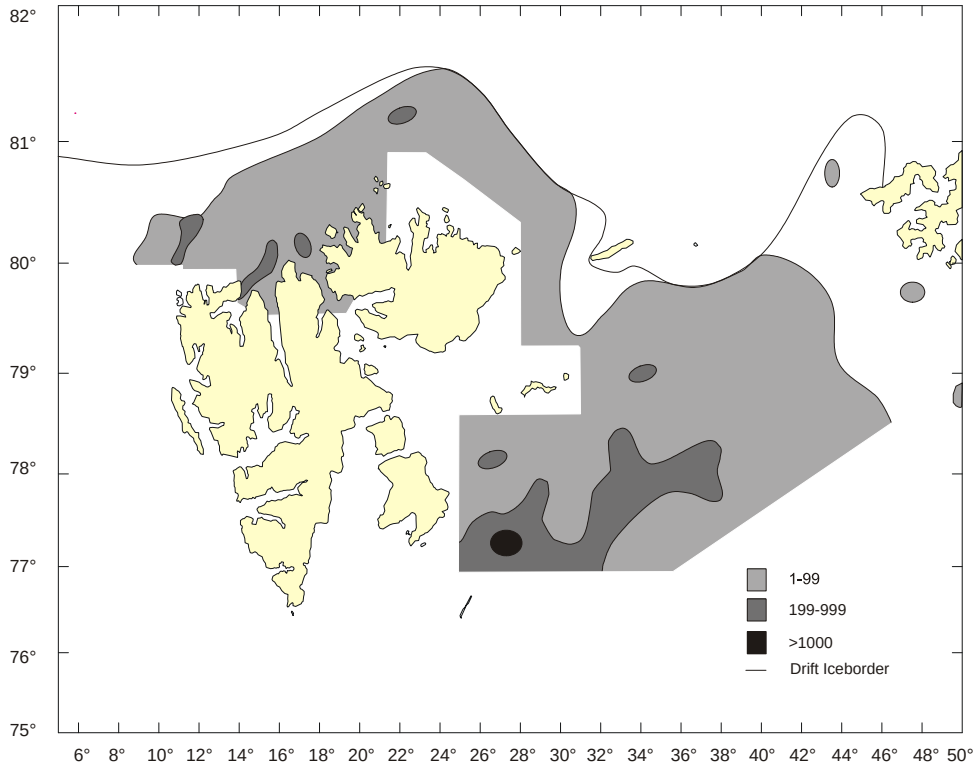

Figure 8.1. LONG ROUGH DAB. Distribution in trawl catches in August-September 2002 (number per hour trawling)

Table 8.1 presents the abundance indices by length in 2002, for each sub area with standard error in addition to the coefficient of variation for the total. For the length groups between 20 and 34 cm the CV's were less than 30%. As usual, long rough dab smaller than 30 cm was most abundant. The length group 10-14 cm was most numerous (40 % of the total estimate).

Time series (1996-2002) is presented in Table 8.2. In 2002 the lowest values were obtained for the entire period of observations. Compared to 2001, the abundance decreased markedly in length groups less than 25 cm. In general, a decreasing tendency in the abundance indices caused by the reduction of fish less than 20 cm (at the age of 1-2) has been observed since the year of 2000. This could reflect a reduction of the spawning stock of the Barents Sea population.

Table 8.1 ***LONG ROUGH DAB*. Abundance indices (I) at length with standard error of the mean (S) from bottom trawl hauls for main areas north and east of Spitsbergen in August-September 2002 (numbers in thousands)**

