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INVESTIGATIONS OF DEMERSAL FISH IN THE SVALBARD AREA IN THE AUTUMN 2003, 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 obtained in 2003.

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 2003 were:

- Ice conditions in 2003 were the worst in the survey history and this caused significant limitation of surveyed area.
- Water temperature on the investigated area at surface was less than in 2002, and near bottom slightly lower in the eastern part and higher in the northern area.
- Due to heavy ice conditions it had been impossible to conduct observations in the important areas where dense concentrations of young Greenland halibut had been found in previous years.
- It leads to a decline in the abundance indices of all Greenland halibut length groups in comparison with estimates obtained in 2002.
- Abundance index for cod in 2003 was four times less than in 2002 and interpreted as the second smallest in the time series, only the result from 1998 was lower. The reduction was observed in all length groups with the exception of the young fish within 10-14 cm.
- The abundance of redfishes (both S. marinus and S. mentella) was about two times higher than in 2002 in spite of the reduced distribution area.
- Long rough dab abundance indices in 2003 were higher than what was found in 2002, but still remained at the low level in comparison with 1999-2001.

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 1–15 September 2003 and the Russian vessel R/V "Nerey" in the period 12–24 September 2003. In the previous years (the years 1996-2002) the 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. 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 both Norwegian and Russian vessels was equipped with a CTD-probe causing a better coverage of the hydrographical conditions in the survey area.

In 2003 due to heavy ice conditions the vessels had worse coverage of the total area than in 2000-2002 (Table 3.2, 3.3).

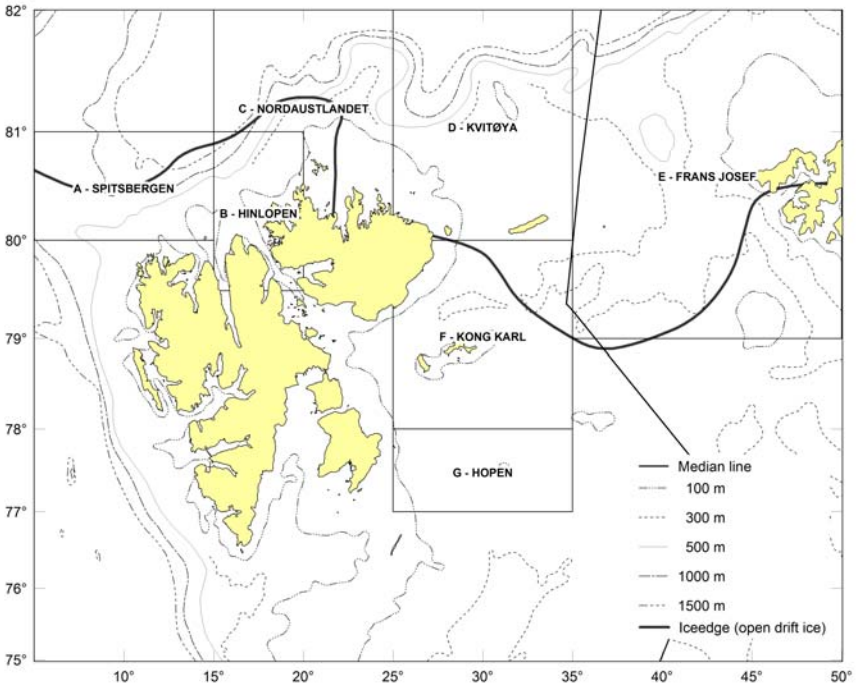

Figure 3.1. Map of the survey area with sub areas and ice edge marked

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	-

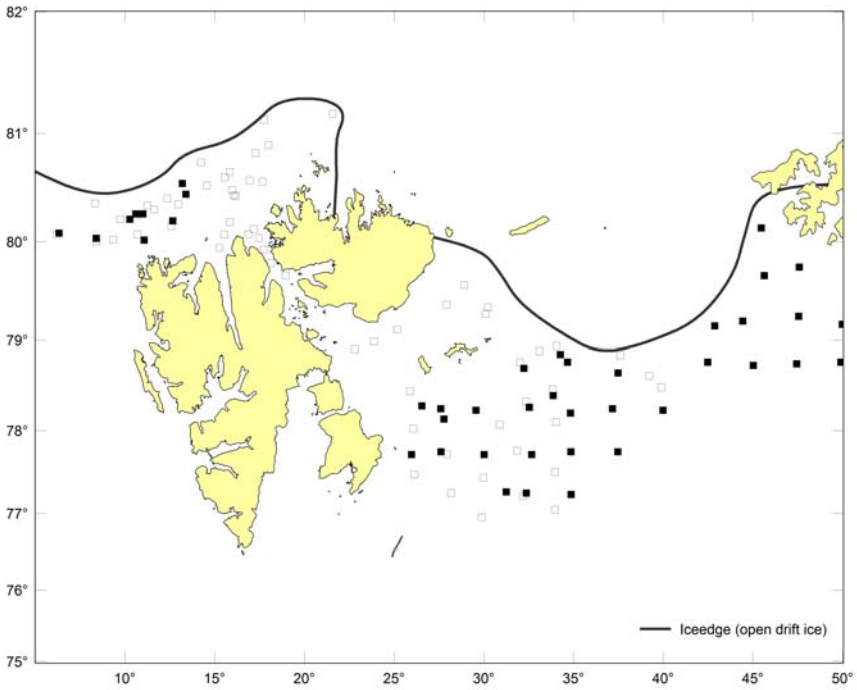

Figure 3.2. Trawl stations in the bottom trawl survey in 2003. Filled symbols are stations carried out by Nerey and open symbols are carried out by Jan Mayen.

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
RV Jan Mayen	01/9-15/9 -03	5	6	3	10	8		2	1								11	3		8			57

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	02/9-14/9 -00	1			1									10	10	2	3			6			33
RV Nerey	01/9-24/9 -01	2	3	5	3	3		4	3	5	8	4	6	12	16	3	9	8		8			102
RV Nerey	08/9-25/9 -02	3	2	8	3	7	1	1	1					7	11		11	8		8			71
RV Nerey	12/9-24/9-03	3	3	3										3	4		6	4		8			34

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 near bottom in 2003 (based on Norwegian data).

