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INVESTIGATIONS ON DEMERSAL FISH IN THE BARENTS SEA WINTER 2003

Detailed report

Institute of Marine Research - IMR

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Joint IMR-PINRO report

Investigations on demersal fish in the Barents Sea winter 2003

Detailed report

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PREFACE

Annual catch quotas and other regulations of the Barents Sea fisheries are set through negotiations between Norway and Russia. Assessment of the state of the stocks and quota advices are given by the International Council for the Exploration of the Sea (ICES). Their work is based on survey results and the international landings statistics. The results from this demersal fish winter survey in the Barents Sea are an important source of information for the annual stock assessment.

The survey started in the mid 1970-ies, focused on acoustic measurements of cod and haddock. Since 1981 it has been designed to produce both acoustic and swept area estimates of fish abundance. Some development has taken place since then, both in area coverage and in methodology. The development is described in detail by Jacobsen et al. (1997). At present the survey provides the main data input for a number of projects at the Institute of Marine Research, Bergen:

- monitoring abundance of the Barents Sea demersal stocks
- mapping fish distribution in relation to climate and prey abundance
- monitoring food consumption and growth
- estimating predation mortality caused by cod

This report presents the results from the survey in February 2003. As in 2002 the Russian research vessel “Persey 3” participated in addition to the Norwegian research vessels “G.O. Sars” and “Johan Hjort”. The total duration of the survey was from 27 January to 05 March. One scientist from PINRO, Murmansk, participated onboard ”Johan Hjort”.

SUMMARY

A combined acoustic and bottom trawl survey to obtain indices of abundance and estimates of length and weight at age has been carried out each winter (4-6 weeks in January- March) since 1981 in the Barents Sea. The target species are cod and haddock, but abundance indices have also been worked out for the redfish species since 1986 and Greenland halibut since 1990. Prior to 1993 a fixed standard area (ABCD in Fig. 2.1) was covered, but in 1993 the survey area was extended to the north and east in order to obtain a more complete coverage of the younger age groups of cod. In winter 1997 only the Norwegian part of the Barents Sea and a small part of the Svalbard area was covered, while in 1998 also a small part of the Russian EEZ was covered. In 1999 and 2000 the Norwegian vessels had full access to the Russian EEZ. In the years 2001-2003 a Russian research vessel covered the areas where the Norwegian vessels did not have access.

The main results in 2003 were:

- the abundance of the 2002 year-class of **cod** is above average, the 2001 year class is very weak and the 2000 year class is indicated to be above average.
- The 1999 and 1998 year classes are more abundant than expected from last years survey
- the swept area indices of 6-8 year old cod (1997-1995 year classes) are as expected from the last years survey, while the acoustic indices of these year classes are higher than expected.
- the numbers of 9 year and older cod are very low
- lengths and weights at age and weight increments are slightly less than those observed in 2001, for most age groups.
- the mortality rate has been reduced compared with the previous years for all age groups
- for **haddock** the 2002 year class appears to be strong and the year classes 1998 to 2001 are indicated to be at or above average, while the amount of age 6 and older is low .
- length and weight at age and weight increments indicate reduced growth
- the abundance indices of the **redfish** species are among the lowest in the time series and there are no signs of improved recruitment
- compared to the 2002-results the abundance indices of **Greenland halibut** in the size range 15 to 44 cm have decreased, while they are at the 2002 level for larger size groups.

1. INTRODUCTION

The Institute of Marine Research (IMR), Bergen, has performed acoustic measurements of demersal fish in the Barents Sea since 1976. Since 1981 a bottom trawl survey has been combined with the acoustic survey. The survey area was extended in 1993. Since then the typical effort of the combined survey has been 10-14 vessel-weeks, and about 350 bottom trawl hauls have been made each year. Most years 3 vessels have participated from about 1 February to 1 March.

The purpose of the investigations is:

- Obtain acoustic abundance indices by length and age for cod, haddock and redfish
- Obtain swept area abundance indices by length (and age) for cod haddock, redfish and Greenland halibut.
- Map the geographical distribution of those fish stocks
- Estimate length, weight and maturity at age for those stocks
- Collect and analyse stomach samples from cod, for estimating predation by cod

Data and results from the survey are used both in the ICES stock assessments and by several research projects at IMR and PINRO.

From 1981 to 1992 the survey area was fixed (ABCD in Fig. 2.1). Due to improved climate and increasing stock size in the early 1990-ies, the cod distribution area increased. In 1993 the survey area therefore was increased towards east and north, and since then the survey has been aiming at covering the whole cod distribution area outside the ice-border. Since 1997 Norwegian research vessels have had limited access to the Russian EEZ. In 1997 and 1998 the vessels were not allowed to cover the Russian EEZ, and in 1999 the coverage was partly limited by a rather unusually wide ice-extension. Adjustments, associated with large uncertainties, are applied to the estimates in 1997 and 1998 to compensate for the lack of coverage. The results for those years may therefore not be comparable to the results for other years. Since 2000 Russian research vessels have participated in the survey and the coverage have been satisfactory.

2. METHODS

2.1 Acoustic measurements

The method is explained by Dalen and Smedstad (1979, 1983), Dalen and Nakken (1983), MacLennan and Simmonds (1991) and Jakobsen *et al*. (1997). The acoustic equipment has been continuously improved. Since the early 1990-ies Simrad EK500 echo sounder and Bergen Echo Integrator (BEI, Knudsen 1990) have been used. In the mid 1990-ies the echo sounder transducers were moved from the hull to a protrudable centreboard. This latter change has largely reduced the signal loss due to air bubbles in the close to surface layer.

Acoustic backscattering values (s_A) are stored at high resolution in the BEI-system. After scrutinizing and allocating the values to species or species groups, the values are stored with 10m vertical resolution and 1 nautical mile horizontal resolution. The procedure for allocation by species is based on:

- composition in trawl catches (pelagic and demersal hauls)
- the appearance of the echo recordings
- inspection of target strength distributions

For each trawl catch the relative s_A-contribution from each species is calculated (Korsbrekke 1996) and used as a guideline for the allocation. In these calculations the fish length dependent catching efficiency of cod and haddock in the bottom trawl (Aglen and Nakken 1997) is taken into account. If the trawl catch gives the true composition of the species contributing to the observed s_A value, those catch-based s_A -proportions could be used directly for the allocation. In the scrutinizing process the scientists have to evaluate to what extent these catch-based s_A -proportions are reasonable, or if they should be modified on the basis of knowledge about the fish behaviour and the catching performance of the gear.

Estimation procedures

The area is divided into rectangles of 1/2° latitude and 1° longitude. For each rectangle and each species an arithmetic mean s_A is calculated for the demersal zone (less than 10m above bottom) and the pelagic zone (more than 10m above bottom). Each of those acoustic densities by rectangle are then converted to fish densities by the equation:

$$\overline{\rho}_A = \frac{\overline{s}_A}{\overline{\sigma}_A} \quad (1)$$

$\overline{\rho}_A$ is average fish density (number of fish / square n.mile) by rectangle
$\overline{s}_A$ is average acoustic density (square m / square n.mile) by rectangle
$\overline{\sigma}_A$ is average backscattering cross-section (square m) by rectangle

For cod, haddock and redfish the backscattering cross-section (σ), target strength (TS) and fish length (L cm) is related by the equation (Foote, 1987):

$$\mathrm{TS} = 10 \cdot \log\left(\frac{\sigma}{4\pi}\right) = 20 \cdot \log(L) - 68 \quad (2)$$

Indicies for the period 1981-1992 have been recalculated (Aglen and Nakken 1997) taking account of:

-changed target strength function

-changed bottom trawl gear (Godø and Sunnanå 1992)

-size dependant catching efficiency for cod and haddock (Dickson 1993a,b).

In 1999 some errors in the time series were discovered and corrected (Bogstad *et al.* 1999).

Combining equations 1and 2 gives:

$$\overline{\rho}_A = 5.021 \cdot 10^5 \cdot \overline{s}_A \,/\, \overline{L^2} \quad (3)$$

$\overline{L^2}$ is average squared fish length by rectangle and by depth channels (i.e., pelagic and bottom)

As a basis for estimating $\overline{L^2}$ trawl catches considered to be representative for each rectangle and depth zone are selected. (Anon. 1998). This is a partly subjective process, and in some cases catches from neighbouring rectangles are used. Only bottom trawl catches are used for the demersal zone, while both pelagic and bottom trawl catches are applied to the pelagic zone. Length frequency distributions by 5cm length groups form the basis for calculating mean squared length. The bottom trawl catches are normalised to 1 nautical mile towing distance and adjusted for length dependant fishing efficiency (Aglen and Nakken 1997, see below). Length distributions from pelagic catches are applied unmodified.

Let f_i be the (adjusted) catch by length group *i* and let L_i be the midpoint (cm) of the length interval *i*. Then:

$$\overline{L}^2 = \frac{\sum_{i=i_{\min}}^{i_{\max}} f_i \cdot L_i^{\,2}}{\sum_{i=i_{\min}}^{i_{\max}} f_i} \qquad (4)$$

For each species the total density ($\overline{\rho}_A$) by rectangle and depth zone is now calculated by equation (3). This total density is then split on length groups according to the estimated length distribution. Next, hese densities are converted to abundance by multiplying with the area of the rectangle. The abundance by rectangle is then summed for defined main areas (Figure 3.2). Estimates by length are converted to estimates by age using an age length key for each main area.