Length (cm)	Area														Total		
	A		B		C		D		E		F		G				
	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	CV(%)
5-9			124	59	166	100	1 208	1 118	1 052	660	527	206	3 034	1 529	6 110	2 020	33.1
10-14	163	73	428	139	636	471	1 345	1 103	2 919	1 834	2 987	1 167	22 068	11 434	30 546	11 702	38.3
15-19	664	263	435	211	159	88	322	239	1 628	677	1 919	580	6 319	3 672	11 446	3 802	33.2
20-24	443	144	195	123	44	33	146	128	1 546	783	2 325	793	5 040	1 945	9 739	2 254	23.1
25-29	209	69	109	45	37	31			625	201	2 758	865	4 393	1 579	8 130	1 814	22.3
30-34	180	70	106	33	71	54	56	43	381	144	947	329	2 852	1 261	4 594	1 315	28.6
35-39	49	24	6	5	12	12	10	10	139	66	251	71	2 908	1 075	3 375	1 080	32.0
40-44											145	82	1 036	442	1 181	449	38.0
45-49											20	20	91	64	111	68	60.7
50-54																	
55-59																	
>60																	
Sum	1 708		1 403		1 124		3 086		8 290		11 879		47 742		75 232		

Table 8.2 ***LONG ROUGH DAB*. Abundance indices from bottom trawl surveys north and east of Spitsbergen in August-September 1996-2002 (numbers in thousands)**

Year	Length group (cm)												Total
	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	>60	
1996*	7 695	21 965	43 042	26 560	9 542	2 690	1 144	242	0	0	0	0	112 881
1997*	16 205	25 709	11 944	11 186	4 888	1 783	2 235	1 080	404	0	0	0	75 434
1998	2 794	31 989	13 476	13 513	9 175	4 768	2 069	735	0	0	0	0	78 517
1999	3 859	58 512	18 041	10 819	2 084	4 934	7 267	1 533	0	0	0	0	107 050
2000	35 010	33 342	38 986	13 728	7 674	4 238	4 134	1 125	68	0	0	0	138 304
2001	16 850	32 857	16 496	26 113	8 744	4 061	3 648	1 179	106	0	0	0	110 054
2002	6 110	30 546	11 446	9 739	8 130	4 594	3 375	1 181	111	0	0	0	75 232

* No coverage in Russian EEZ.

8.2. Considerations and conclusions

The distribution of long rough dab covered more or less the whole survey area and this species was only absent from the areas with the coldest bottom water. This is reflected in the abundance estimates showing total values with smaller variability from year to year than the other species included in this report. However, the highest catch rates were found in the warmer water in the southern part where slight changes in the bottom temperature probably can force the higher concentrations of long rough dab out of the survey area. Consequently, it is important to see this abundance index in comparison with other surveys in the Barents Sea to make conclusions about the stock status of long rough dab.

9. COMPARISONS BETWEEN RESEARCH VESSELS

Unfortunately, due to late beginning of the Russian vessel cruise, parallel hauls have not been conducted in 2002. It was decided to carry out this work next year.

Considering the two strata where the overlap between the Russian and Norwegian vessels was relatively equal with respect to geographic coverage and number of stations a further comparison was done. The two strata used were strata 16 and 17, which represents an overlapping area of 11 689 square nautical miles within sub-area F. For comparison these estimates were based on a fishing width of 25 m, independent of the fish length. The results by length groups are shown in Table 9.1 and Figure 9.1.

Table 9.1. Swept area estimates (in thousands) referring to 25 m fishing width, independent of fish length for Greenland halibut from Russian vessel Nerey and Norwegian vessel Jan Mayen in the overlapping strata of coverage

Length	Stratum 16		Stratum 17	
	Nerey	Jan Mayen	Nerey	Jan Mayen
5-9	137	180	189	34
10-14	4215	2087	22348	16550
15-19	412	419	10928	9435
20-24	870	173	6925	21696
25-29	229	203	5972	9140
30-34	275	196	2787	5881
35-39	46	72	733	2015
40-44	137	72	304	622
45-49	0	36	10	23
50-54	0	0	0	0
55-59	0	0	0	0
>60	0	0	10	0
Sum	6322	3438	50206	65396