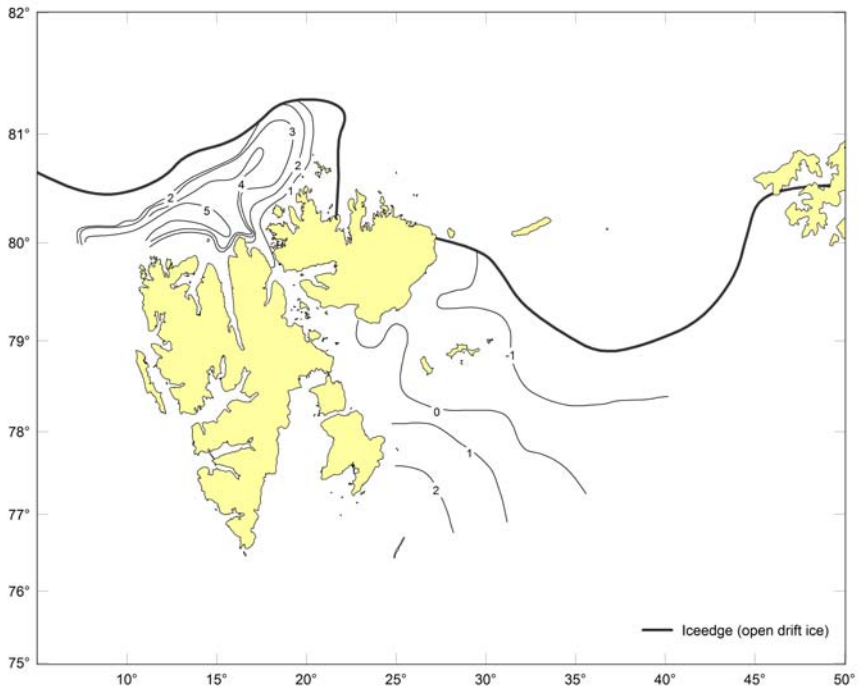

Figure 4.1. Temperature distribution at 5 m below surface in September 2003.

During the survey in 2003, due to the wind regime, ice condition was much worse even than in 2002 when a large part of the standard area also was covered by drift ice. In 2003 the iceedge in area E had reached 79° N (Figs. 4.1 and 4.2). This caused significant reduction of number of trawl stations in sub-areas D and E compared to previous years.

The results of hydrographical observations show that on the surveyed area water temperature at the sea surface in 2003 was generally less than in 2002. In contradiction to 2002, water masses with temperature more than 6°C north of Spitsbergen was not found. The isotherm of 2°C was tracked in the area G (Hopen) and the temperature in this area in 2002 was 1-2°C higher.

The water temperature near bottom in 2003 was slightly lower in the eastern part of the survey area and also in area A (westernmost area), but slightly higher in area B and C (Table 4.1)

The reduction in temperature in the surface layers in September 2003 was related to predominance of northerly winds, which caused the movement of both the iceedge and coldwater masses from the Polar Basin to the south.

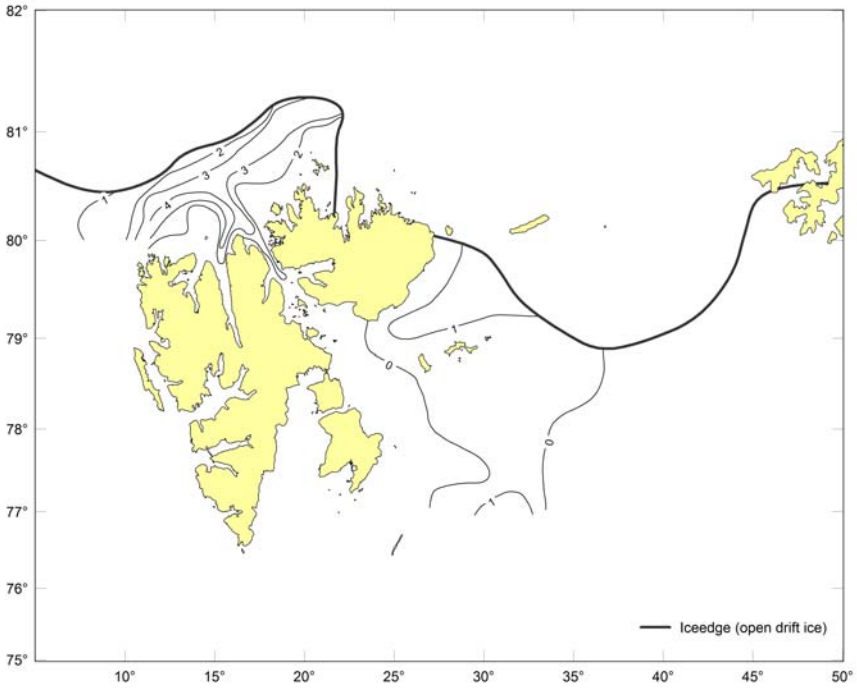

Figure 4.2. Temperature distribution near bottom in September 2003.

Table 4.1 Mean bottom temperature (°C) in different sub areas in the period 1997-2003. 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
2003	2.54	2.86	2.94	-	-	0.63	-0.02

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 2003 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. Unfortunately, due to hard ice conditions it had been impossible to conduct observations in areas with high densities of juvenile Greenland halibut in previous years (such as part of the area south of White Island, channel Franz-Victoria). This especially concerns the Russian vessel "Nerey", which started the survey about two weeks later than Norwegian vessel "Jan Mayen".

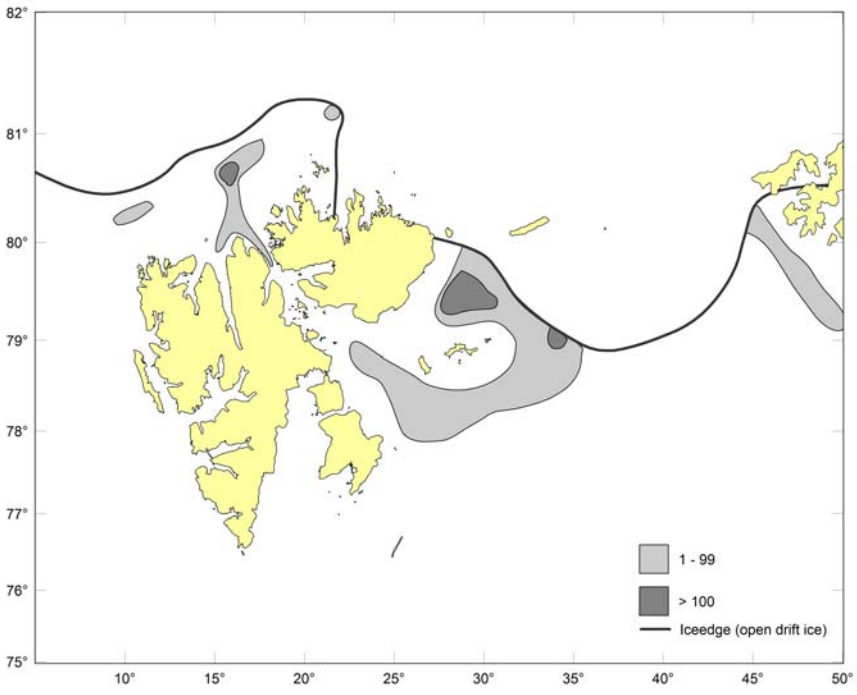

Figure 5.1. *GREENLAND HALIBUT* < 15 CM. Distribution in trawl catches in September 2003 (number per hour trawling).