2.2 Swept area measurements

All vessels were equipped with the standard research bottom trawl Campelen 1800 shrimp trawl with 80 mm (stretched) mesh size in the front. Prior to 1994 a cod-end with 35-40 mm (stretched) mesh size and a cover net with 70 mm mesh size were used. Since this mesh size may lead to considerable escapement of 1 year old cod, the cod ends were in 1994 replaced by cod-ends with 22 mm mesh size. At present a cover net with 116 mm meshes is mostly used. The trawl is now equipped with a rockhopper ground gear. Until and including 1988 a bobbins gear was used, and the cod and haddock indices from the time period 1981-1988 have since been recalculated to 'rockhopper indices' and adjusted for length dependent fishing efficiency and/or sweep width (Godø and Sunnanå 1992, Aglen and Nakken 1997). The sweep wire length is 40 m, plus 10 m wire for connection to the doors. Vaco doors ($6m^2$, 1500kg), which are considered to be the best compromise when doing both pelagic and bottom trawling, have been used as standard trawldoors on board the Norwegian research vessels. On hired vessels V-type doors (ca 7 m^2) have been used. In 2003, R/V "Johan Hjort" and R/V "G.O.Sars" used Vaco doors ($6m^2$, 1500kg), while R/V "Persey 3" used a V-type door ("Steinshamn W-9", $7.1m^2$, 2050kg). R/V "Johan Hjort" changed to a Tyborøen door for the last period of the survey (from 8 February). In order to achieve constant sampling width of a trawl haul independent of e.g. depth and wire length, a 10 m rope "locks" the distance between the trawl wires 150-180 m in front of the trawl doors. This is called "strapping". The distance between the trawl doors then become almost constant of (48-52 m) regardless of depth (Engås and Ona 1993, Engås 1995). Strapping was first attempted in the 1993 survey on board one vessel, in 1994 It was used on every third haul and in 1995-1997 on every second haul on all vessels. Since 1998 it has been used on all hauls

when weather conditions permitted. Standard tow duration is 30 minutes (until 1985 the tow duration was 60 min.). Trawl performance is constantly monitored by Scanmar trawl sensors, i.e., distance between the doors, vertical opening of the trawl and bottom contact control.

The positions of the trawl stations are pre-defined. When the swept area investigations started in 1981 the survey area was divided into four main areas (A, B, C og D, Fig 3.2) and 35 strata.

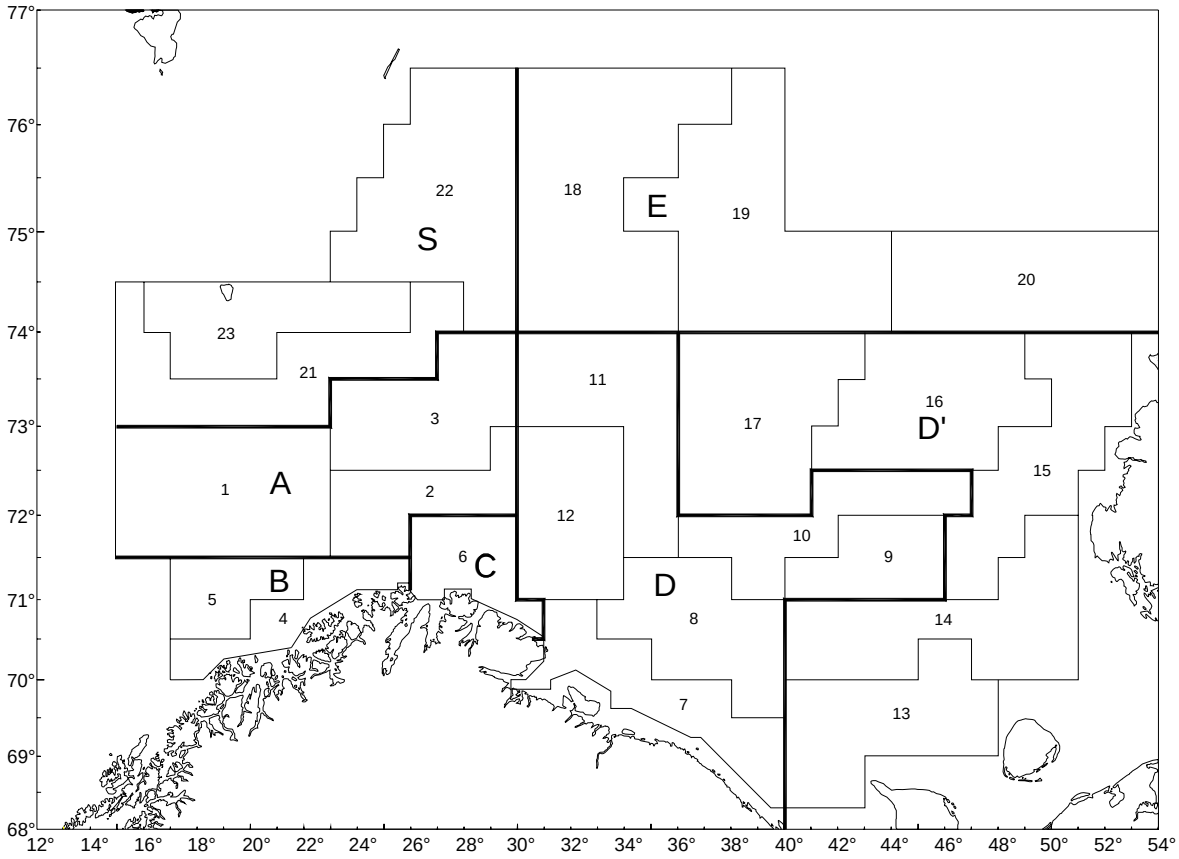

Figure 2.1 Strata (1-23) and Main Areas (A,B,C,D,D',E and S) used for swept area estimations. The Main Areas are also used for acoustic estimation.

During the first years the number of trawl stations in each stratum was set based on expected fish distribution in order to reduce the variance, i.e., more hauls in strata where high and variable fish densities were expected to occur. During the 1990ies trawl stations have been spread out more evenly, yet the distance between stations in the central cod distribution area is shorter (16 n.miles) compared to the more marginal areas (24 or 36 n.miles). During the 1990-ies considerable amounts of young cod were distributed outside the initial four main areas, and in 1993 the investigated area was therefore enlarged by areas D', E, and the ice-free part of Svalbard (S) (Fig. 3.2 and Table 3.1); 28 strata altogether. In the 1993- and 1994 survey reports, the Svalbard area was included in A' and the western (west of 30°E) part of area E. Since 1996 a revised strata system with 23 strata has been used (Figure 2.1). The main reason for reducing the

number of strata was the need for a sufficient number of trawl stations in each stratum to get reliable estimates of density and variance.

Swept area fish density estimation

Swept area fish density estimates ($\rho_{s,l}$) by species (s) and length (l) were estimated for each bottom trawl haul by the equation:

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

$\rho_{s,l}$ number of fish of length l per n.m.^{2} observed on trawl station s

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

$a_{s,l}$ swept area:

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

d_s towed distance (n.mile)

EW_l length dependent effective fishing width:

$$EW_l = \alpha \cdot l^{\beta} \text{ for } l_{\min} < l < l_{\max}$$
$$EW_l = EW_{l_{\min}} = \alpha \cdot l_{\min}^{\beta} \text{ for } l \le l_{\min}$$
$$EW_l = EW_{l_{\max}} = \alpha \cdot l_{\max}^{\beta} \text{ for } l \ge l_{\max}$$

The parameters are given in the text table below:

Species	α	β	$l_{\min}$	$l_{\max}$
Cod	5.91	0.43	15 cm	62 cm
Haddock	2.08	0.75	15 cm	48 cm

The fishing width was previously fixed to 25 m = 0.0135 nm. Based on Dickson (1993a,b), length dependent effective fishing width for cod and haddock was included in the calculations in 1995 (Korsbrekke *et al*., 1995). Aglen and Nakken (1997) have adjusted both the acoustic and swept area time series back to 1981 for this length dependency based on mean-length-at-age information. In 1999, the swept area 1983-1995 time series was recalculated for cod and haddock using the new area and strata divisions (Bogstad *et al.* 1999).

For redfish, Greenland halibut and other species, a fishing width of 25 m was applied, independent of fish length.

For each station, s, observations of fish density by length ($\rho_{s,l}$) is summed in 5 cm length-groups. Stratified indices by length-group and stratum will then be:

$$L_{p,l} = \frac{A_p}{S_p} \cdot \sum_{s \text{ in stratum } p} \rho_{s,l}$$

$L_{p,l}$ index, stratum *p*, length-group *l*
A_p area (n.m.^{2}) of stratum *p* (or the part of the stratum covered by the survey)
S_p number of trawl stations in stratum *p*

The coverage of the northern- and easternmost strata differs from year to year. The areas of these strata are therefore calculated according to the coverage each year. Indices are estimated for each stratum within the main areas A, B, C, D, D', E and S. Total number of fish in each 5 cm length group in each main area is estimated by adding the indices of all strata within the area. Total number of fish at age is estimated by using an age-length key constructed for each main area. Total indices on length and age are estimated adding the values for all main areas.