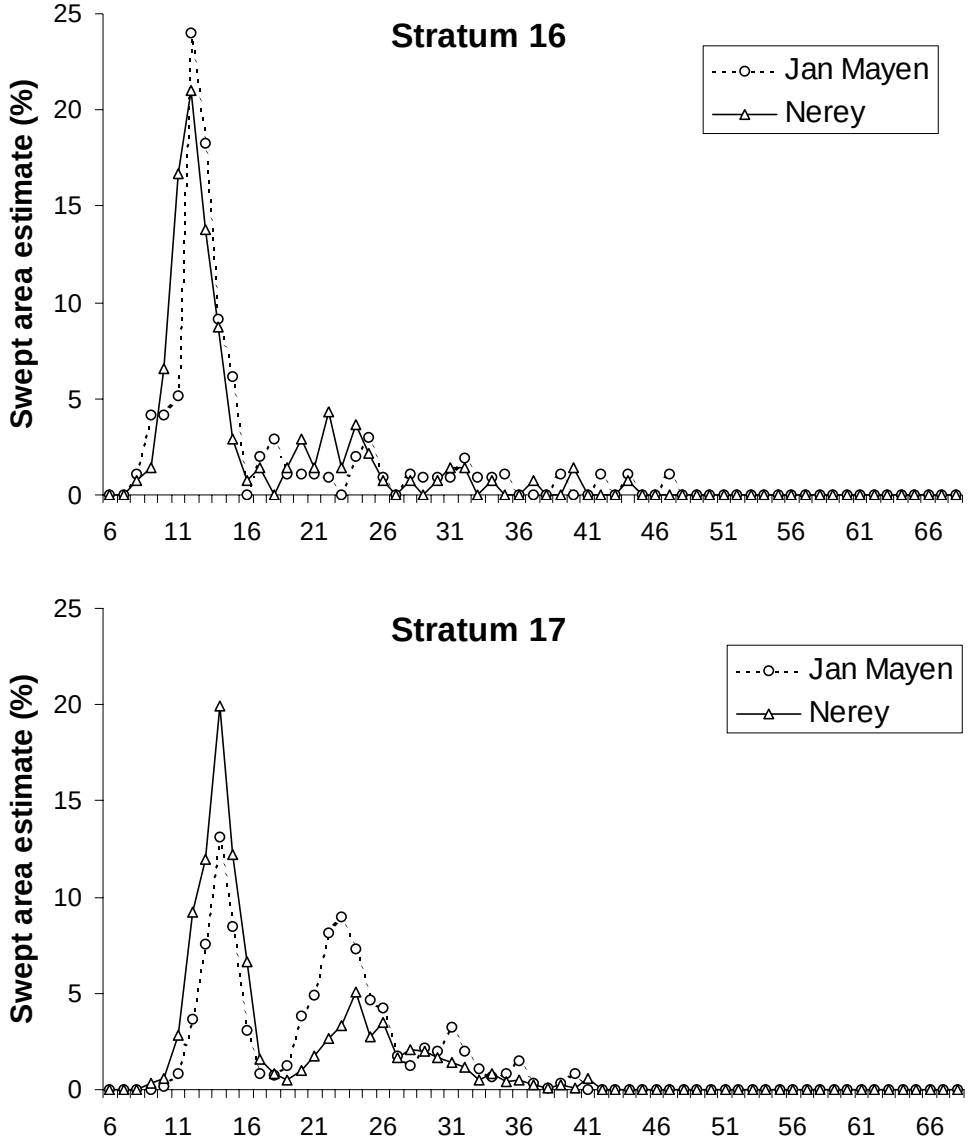

Figure. 9.1. Swept area estimates (referring to 25 m fishing width, independent of fish length) for Greenland halibut by Russian vessel Nerey and Norwegian vessel Jan Mayen in the overlapping area of coverage. The figures represents stratum 16 and 17

Differences were observed, but there were no consistent trend in the result and the differences could be due to separation in timing. The vessels did not cover these areas to the same time and also the location of the stations differed slightly. With respect to the length distribution in the catches the estimates were relatively similar and the results gave no reason to conclude that there were considerable differences between the vessels.

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11. LIST OF PARTICIPANTS

2002

Vessel:	F/F Jan Mayen	R/V Nerey
Departure:	Longyearbyen, 25.08.02	Murmansk, 05.09.02
Arrival:	Longyearbyen, 10.09.02	Murmansk, 16.10.02
Personnel:	H. Larsen (cruise leader) O. Bjelland T. Wenneck O. Djupevåg W. Richardsen J. Kristiansen	Yu. Ozerov (cruise leader) A. Dolgov V. Ignashkin A. Karsakov V. Polischuk

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