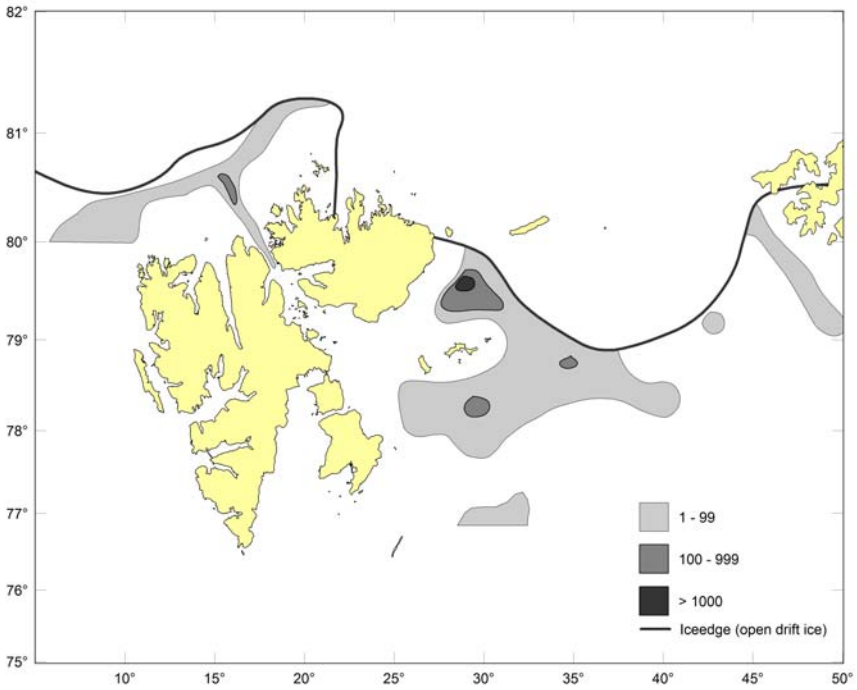

Figure 5.2. *GREENLAND HALIBUT* > 15 CM. Distribution in trawl catches in September 2003 (number per hour trawling)

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 25 cm of age up to 3 years dominated the estimates and the highest abundance as usual were observed in sub area F and E.

Time series (1996 – 2003) 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 all age groups in 2003 declined in comparison with 2002. At the same time, estimates for age group 1 and 2 remained at a relatively high level while the abundance of age groups 3 and older was at a minimum for the whole time series. From our point of view, the significant underestimation conditioned by lessening of surveyed area related with hard ice conditions was the main cause of these results.

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 September 2003 (numbers in thousands). No coverage in area D and bad coverage in area C and E.

	Area														Total		
	A		B		C		D		E		F		G				
Length (cm)	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	CV(%)
5 - 9	36	36			10	10					279	215			325	218	67.1
10 - 14	3	2	2 294	1630					1 384	1 002	18 447	10 123			22 128	10 302	46.6
15 - 19	36	36	316	184					2 076	860	16 021	9 000	23	23	18 471	9 043	49.0
20 - 24	36	36	218	105					989	656	12 111	6 464			13 354	6 498	48.7
25 - 29	144	107	287	137	83				395	395	1 136	445			2 046	620	30.3
30 - 34	188	67	300	143	110				297	189	1 803	770	23	23	2 720	809	29.7
35 - 39	376	92	278	137	165						1 127	484	23	23	1 968	512	26.0
40 - 44	147	72	124	58							162	74			433	118	27.3
45 - 49	253	141	17	8											270	142	52.5
50 - 54	72	46	6	3											78	46	58.5
55 - 59																	
60 - 64																	
65 - 69																	
70 - 74																	
75 - 79																	
80 - 84																	
>85																	
Sum	1 291		3 839		368				5 140		51 086		68		61 793		

Table 5.2 GREENLAND HALIBUT. Abundance indices at length and age from bottom trawl survey north and east of Spitsbergen in September 2003 (numbers in thousands). 0-group excluded from the table.

Length (cm)	Age (year-class)						Sum
	1 (02)	2 (01)	3 (00)	4 (99)	5 (98)	6+	
5 - 9							
10 - 14	22 127						22 127
15 - 19	9 093	9 378					18 471
20 - 24		12 377	977				13 354
25 - 29		348	1 697				2 045
30 - 34			1 729	974	17		2 720
35 - 39				1 223	745		1 968
40 - 44				77	196	160	433
45 - 49						270	270
50 - 54						78	78
55 - 59							
60 - 64							
65 - 69							
70 - 74							
75 - 79							
80 - 84							
>85							
Sum	31 220	22 103	4 403	2 274	958	508	61 466

Table 5.3 GREENLAND HALIBUT. Abundance indices from bottom trawl hauls for main areas north and east of Spitsbergen in September 2003 (numbers in thousands). n = number of valid hauls in each sub area. 0-group excluded.

Sub area	Age (year-class)						Total	n
	1 (02)	2 (01)	3 (00)	4 (99)	5 (98)	6+		
A	21	52	79	261	371	471	1 255	23
B	2 325	421	563	284	210	36	3 839	18
C		28	165	83	83		359	3
D								
E	2 406	2 037	589	106	2		5 140	7
F	26 457	19 553	2 994	1 519	284		50 807	24
G	11	12	14	22	9		68	16
Total	31 220	22 103	4 404	2 275	959	507	61 468	91

Table 5.4 GREENLAND HALIBUT. Abundance indices from bottom trawl surveys north and east of Spitsbergen in August-September 1996-2003 (numbers in thousands). Indices in 1996-1999 based on Norwegian surveys only.

	Age						Total
Year	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
2003	31 220	22 103	4 404	2 275	959	507	61 468

* 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

Mean length and weight of specimens in age group 1 in 2003 increased slightly in comparison with 2002 whereas these parameters have decreased for all others groups, especially for fish older than 4 year. Annual increments to the body weight of Greenland halibut younger than 4 years old were similar to average for the period 1997-2002. The growth rate of the elder age groups was found at the minimum level. One plausible reason which could explain this is redistribution of the fastest growing fish under the conditions of temperature fall to areas located outside the surveyed area or to parts of the standard area covered by ice (for instance northern part of the Franz-Victoria channel).