2.3 Sampling of catch and age-length keys.

Sorting, weighing, measuring and sampling of the catch are done according to instructions given in Fotland *et al*. (1997). Since 1999 all data except age are recorded electronically by Scantrol Fishmeter measuring board, connected to stabilized scales. The whole catch or a representative sub sample of most species was length measured on each station.

At each trawl station age (otoliths) and stomach were sampled from 1 cod per 5 cm length-group. All cod above 90 cm were sampled. The stomach samples were frozen and analysed after the survey. Haddock otoliths were sampled from 1 specimen per 5 cm length-group. Regarding the redfish species, *Sebastes marinus* and *S. mentella*, otoliths for age determination were sampled from 2 fish in every 5 cm length-group on every station. This regular sampling was supplemented with extra samples from hauls with big redfish catches. Greenland halibut were sorted by sex before length measurement and age (otolith) sampling. From this species otoliths were collected from 5 fish per 5 cm length group for each sex on all stations. Table 3.2 gives an account of the sampled material.

An age-length key is constructed for each main area. All age samples are included and weighted according to:

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

$w_{p,l}$ - weighting factor

$L_{p,l}$ - swept area index of number fish in length-group l in stratum p

$n_{p,l}$ - number of age samples in length-group l and stratum p

Fractions are estimated according to:

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

$p_a^{(l)}$ - weighted fraction of age a in length-group l and stratum p

$n_{p,a,l}$ - number of age samples of age a in length-group l and stratum p

Number of fish by age is then estimated following the equation:

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

Mean length and –weight by age is then estimated according to (only shown for weight):

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

$W_{a,p,l,j}$ - weight of sample j in length-group l, stratum p and age a

3. SURVEY OPERATION

The survey in 2003 was conducted with R/V "G.O. Sars" 30.01-04.03 (IMR-BEI-survey no. 2003002, IMR-series no. 80001-80164), R/V "Johan Hjort" 29.01-03.03 (IMR-BEI-survey no. 2003202, IMR-series no. 80301-80450), and R/V “Persey 3” from PINRO 31.01-25.02. The catch data and biological samples from R/V “Persey 3” were converted to the IMR-format “Regfisk” (IMR-series no. 80501-80633). The acoustic data from R/V “Persey 3” was reported to IMR as allocated values by species at 5 n.mile intervals, split on a bottom layer (<10m from bottom) and a pelagic layer (>10m above bottom).

Fig. 3.1 shows survey tracks and trawl stations, and fig. 3.2 shows the survey area with the main areas A, B, C, D, D', E and S (part of the Svalbard area). Table 3.1 shows the area covered by the

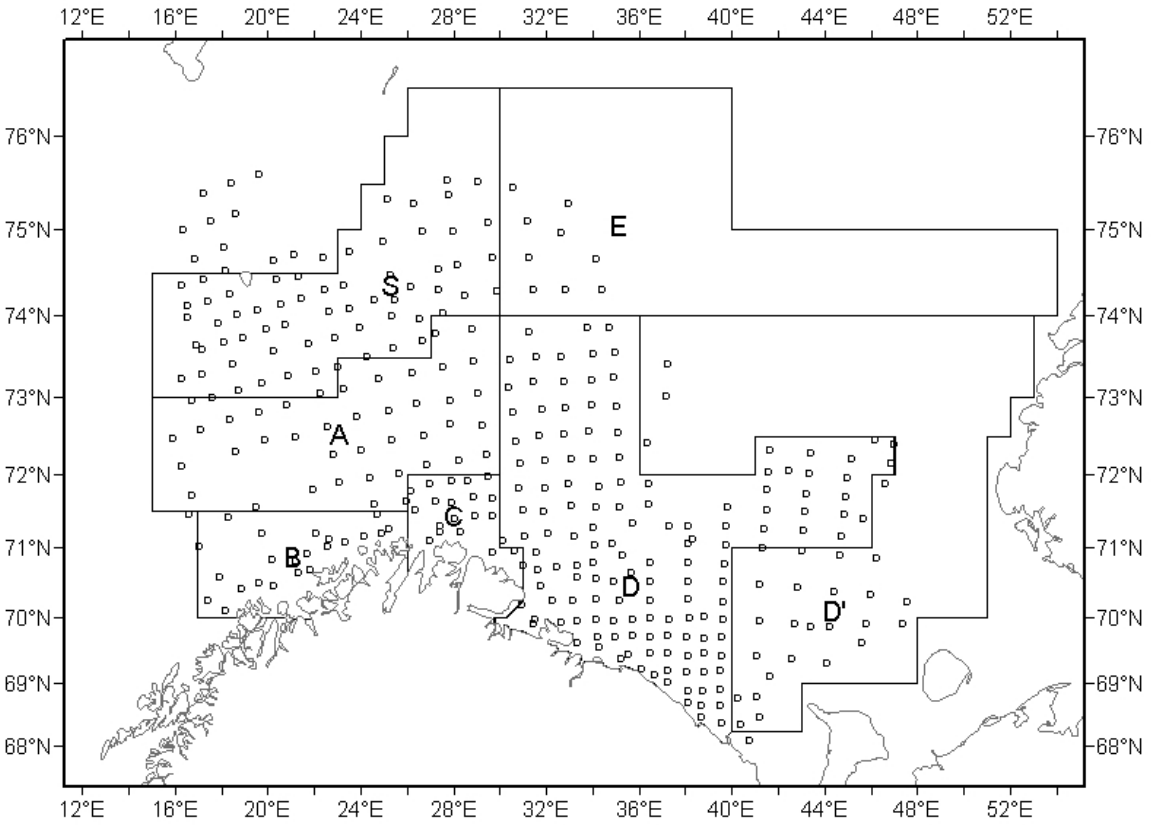

Figure 3.1. Bottom trawl stations used in the swept area estimation in 2003 and borders for the main areas.

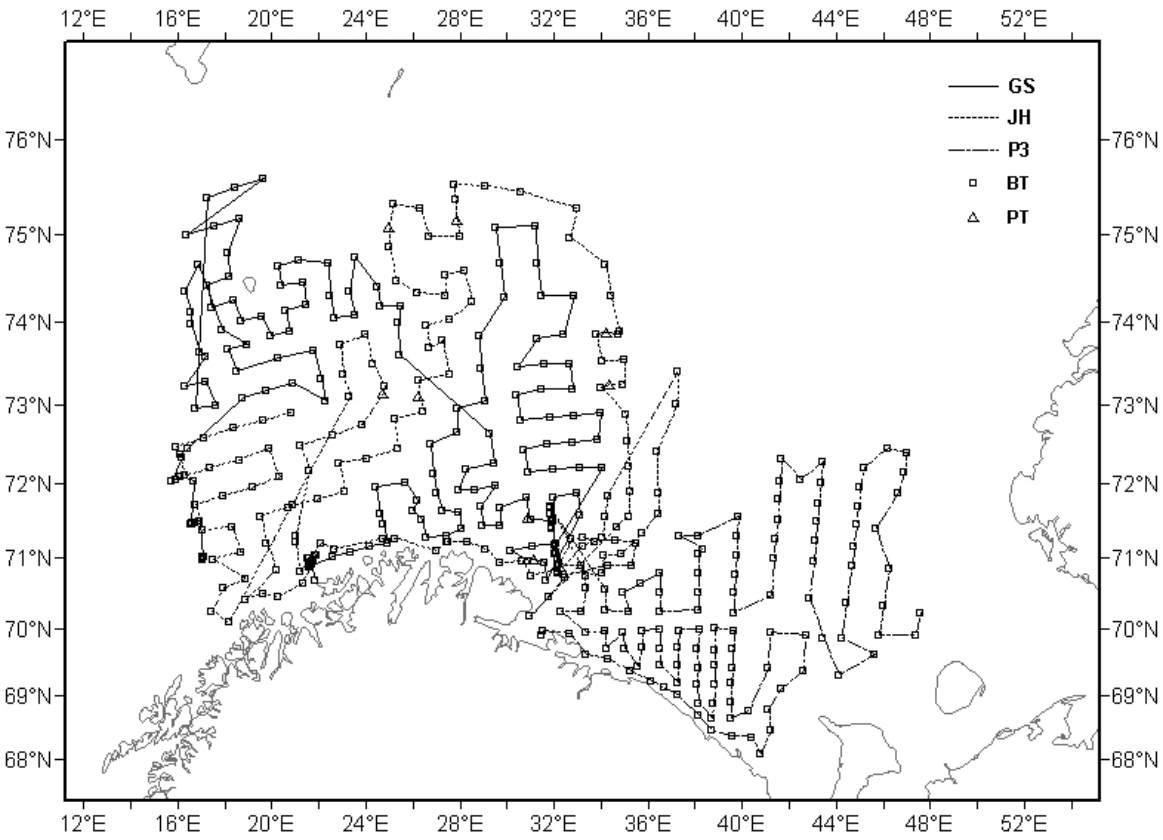

Figure 3.2. Survey tracks and trawl stations R/V "G.O. Sars" and R/V "Johan Hjort" and R/V "Persey 3" 29.1-6.3.2003.

survey every year. In the 2003 survey 247 hydrographical (CTD) stations and 447 trawl stations were taken (fig. 3.1, table 3.2). 9 of the trawl stations were pelagic trawl hauls using Åkrahamn pelagic trawl (3200 mm mesh size in front and 20 mm in the cod end; see Valdemarsen and Misund 1995) in order to get more samples and information to improve the echo scrutinizing by species and fish length. For the calculation of swept area indices, only the successful pre-defined bottom trawl stations within the defined strata system were used. Those added up to 319 stations. Among the bottom trawl stations not used in the swept area calculation are; 52 stations taken for trawl comparisons (32 comparing "Johan Hjort" and "G.O. Sars", 20 comparing "Johan Hjort" and "Persey 3"), 14 stations for some special studies on haddock in main area A and B, and 8 stations taken for a special study in the "Grey Zone", and 2 non-predefined hauls for identification of acoustic records. The rest was either outside the strata system defined in Figure 2.1 (11 NW of Bear Island and 12 close to the Murman coast) or they were rejected due to damage or malfunction of the gear. Age sampling from these additional bottom trawl hauls and from pelagic hauls has been used in the calculations, as long as they were taken within the defined strata system.