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							
	1	2	3	4	5	6	7	N
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
2003	14.1 (0.54)	20.8 (1.53)	27.8 (3.18)	35.1 (2.67)	37.6 (2.48)	45.2 (2.41)	49.6 (1.26)	236
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
2003	17	68	188	397	491	777	1 102	236

* 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 – 2003

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
2002 – 2003	54	115	193	72	24

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.

The Greenland halibut abundance estimates obtained in 2003 based on results of both vessels were significantly lower in comparison with 2002. This is most likely a result of the significantly reduced survey area and does probably not reflect negative tendencies in the stock dynamics. It is also supported by most of the other surveys conducted on Greenland halibut in 2003, which showed an increase in numbers and biomass of the total- and spawning stocks of Greenland halibut (ICES, 2004).

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 2003 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.

Cod was quite widely distributed in the surveyed area. A character of distribution in 2003 on the whole was similar to that recorded in 2002. However, the temperature decrease led to the northern border of cod in the area between Spitsbergen and Franz Josef Land in 2003 (about 78° N) was observed about 70-80 nautical miles to the south in comparison with 2002.

The cod were of very good condition and basic food was polar cod, capelin and shrimp. Greenland halibut juveniles (6-7 cm, 2003 year-class) repeatedly were found in the cod stomachs on the area north of Spitsbergen.

Table 6.1 presents the abundance indices by length in 2003, for each sub area with standard error in addition to the coefficient of variation for the total. The CV's were relatively high (more than 30%) for all of the length groups.

Time series (1996-2003) 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 fluctuated around 20 mill individuals with relatively low numbers of fish smaller than 25 cm. In 2002 the total estimate was 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.

Specimens of 8-80 cm length were found in the catches in 2003. In contrast to 2002, big cod with body length 60-69 cm were most numerous in 2003. The abundance of young fish (20-34 cm length), which dominated in 2002, showed a significant decrease.

The total abundance index for cod in 2003 was four times less than in 2002 and the second smallest in the time series. Only the estimate from 1998 was smaller. The abundance reduction was observed in all length groups with the exception of the young fish within 10-14 cm. The result is, as for Greenland halibut, probably connected to the reduced temperature in the northern Barents Sea in 2003.

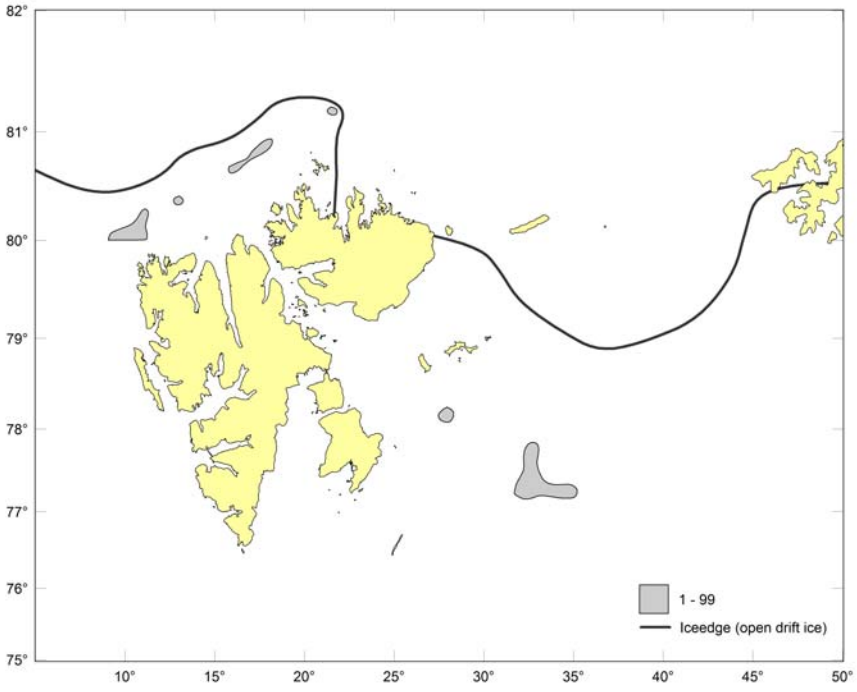

Figure 6.1. *COD* < 20 CM. Distribution in trawl catches in September 2003 (number per hour trawling).

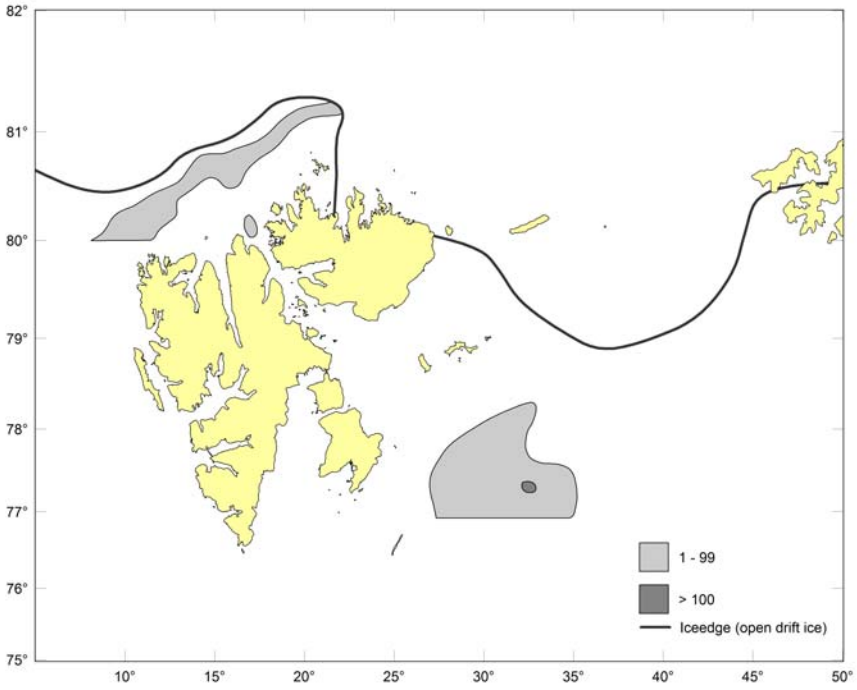

Figure 6.2. *COD* > 20 CM. Distribution in trawl catches in September 2003 (number per hour trawling).

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 September 2003 (numbers in thousands).