Table 3.2 gives an account of the sampled length- and age material from pre-defined bottom trawl hauls, other bottom hauls and pelagic hauls.

One scientist from PINRO, Murmansk, participated onboard "Johan Hjort" during the period when comparative studies between "Johan Hjort" and "Persey 3" were performed.

Table 3.1. Area (n.miles^2) covered in the bottom trawl surveys in the Barents Sea winter 1981-2003.

	Main Area							Sum	
Year	A	B	C	D	D'	E	S	ABCD	Total
1981-92	23299	8372	5348	51116	-	-	-	88135	88135
1993	23929	8372	5348	51186	23152	8965	16690	88835	137642
1994	27131	8372	5348	51186	24975	12576	14252	92037	143840
1995	27131	8372	5348	51186	56822	14859	22836	92037	186554
1996	25935	9701	5048	53932	53247	5818	11600	94616	165281
1997	27581	9701	5048	23592	2684	1954	16989	65922	87549
1998	27581	9701	5048	23592	5886	3819	23587	65922	99214
1999	27581	9701	5048	43786	7961	5772	18470	86116	118319
2000	27054	9701	5048	52836	28963	14148	24685	94639	162435
2001	26469	9701	5048	53932	29376	15717	23857	95150	164100
2002	26483	9701	5048	53932	21766	15611	24118	95165	156659
2003	26483	9701	5048	52805	23506	6185	22849	94038	146578

Table 3.2. Number of trawl stations, fish measured for length (L) and age (A) for main areas and trawl types in the Barents Sea winter 2003. B1=fixed bottom trawl, B2=other bottom trawl, P=pelagic trawl. BINW is the additional area covered North and West of Bear Island.

Area	Trawl type	No. hauls	Cod		Haddock		*S.marinus*		*S. mentella*		Greenland halibut	
			L	A	L	A	L	A	L	A	L	A
A	B1	41	2457	447	3299	320	75	45	1388	235	41	38
	B2	8	213	0	754	239	19	7	353	0	7	0
	P	1	15	5	61	5	1	1	0	0	0	0
B	B1	23	1450	213	2031	208	272	106	11	3	0	0
	B2	48	2261	20	2715	115	93	0	206	0	0	0
	P	0	0	0	0	0	0	0	0	0	0	0
C	B1	21	1967	252	2647	201	90	30	398	27	0	0
	B2	1	0	0	0	0	0	0	0	0	0	0
	P	0	0	0	0	0	0	0	0	0	0	0
D	B1	133	31917	1074	31962	568	178	36	595	87	131	68
	B2	31	5244	52	7381	31	137	0	84	0	8	1
	P	5	59	13	19	5	0	0	0	0	0	0
D'	B1	29	5448	11	1487	6	1	0	0	0	0	0
	B2	0	0	0	0	0	0	0	0	0	0	0
	P	0	0	0	0	0	0	0	0	0	0	0
E	B1	9	664	58	33	7	14	6	8	4	13	12
	B2	0	0	0	0	0	0	0	0	0	0	0
	P	0	0	0	0	0	0	0	0	0	0	0
S	B1	63	7841	712	2449	178	227	87	1611	119	457	272
	B2	0	0	0	0	0	0	0	0	0	0	0
	P	3	1	0	0	0	0	0	0	0	0	0
Total	B1	319	51744	2767	43908	1488	857	310	4011	475	642	390
	B2	88	7718	72	10850	385	249	7	643	0	15	1
	P	9	75	18	80	10	1	1	0	0	0	0
Sum		416	59573	2857	54838	1883	1102	318	4654	475	657	391
BINW	B1	11	1035	58	204	10	1	0	32	0	4	4

4. HYDROGRAPHY

The standard hydrographical sections ”Fugløya-Bjørnøya” and “Vardø-north” taken at a Norwegian survey one or two weeks after the fish survey, showed moderate changes in mean temperature at 50-200 m depth, compared to the period 1999-2002 (Fig. 4.1). The Sem Islands section was not covered in 2003.

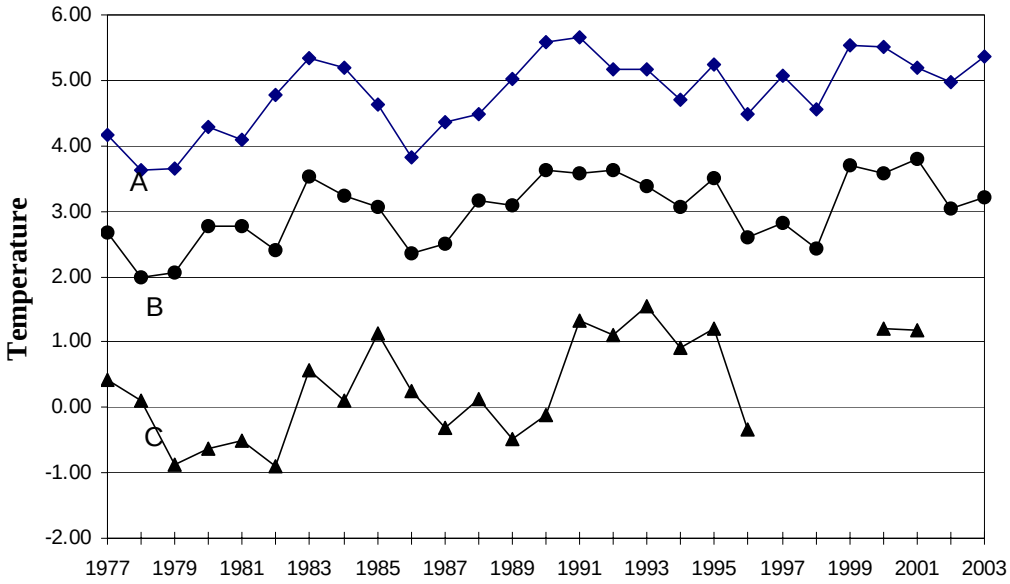

Fig.4.1. Mean temperatures in 50-200 m depth in 1977-2003. A) "Fugløya-Bjørnøya" in March, B) "Vardø-Nord" in March, C) Sem Islands in January-February.

5. TOTAL ECHO ABUNDANCE OF COD AND HADDOCK

Table 5.1 shows the echo abundance (echo density multiplied by area) distributed on main areas as well as on pelagic versus bottom channels, and table 5.2 presents the time series of total echo abundance of cod and haddock in the investigated areas. The echo abundance of both species was substantially higher in 2003 than in any of the previous 7 years, and was at the level experienced in the mid 90ies.

The increase was observed in all main areas except E, and both in the pelagic and in the bottom layer. The fraction of the total echo abundance recorded in the bottom layer was close to the 2002 values for both species; 0.34 for cod and 0.22 for haddock.

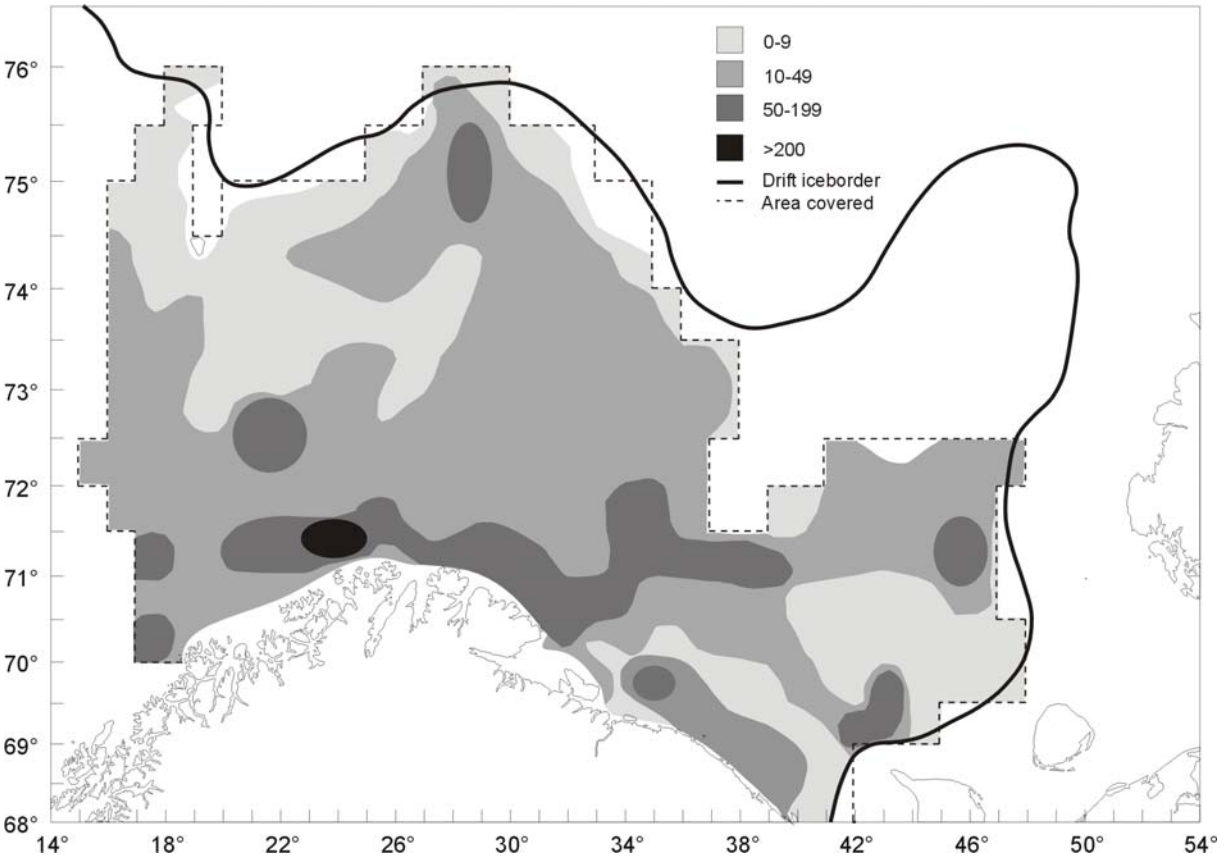

Figure 5.1. COD. Distribution of total echo abundance winter 2003. Unit is area back scattering surface (s_A) per square nautical mile (m^2/n.mile^2).

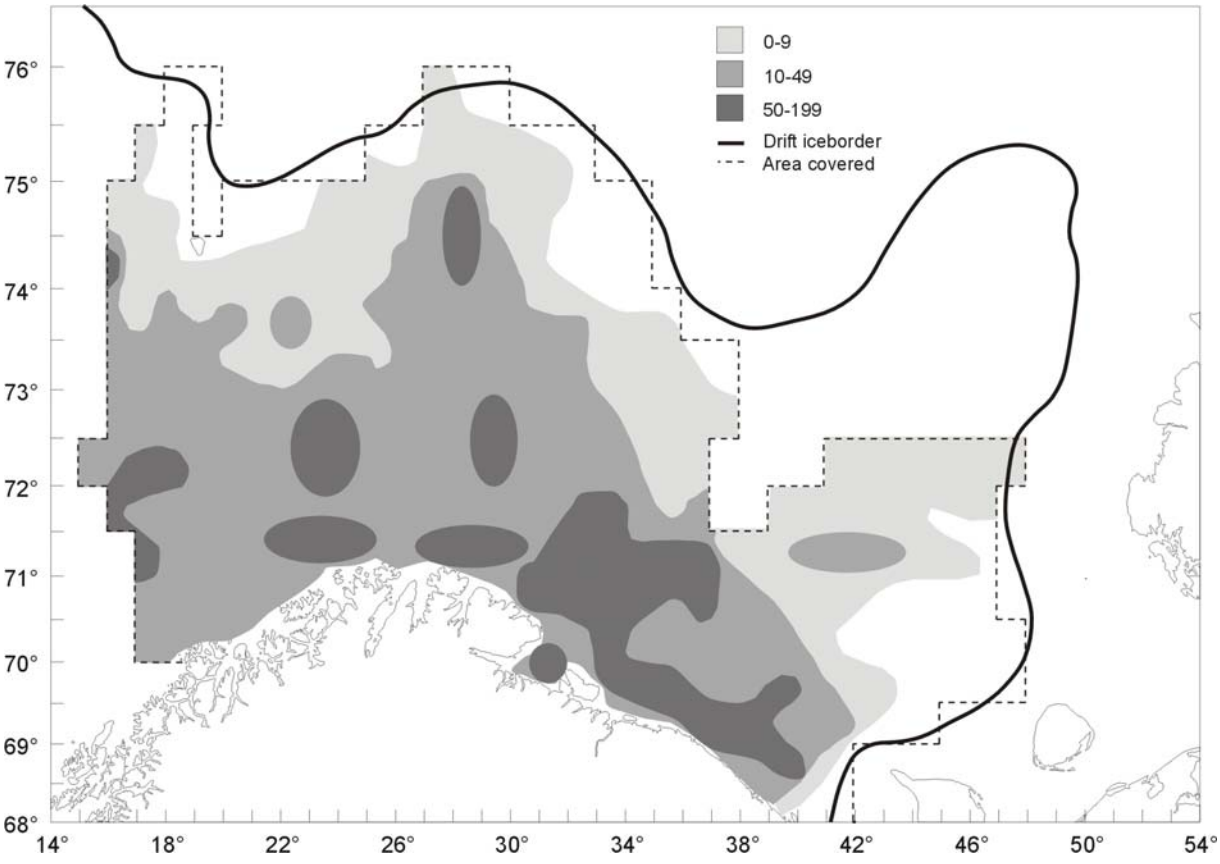

Figure 5.2. HADDOCK. Distribution of total echo abundance winter 2003. Unit is area back scattering surface (s_A) per square nautical mile (m^2/n.mile^2).

Table 5.1. Echo abundance of cod and haddock in the pelagic layer (P) and in the 10 m layer above the bottom (B) in main areas of the Barents Sea winter 2003 (m^2 reflecting surface · 10^{-3}).

	Cod			Haddock		
Area	P	B	Total	P	B	Total
A	406	157	563	634	112	746
B	499	165	664	299	117	416
C	227	76	303	214	39	253
D	973	576	1549	1189	444	1633
D'	63	167	230	38	22	60
E	35	13	48	4	1	5
S	247	94	341	267	19	286
Total	2451	1248	3699	2645	753	3398
BINW	9	8	17	8	1	9

Table 5.2. Cod and haddock. Total echo abundance and echo abundance in the 10 m layer above the bottom from acoustic surveys in the Barents Sea winter 1981-2003 (m^2 reflecting surface · 10^{-3}). 1981 - 1992 includes mainly areas A, B, C and D.

	Echo abundance								
	Total			bottom			bottom/total		
Year	Cod	Had.	Sum	Cod	Had.	Sum	Cod	Had.	Sum
1981			2097			799			0.38
1982			686			311			0.45
1983			597			169			0.28
1984			2284			604			0.26
1985			5187			736			0.14
1986			5990			820			0.14
1987			2676			608			0.23
1988			1696			579			0.34
1989			914			308			0.34
1990			1355			536			0.40
1991			2706			803			0.30
1992			4128			951			0.23
1993	3905	2854	6759	1011	548	1559	0.26	0.19	0.23
1994	5076	3650	8726	1201	609	1810	0.24	0.17	0.21
1995	4125	3051	7176	1525	651	2176	0.37	0.21	0.30
1996	2729	1556	4285	1004	626	1630	0.37	0.40	0.38
1997[1]	1354	995	2349	530	258	788	0.39	0.26	0.34
1998[1]	2406	581	2987	632	143	775	0.26	0.29	0.26
1999	1364	704	2068	389	145	534	0.29	0.21	0.26
2000	2596	1487	4083	610	343	953	0.23	0.23	0.23
2001	2085	1440	3525	698	615	1313	0.34	0.43	0.37
2002	1943	2329	4272	627	477	1104	0.32	0.20	0.26
2003	3699	3398	7097	1248	753	2001	0.34	0.22	0.28

[1)] Norwegian EEZ and part of the Svalbard area

6. DISTRIBUTION AND ABUNDANCE OF COD

6.1 Acoustic estimation

Surveys in the Barents Sea at this time of the year mainly cover the immature part of the cod stock. Most of the mature cod (age 7 and older) have started on its spawning migration southwards out of the investigated area, and is therefore to a lesser extent covered.

Acoustic indices by length and age are given in table 6.1. Table 6.2 shows the acoustic indices for each age group by main areas, in the pelagic layer (P) and in the 10 m layer above the bottom (B).

The time series (1981-2003) is presented in table 6.3. The indices for 1997 and 1998 are raised to also represent the Russian EEZ. Indices for the Russian EEZ in 1997 and 1998 were calculated by interpolation of the ratios found in the Russian EEZ in 1996 and 1999, age group by age group. Since the coverage of the Svalbard area (S) varies from year to year due to ice, this area has been excluded in the extrapolation of fish abundance in the Russian EEZ in 1997-1998, and just added to the total index afterwards.