	Area																
	A		B		C		D		E		F		G		Total		
Length (cm)	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	CV(%)
5 - 9	167	123	7	7											174	123	70.8
10 - 14	14	14	58	39	161	161							391	245	623	296	47.5
15 - 19			114	76	143	143					14	14	146	91	417	187	44.8
20 - 24	6	6	246	124	47	47									299	133	44.4
25 - 29	24	18	77	38									72	39	173	57	32.9
30 - 34	72	34	62	39									329	197	463	204	44.1
35 - 39	53	27	24	15									213	109	290	113	38.9
40 - 44	42	27											221	110	263	113	42.8
45 - 49	24	14											116	68	139	70	50.1
50 - 54	70	40	4	4									216	106	290	114	39.3
55 - 59	104	46									154	154	456	224	714	276	38.6
60 - 64	157	77									192	192	608	242	957	318	33.2
65 - 69	120	73									340	340	524	176	984	390	39.6
70 - 74	137	60									149	128	265	110	551	179	32.6
75 - 79											170	121	216	93	414	155	37.3
80 - 84											21	21	121	50	143	54	37.9
85 – 89																	
90 - 94																	
>95																	
Sum	1 018		592		351		0		0		1 040		3 891		6 893		

Table 6.2 COD. Abundance indices from bottom trawl surveys north and east of Spitsbergen in August-September 1996 - 2003 (numbers in thousands).

	Length group (cm)																		
Year	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	Total
1996*	1 490	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
2003	174	623	417	299	173	463	290	263	139	290	714	957	984	551	414	143				6 893

* No coverage in Russian EEZ

6.2 Considerations and conclusions

The cod distribution is very dependent of the bottom temperature 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 on 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 shows the horizontal distribution of *Sebastes marinus* in 2003. The general picture was that the abundance of *S. marinus* was very low in the survey area and the distribution was also very limited as in previous years.

In contrast to 2002 *S. marinus* in 2003 was not found on the area between Spitsbergen and Franz Josef Land. Another distinct feature in 2003 was that specimens smaller 20 cm were absent from the catches.

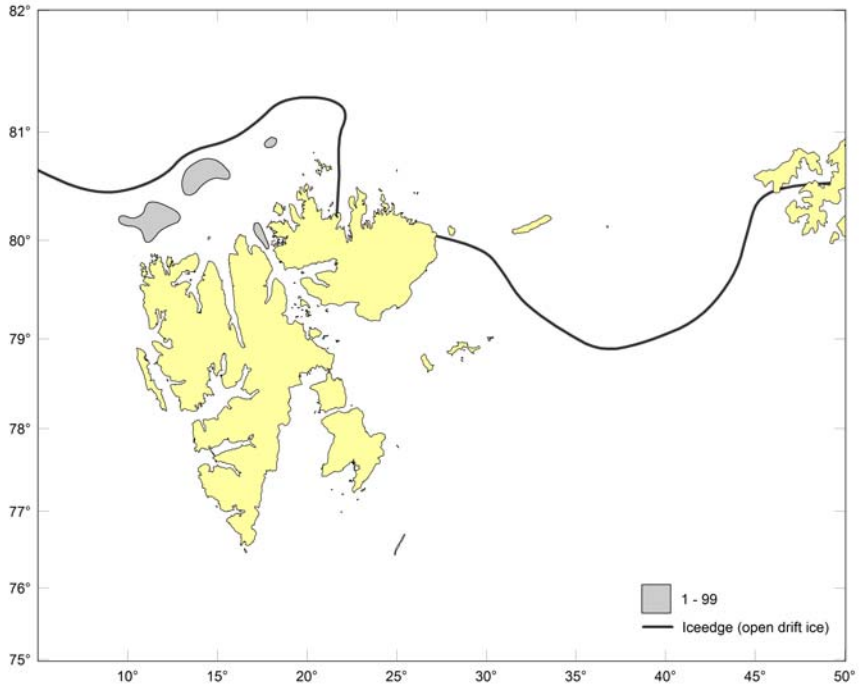

Figure 7.1. *SEBASTES MARINUS*. Distribution in trawl catches in September 2003 (number per hour trawling).

Table 7.1 presents the abundance indices by length in 2003, for each sub area with standard error in addition to the coefficient of variation for the total. The CV's were high (more than 50 %) for all the length groups. In 2003 the most abundant length group in the catches was 25-29 cm with an estimate of 41 % of the total abundance.

Time series (1997-2003) 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 down to the second lowest observed in the time series.

The total abundance index for *S. marinus* in 2003, in spite of the reduction in the survey area, showed an increase to 219 thousand individuals, which is about two times the index in 2002.

7.1.2 Sebastes mentella

Figure 7.2 shows the horizontal distribution of *Sebastes mentella* in 2003. In contrast to previous years *Sebastes mentella* were distributed only in smaller pockets. The largest catches (up to 477 spec./30 min.) were taken at the depths 220-350 m northwest of Spitsbergen.

Table 7.3 presents the abundance indices by length in 2003, 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 the smallest one (about 42 %) was found for the length group 10-14 cm. In 2003 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. 80 % of the total estimate.

Time series (1996-2003) 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 2003 the total abundance index for *S. mentella* (12.2 thou. spec.) was two times higher than in 2002 and also slightly higher than the estimate from 2001.

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 September 2003 (numbers in thousands).

	Area														Total		
	A		B		C		D		E		F		G				
Length (cm)	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	CV(%)
5 - 9																	
10 - 14																	
15 - 19																	
20 - 24	33	21	2	2											35	21	59.8
25 - 29	83	48	6	5											89	48	54.5
30 - 34	52	42													52	42	79.8
35 - 39	7	5													7	5	77.8
40 - 44	36	36	1	2											37	36	96.4
45 - 49																	
50 - 54																	
55 - 59																	
> 60																	
Sum	211		9												219		

Table 7.2 *SEBASTES MARINUS*. Abundance indices from bottom trawl surveys north and east of Spitsbergen in August-September 1996 - 2003 (numbers in thousands).

	Length group (cm)												
Year	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	> 60	Total
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
2003	0	0	0	35	89	52	7	37	0	0	0	0	219