The 2003 results show unexpectedly high indices of abundance for all age groups 2-7 as compared with the indices in 2002. In particular the 2003 values for 4, 5 and 6 year olds seem strange since these year classes apparently all have increased considerably in abundance during 2002; the 2003 index of age 6 being the highest in the time series. A significant contribution to the high estimates of 5 and 6 year olds is from dense recordings along the coast between 21° and 25° east. The offshore extension of these recordings is not known due to no transects in-out from the coast (figure 3.1). The obtained mean s_A for cod might thus be biased upwards.

Table 6.1. COD. Abundance indices at length and age from the acoustic survey in the Barents Sea winter 2003 (numbers in millions).

	Age (year-class)											
Length	1	2	3	4	5	6	7	8	9	10+	Sum	Biomass
cm	(02)	(01)	(00)	(99)	(98)	(97)	(96)	(95)	(94)			('000 t)
5-9	72.4										72.4	0
10-15	1604.9										1604.9	25
15-20	16.6	41.2	0.7								58.5	2
20-25		11.9	29.6								41.5	4
25-30		8.3	123.9	0.3							132.4	22
30-35		+	100.3	11.7							112.1	31
35-40			40.5	25.2	0.2						66.0	28
40-45			6.7	33.7	2.3	0.2					42.9	26
45-50			1.7	32.0	16.4	0.3					50.4	43
50-55				9.8	45.4	7.7					62.9	72
55-60				1.7	50.8	21.9	0.7				75.2	114
60-65					13.1	49.4	2.5				65.0	126
65-70					0.7	30.8	6.8	0.5			38.9	95
70-75						3.5	15.5	0.7	+		19.7	60
75-80					+	0.9	7.5	2.3	0.3		11.1	41
80-85						0.1	1.0	2.1	0.1	0.2	3.5	16
85-90						+	0.3	1.3	0.5	+	2.1	11
>90							0.1	0.7	1.0	0.3	2.1	13
sum	1693.9	61.5	303.4	114.4	129.0	114.9	34.3	7.7	1.9	0.5	2461.5	
Biomass	25	5	70	70	173	234	102	35	12	4		731

Table 6.2. COD. Acoustic abundance indices in the pelagic layer (P) and in the 10 m layer above the bottom (B) for the main areas of the Barents Sea winter 2003 (numbers in millions). BINW is the additional area covered North and West of Bear Island (not included in the total).

		Age (year-class)										
		1	2	3	4	5	6	7	8	9	10+	Biomass
Area	Layer	(02)	(01)	(00)	(99)	(98)	(97)	(96)	(95)	(94)		('000 t)
A	P	17.1	0.4	10.0	9.0	20.5	19.2	3.9	1.3	0.4	0.1	94
	B	8.0	0.2	3.4	3.1	7.6	7.6	1.7	0.5	0.2	0.0	36
B	P	6.3	0.3	0.6	4.4	13.4	28.8	10.9	2.3	0.6	0.3	137
	B	1.3	0.1	0.2	2.0	4.6	9.5	3.4	0.7	0.2	0.1	45
C	P	28.2	0.4	5.0	5.4	10.8	9.7	2.9	0.4	0.1	0.0	54
	B	9.0	0.1	1.6	1.7	3.5	3.3	1.0	0.2	0.0	0.0	18
D	P	530.5	9.4	122.1	47.1	32.8	19.6	5.1	1.1	0.2	0.0	166
	B	373.8	7.7	92.7	28.2	15.7	9.2	2.3	0.5	0.1	0.0	91
D'	P	142.3	7.7	7.6	0.7	0.2	0.1	0.0	0.0	0.0	0.0	5
	B	449.4	24.0	11.3	0.6	0.3	0.1	0.0	0.0	0.0	0.0	12
E	P	30.6	0.9	2.7	0.8	1.8	0.2	0.3	0.1	0.0	0.0	6
	B	11.1	0.4	1.1	0.3	0.7	0.1	0.1	0.0	0.0	0.0	2
S	P	64.9	7.4	32.0	7.9	12.4	5.5	2.0	0.5	0.0	0.0	46
	B	21.3	2.6	13.1	3.1	4.7	2.0	0.7	0.2	0.0	0.0	17
ABCD	P	582.1	10.4	137.8	65.9	77.4	77.4	22.8	5.1	1.4	0.4	451
	B	392.1	8.1	97.9	35.1	31.5	29.7	8.5	1.8	0.5	0.1	191
Total	P	820.0	26.4	180.1	75.3	91.9	83.1	25.1	5.6	1.4	0.4	508
	B	873.9	35.1	123.4	39.1	37.1	31.8	9.3	2.1	0.5	0.1	222
	sum	1693.9	61.5	303.4	114.4	129.0	114.9	34.3	7.7	1.9	0.5	731
BINW	P	8.4	0.6	1.7	0.5	0.2	0.0	0.0	0.0	0.0	0.0	1
	B	6.3	0.6	1.5	0.4	0.2	0.0	0.0	0.0	0.0	0.0	1

Table 6.3. COD. Abundance indices from acoustic surveys in the Barents Sea winter 1981-2003 (numbers in millions). 1981-1992 includes mainly areas A, B C and D.

	Age											Biomass
Year	1	2	3	4	5	6	7	8	9	10+	Total	('000 t)
1981	8.0	82.0	40.0	63.0	106.0	103.0	16.0	3.0	1.0	1.0	423.0	595
1982	4.0	5.0	49.0	43.0	40.0	26.0	28.0	2.0	0.0	0.0	197.0	303
1983	60.5	2.8	5.3	14.3	17.4	11.1	5.6	3.0	0.5	0.1	120.5	111
1984	745.4	146.1	39.1	13.6	11.3	7.4	2.8	0.2	0.0	0.0	966.0	134
1985	69.1	446.3	153.0	141.6	19.7	7.6	3.3	0.2	0.1	0.0	840.9	392
1986	353.6	243.9	499.6	134.3	65.9	8.3	2.2	0.4	0.1	0.0	1308.2	503
1987	1.6	34.1	62.8	204.9	41.4	10.4	1.2	0.2	0.7	0.0	357.3	207
1988	2.0	26.3	50.4	35.5	56.2	6.5	1.4	0.2	0.0	0.0	178.4	99
1989	7.5	8.0	17.0	34.4	21.4	53.8	6.9	1.0	0.1	0.1	150.1	155
1990	81.1	24.9	14.8	20.6	26.1	24.3	39.8	2.4	0.1	0.0	234.1	246
1991	181.0	219.5	50.2	34.6	29.3	28.9	16.9	17.3	0.9	0.0	578.7	418
1992	241.4	562.1	176.5	65.8	18.8	13.2	7.6	4.5	2.8	0.2	1092.9	405
1993	1074.0	494.7	357.2	191.1	108.2	20.8	8.1	5.0	2.3	2.5	2264.0	753
1994	858.3	577.2	349.8	404.5	193.7	63.6	12.1	3.7	1.7	0.9	2465.4	950
1995	2619.2	292.9	166.2	159.8	210.1	68.8	16.7	2.1	0.7	1.0	3537.4	713
1996	2396.0	339.8	92.9	70.5	85.8	74.7	20.6	2.8	0.3	0.4	3083.8	450
1997*	1623.5	430.5	188.3	51.7	49.3	37.2	22.3	4.0	0.7	0.1	2407.5	322
1998*	3401.3	632.9	427.7	182.6	42.3	33.5	26.9	13.6	1.7	0.3	4762.8	506
1999	358.3	304.3	150.0	96.4	45.1	10.3	6.4	4.1	0.8	0.3	976.0	224
2000	154.1	221.4	245.2	158.9	142.1	45.4	9.6	4.7	3.0	1.1	985.4	481
2001	629.9	63.9	138.2	171.6	77.3	39.7	11.8	1.4	0.5	0.2	1134.7	408
2002	18.2	215.5	69.3	112.2	102.0	47.0	18.0	3.0	0.4	0.3	585.9	416
2003	1693.9	61.5	303.4	114.4	129.0	114.9	34.3	7.7	1.9	0.5	2461.5	731

1) Indices raised to also represent the Russian EEZ.

6.2 Swept area estimation

Figs. 6.1-6.4 show the geographic distribution of bottom trawl catch rates (number of fish per 3 naut.mile, corresponding to 1 hours towing) for cod for each of the size groups < 20 cm, 20-34 cm, 35-49 cm and > 50 cm. As in previous years the greatest concentrations of the smallest cod (<20 cm) were found in the eastern part of the survey area within the Russian EEZ. Also the size groups 20-34 cm and 35-49 cm show highest densities in this eastern area. For cod larger than 50 cm the areas with catch rates above 100 per hour have increased compared to the results from the 2002 survey with particularly high catch rates in coastal waters between 23° and 25° east.

Table 6.4 presents the abundance indices by 5 cm length groups for each main area. Standard error and coefficient of variation (CV) are also given. The CV is lowest (12%) in the size range 35-85 cm, similar to previous years. For smaller fish the CVs are considerably higher than in resent years. Age-length distribution of the total swept area index as well as the distribution of

the index by main area and age is given in tables 6.5 and 6.6, respectively. For age 5 and older the total indices are far less than the acoustic estimates (Table 6.3), while for ages 1-3 the swept area indices are somewhat higher than the acoustic indices.

The time series (1981-2003) is shown in table 6.7. The indices for 1997 and 1998 are adjusted the same way as the acoustic indices to include the uncovered Russian EEZ. In the most resent years the abundance of 6 year and older fish has increased substantially, while the index for 4 and 5 year old fish combined has decreased somewhat. The swept area index of 3 year olds in 2003 is one of the highest observed (the associated CV is also very high), while the abundance of 2 year olds is extremely low. The amount of 1 year olds (2002 year class) in 2003 is the highest since 1998. The overall impression from table 6.7 is that survival has improved significantly in recent years for most age groups.

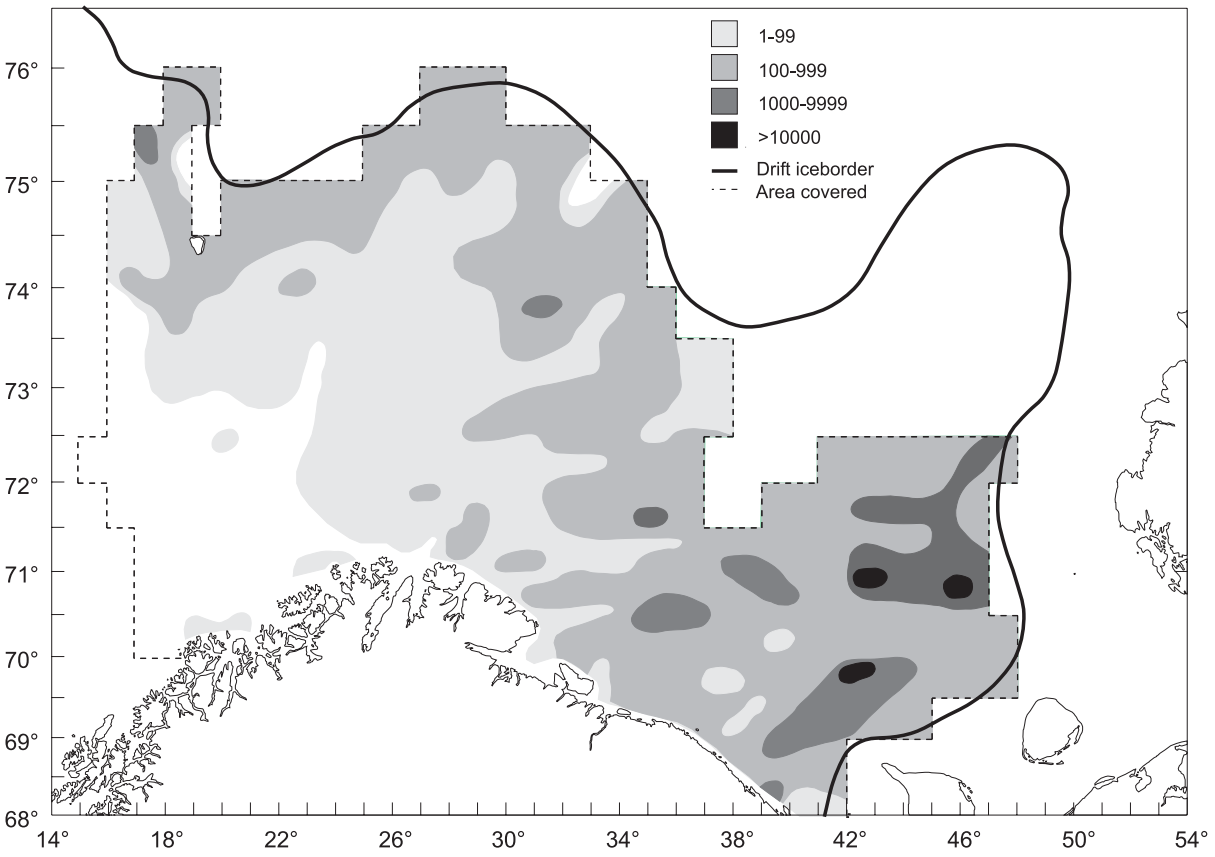

Figure 6.1. COD < 20 cm. Distribution in the trawl catches winter 2003 (number per hour trawling).

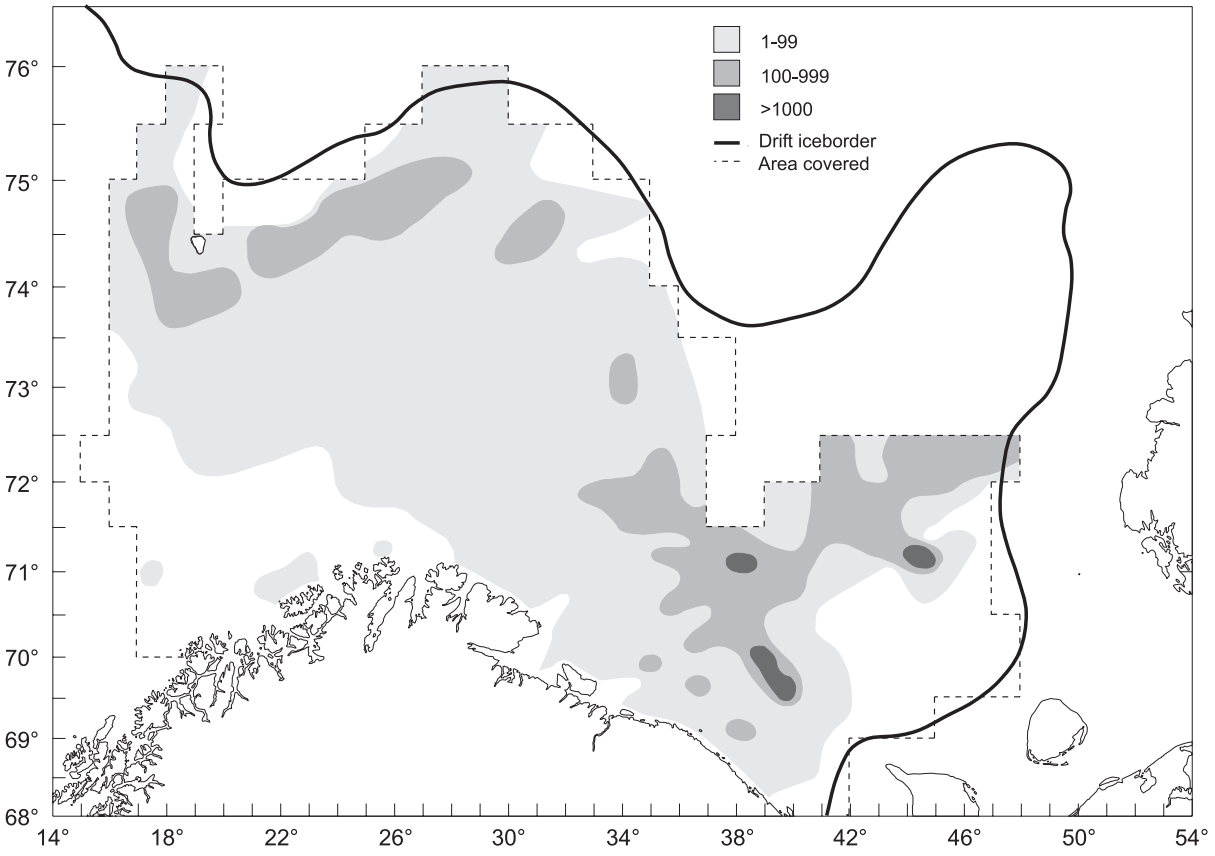

Figure 6.2. COD 20-34 cm. Distribution in the trawl catches winter 2003 (number per hour trawling).