* No coverage in Russian EEZ

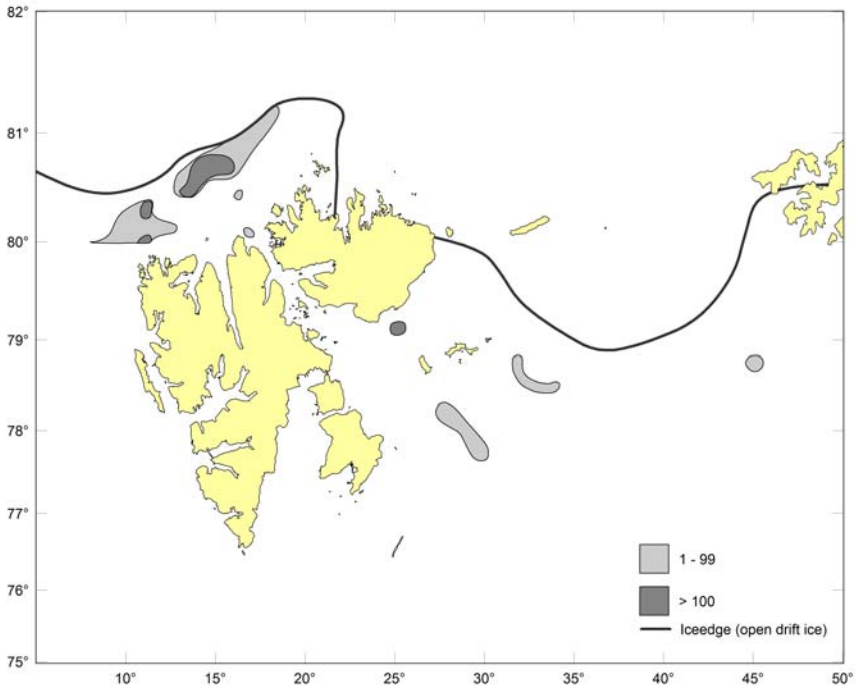

Figure 7.2. *SEBASTES MENTELLA*. Distribution in trawl catches in September 2003 (number per hour trawling).

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.

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 September 2003 (numbers in thousands).

	Area																
	A		B		C		D		E		F		G		Total		
Length (cm)	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	CV(%)
5 - 9	278	242	922	614	570	543					3 630	2 645			5 400	2 780	51.5
10 - 14	2 825	1 782	908	668	210	128					674	351	23	23	4 640	1 939	41.8
15 - 19	1 103	732	38	29	28										1 169	733	62.7
20 - 24	525	283	14	10	110						11	11			659	284	43.1
25 - 29	124	82	6	6											130	82	63.2
30 - 34	44	36	4	3	28						11	11			86	38	44.2
35 - 39	81	46													81	46	56.6
40 - 44	9	6													9	6	66.4
45 - 49																	
50 - 54																	
55 - 59																	
>60	2														2	2	100.0
Sum	4 990		1 892		946						4 325		23		12 175		

Table 7.4 *SEBASTES MENTELLA*. Abundance indices from bottom trawl surveys north and east of Spitsbergen in August-September 1996 - 2003 (numbers in thousands).

	Length group (cm)												
Year	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	> 60	Total
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
2003	5 400	4 640	1 169	659	130	86	81	9	0	0	0	2	12 175

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

8. DISTRIBUTION AND ABUNDANCE OF LONG ROUGH DAB

8.1 Swept area

Figure 8.1 shows the horizontal distribution of long rough dab in 2003. Long rough dab showed the widest distribution among the species included in this report. Highest catches, more than 1000 individuals per 3 nautical miles, as in 2002 were found in the southern part of sub-area G (Hopen).

Length composition of the catches was constituted by specimens of 5-46 cm length with two pronounced peaks at 10-12 cm (age 1) and 17 cm (age 2).

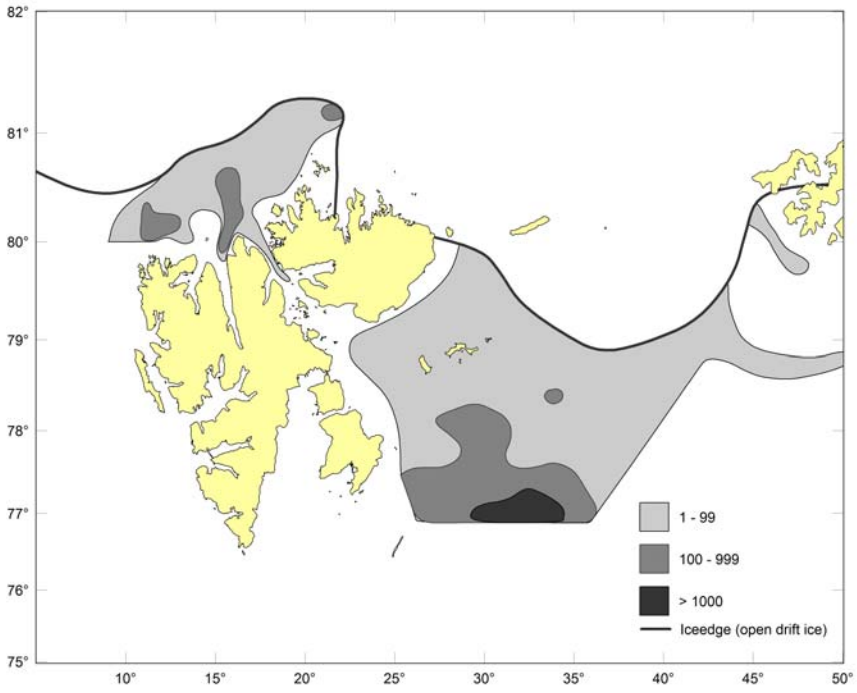

Figure 8.1. ***LONG ROUGH DAB*. Distribution in trawl catches in September 2003 (number per hour trawling)**

Table 8.1 presents the abundance indices by length in 2003, for each sub area with standard error in addition to the coefficient of variation for the total. For the most of length groups 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 (56 % of the total estimate).

Time series (1996-2003) is presented in Table 8.2. In 2002 the lowest values were obtained for the entire period of observations. Long rough dab abundance indices in 2003 increased compared to 2002, but still remain at a lower level than in 1999-2001. The estimated abundance indices for most of the length groups larger than 20 cm in 2003, were lowest or the second lowest in the time series.

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 September 2003 (numbers in thousands).

	Area																
	A		B		C		D		E		F		G		Total		
Length (cm)	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	CV(%)
5 - 9	143	95	416	186	688	578					577	229	3 441	1 258	5 265	1 419	27.0
10 - 14	997	603	874	294	230	203					6 069	1 876	37 996	15 254	46 166	15 385	33.3
15 - 19	2 190	933	1328	533	149	122			593	471	2 981	982	8 258	4 255	15 499	4 524	29.2
20 - 24	965	388	589	213	88	61			593	471	784	213	2 305	892	5 324	1 124	21.1
25 - 29	318	108	184	59	20	20			198	198	2 498	897	2 753	1 102	5 970	1 440	24.1
30 - 34	94	43	43	18	48	20					767	200	707	320	1 658	381	23.0
35 - 39	19	8	60	31					297	99	146	66	752	292	1 274	317	24.8
40 - 44													420	237	420	237	56.3
45 - 49													23	23	23	23	100.0
50 - 54																	
55 - 59																	
>60																	
Sum	4 725		3 493		1 224				1 680		14 116		56 655		81 893		

Table 8.2 LONG ROUGH DAB. Abundance indices from bottom trawl surveys north and east of Spitsbergen in August-September 1996 - 2003 (numbers in thousands).

	Length group (cm)												Total
Year	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
2003	5 265	46 166	15 499	5 324	5 970	1 658	1 274	420	23	0	0	0	81 893

* 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

On September 12-13, in the area south of King Karl Land the Norwegian and Russian vessels have conducted 10 parallel comparative hauls. During the trawling vessels moved along parallel courses with the distance of 3-4 cables between them. As far as possible, the hauling down just as lifting of trawls was executed simultaneously on the both vessels. The brief information about each haul presented in Table 9.1.

Figures 9.1 and 9.2 illustrate the results of comparison of catches rate and length distribution of Greenland halibut in the given parallel hauls series. The catches of "Nerey" slightly exceeded the catches of "Jan Mayen" in 8 cases out of 10. Catches by vessels recalculated for 1.5 miles trawling distance averaged of 87 and 69 specimens correspondingly. At the same time the dynamics of the catches rates was more or less similar (r=0.91). The Greenland halibut length distribution in catches of both vessels also was quite closed to each other (r=0.89). Lengths groups of 11-13 cm (age 1) and 15-19 cm (age 2) distinctly stand out against a background of others.

Table 9.1. Some information about parallel hauls conducted in 2003

Pair # #	Vessel	Trawl # #	Position		Course, degree	Time, min	Depth, m	Speed, knots	Total catch, kg
			Lat. N	Long. E					
1	Jan Mayen	866	78°07	27°52	100	30	313	3.0	95
	Nerey	2	78°07	27°51	90	30	310	3.0	104
2	Jan Mayen	867	78°09	27°56	340	29	326	3.2	113
	Nerey	3	78°09	27°59	340	30	324	3.0	113
3	Jan Mayen	868	78°12	27°46	310	31	-	2.7	83
	Nerey	4	78°11	27°46	300	30	332	3.0	107
4	Jan Mayen	869	78°13	27°27	310	29	313	2.6	205
	Nerey	5	78°14	27°27	300	30	315	3.0	247
5	Jan Mayen	870	78°13	27°12	250	30	323	2.7	498
	Nerey	6	78°14	27°11	240	30	320	3.0	443
6	Jan Mayen	871	78°12	26°56	240	29	322	2.8	455
	Nerey	7	78°12	27°02	240	30	325	3.0	587
7	Jan Mayen	872	78°09	27°01	120	30	309	2.5	159
	Nerey	8	78°09	27°00	115	30	311	3.0	250
8	Jan Mayen	873	78°07	27°17	100	31	311	3.0	181
	Nerey	9	78°08	2717	95	30	308	3.0	257
9	Jan Mayen	875	78°08	27°49	70	30	313	2.9	533
	Nerey	11	78°08	27°48	70	30	313	3.0	547
10	Jan Mayen	876	78°10	28°01	30	30	318	2.4	210
	Nerey	12	78°10	27°39	30	30	317	3.0	654

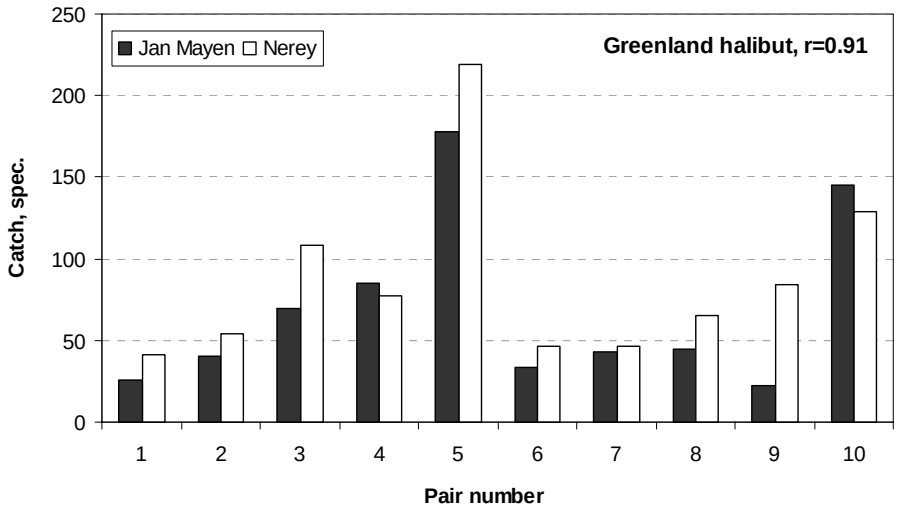

Fig. 9.1. Greenland halibut catches obtained by Norwegian and Russian vessels during the parallel hauls series in 2003 (specimens, recalculated for 1.5 miles trawling distance)

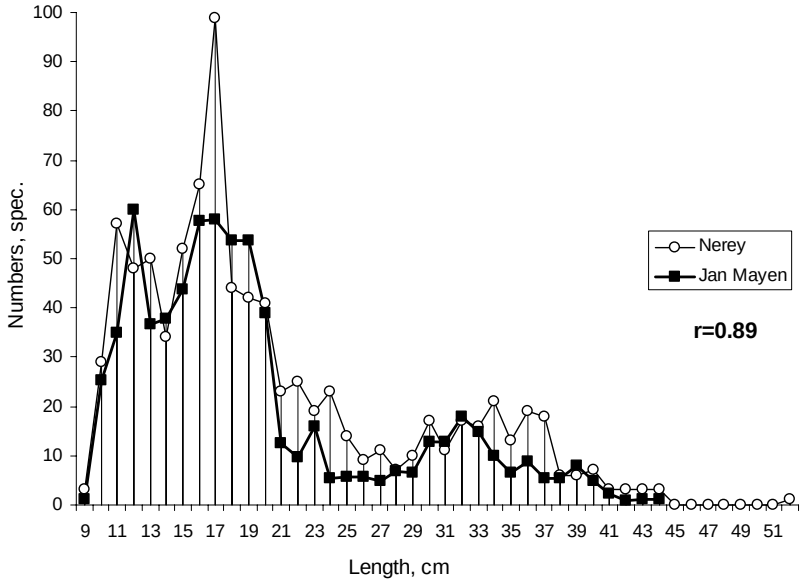

Fig. 9.2. Greenland halibut length distribution in the total catches obtained by Norwegian and Russian vessels during the parallel hauls series in 2003

Comparison of catch rates of another mass species (long rough dab, capelin and polar cod) is shown on Figures 9.3-9.5. As figures indicate, the agreement between vessels was observed even in catches of pelagic fishes (except for capelin in pair 10).

On the whole, wide experience acquired after a lot of experiments conducted last years under both national and international research programs, proves that attempts to get the absolute coincidence of catches in comparative trawling were always failed. Most likely it caused by the "patchiness" of fish distribution. However how hard we try to bring the vessels together, the distance between them under safety requirements remains entirely enough to let sometimes only one vessel from two to run into fish concentration. Concerning the totals of parallel hauls series conducted in 2003 from our standpoint they confirmed that trawl complexes of both vessels had been in good conditions and the results obtained during survey reflect the distribution and abundance of Greenland halibut and other species on the investigated area quite evenly.

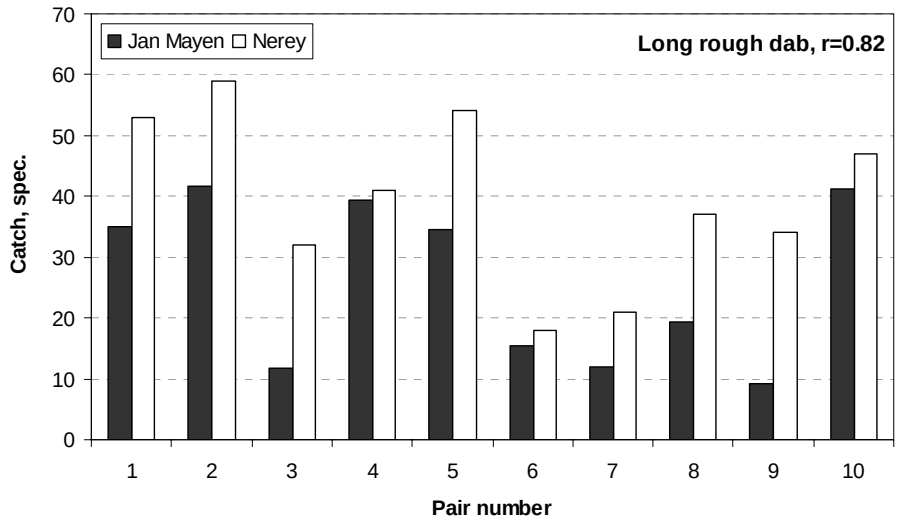

Fig. 9.3. Long rough dab catches obtained by Norwegian and Russian vessels during the parallel hauls series in 2003 (specimens, recalculated for 1.5 miles trawling distance)

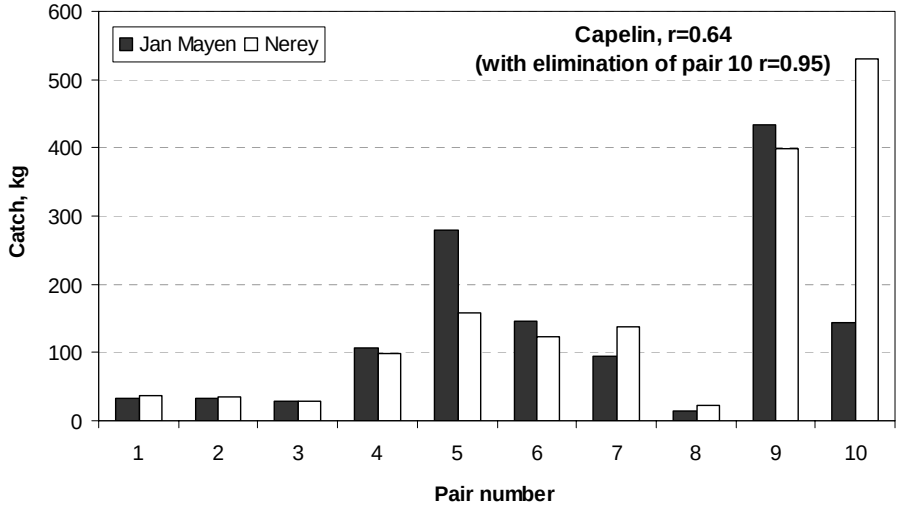

Fig. 9.4. Capelin catches obtained by Norwegian and Russian vessels during the parallel hauls series in 2003 (in weight, recalculated for 1.5 miles trawling distance)

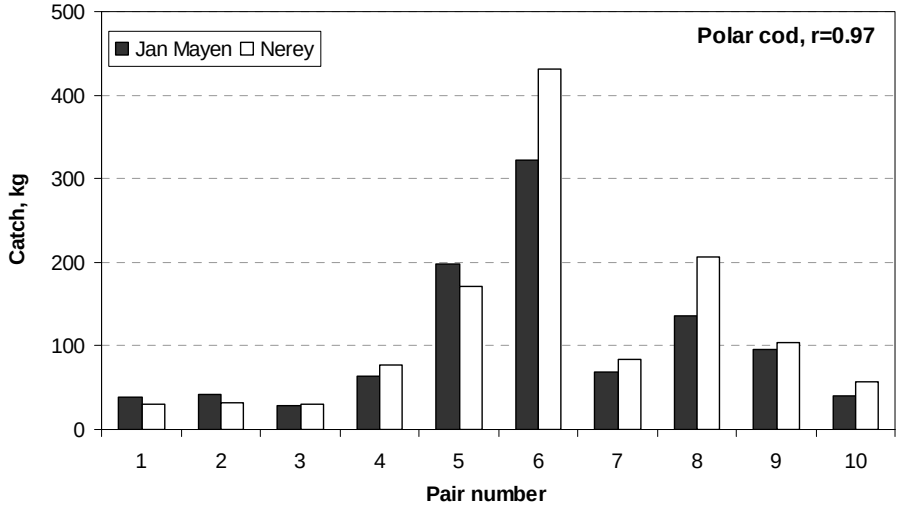

Fig. 9.5. Polar cod catches obtained by Norwegian and Russian vessels during the parallel hauls series in 2003 (in weight, recalculated for 1.5 miles trawling distance)

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11. LIST OF PARTICIPANTS

2003

Vessel:	F/F Jan Mayen	R/V Nerey
Departure:	Longyearbyen, 01.09.03	Murmansk, 09.09.03
Arrival:	Longyearbyen, 15.09.03	Murmansk, 01.10.03
Personnel:	H. Larsen (cruise leader) T. Wenneck E. Hermansen W. Richardsen M. von Minden E. Rafter J. Kristiansen	O. Smirnov (cruise leader) A. Russkikh A. Karsakov A. Amelkin

IMR/PINRO Joint Report Series

1/2004
Bjordal A., Gjøsæter H. and Mehl S. 2004. Management strategies for commercial marine species in northern ecosystems. Proceedings of the 10 Pinro-Imr symposium, Bergen 27-29 August 2003. IMR/PINRO Joint Report Series, No. 1/2004. ISSN 1502-8828, ISBN 82-7461-056-3.168 pp.

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