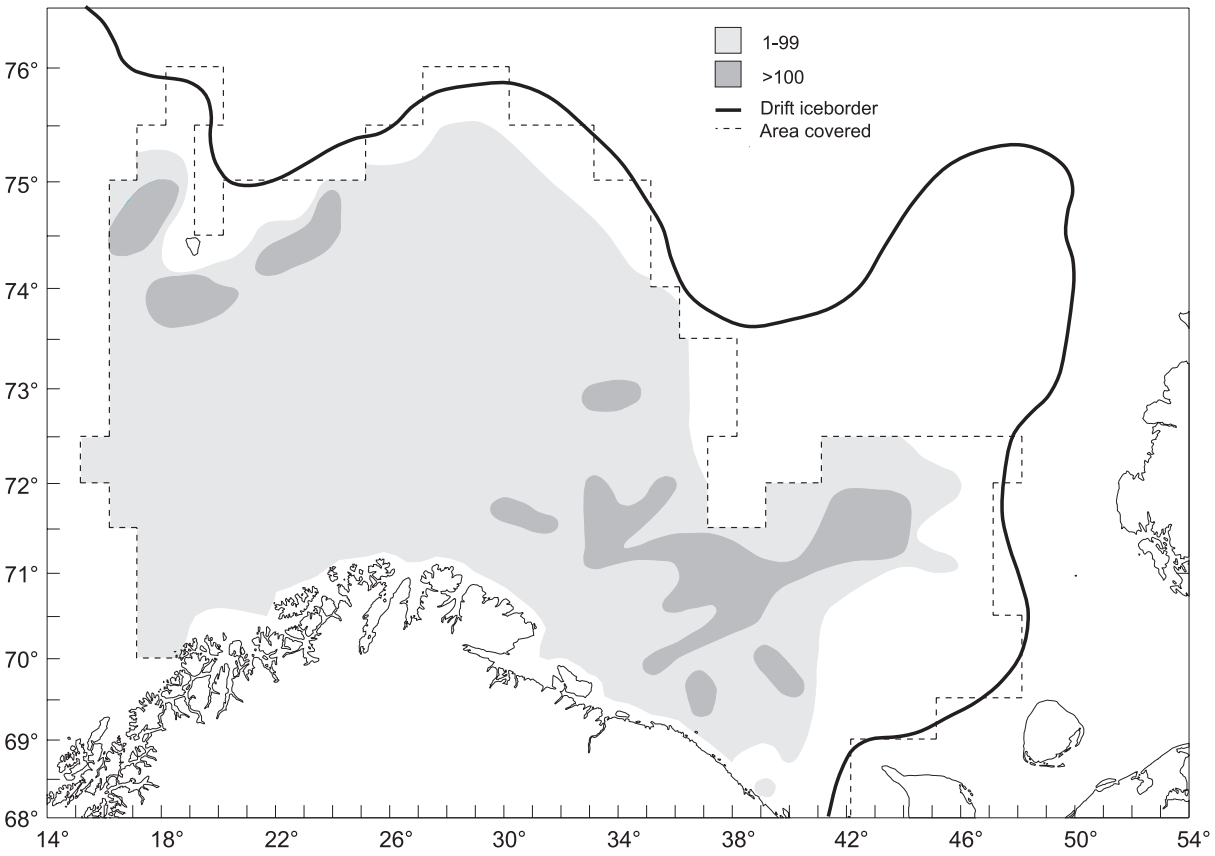

Figure 6.3. COD 35-49 cm. Distribution in the trawl catches winter 2003 (number per hour trawling).

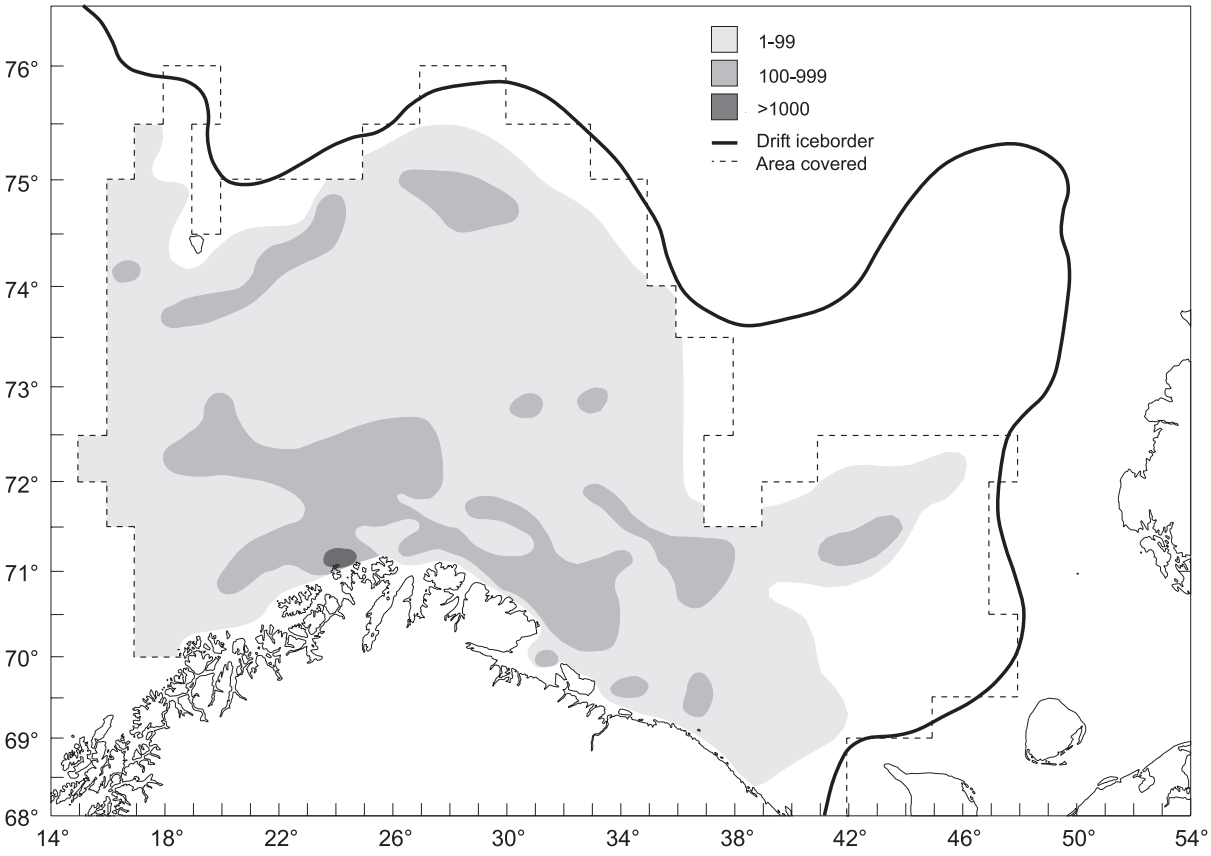

Figure 6.4. COD > 50 cm. Distribution in the trawl catches winter 2003 (number per hour trawling).

Table 6.4. COD. Abundance indices (I) at length with standard error of mean (S) from bottom trawl hauls for main areas of the Barents Sea winter 2003 (no. in millions).

Length	Area A		B		C		D		D'		E		S		Total		
cm	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	CV (%)
5-9	0.5	0.3	0.3	0.2	0.6	0.3	36.6	7.3	56.6	16.3	1.9	0.9	1.5	0.5	98.0	17.9	18.3
10-14	11.8	4.0	1.3	0.4	10.0	2.8	873.7	158.0	1828.5	799.6	70.4	15.0	69.6	7.9	2865.2	815.2	28.5
15-19	0.2	0.1	0.0	0.0	0.0	0.0	26.9	8.1	54.9	29.8	2.2	0.8	7.9	1.8	92.2	31.0	33.6
20-24	0.4	0.1	0.1	0.1	0.1	0.1	43.1	24.1	6.0	3.9	1.5	0.9	8.9	1.9	60.0	24.5	40.8
25-29	2.0	0.5	0.1	0.1	0.4	0.2	161.9	74.6	2.9	1.9	1.2	0.7	21.8	3.9	190.3	74.7	39.3
30-34	3.4	0.6	0.2	0.1	0.9	0.3	113.6	23.7	0.3	0.2	1.3	0.8	18.6	3.3	138.2	24.0	17.3
35-39	3.4	0.6	0.5	0.3	0.9	0.3	55.1	8.1	0.0	0.0	0.9	0.6	9.1	1.6	69.8	8.4	12.0
40-44	3.1	0.4	0.5	0.1	0.8	0.3	25.4	3.6			0.6	0.5	6.7	0.9	37.1	3.8	10.2
45-49	5.9	0.6	1.9	0.6	1.3	0.3	20.6	3.0			0.6	0.3	8.5	1.1	38.7	3.3	8.5
50-54	9.8	1.0	2.4	0.8	1.9	0.4	19.6	2.5			1.0	0.6	10.2	1.4	44.9	3.2	7.1
55-59	12.4	1.7	4.7	1.3	2.8	0.4	20.2	2.5			1.0	0.6	7.5	1.1	48.5	3.5	7.2
60-64	10.2	1.4	7.3	2.3	2.8	0.5	13.5	1.8	0.1	0.1	0.5	0.3	3.6	0.6	37.9	3.3	8.8
65-69	6.4	1.1	4.4	1.5	1.3	0.2	7.0	0.9	0.1	0.1	0.2	0.1	1.2	0.3	20.6	2.1	10.3
70-74	2.2	0.4	2.2	0.6	0.8	0.2	2.9	0.4			0.1	0.1	0.7	0.2	9.0	0.9	10.1
75-79	1.5	0.3	1.4	0.4	0.4	0.1	1.4	0.3			0.2	0.2	0.3	0.1	5.2	0.6	11.3
80-84	0.4	0.1	0.5	0.1	0.1	0.0	0.9	0.2			0.1	0.1	0.2	0.1	2.2	0.2	10.8
85-89	0.4	0.1	0.2	0.1	0.1	0.0	0.4	0.1			0.1	0.0	0.2	0.1	1.4	0.2	12.5
>90	0.3	0.1	0.2	0.1	0.1	0.0	0.6	0.1			0.1	0.0	0.2	0.1	1.2	0.2	13.3
Sum	74.2	5.0	28.2	3.3	25.3	3.0	1423.2	178.6	1949.3	800.3	83.7	15.2	176.5	10.2	3760.3	820.2	21.8

Table 6.5. COD. Abundance indices at length and age from the bottom trawl survey in the Barents Sea winter 2003 (numbers in millions).

	Age (year-class)											
Length cm	1 (02)	2 (01)	3 (00)	4 (99)	5 (98)	6 (97)	7 (96)	8 (95)	9 (94)	10+	Sum	Biomass ('000 t)
5-9	98.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	98.0	0.3
10-15	2865.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2865.2	46.0
15-20	28.5	63.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	92.2	4.1
20-25	0.0	12.4	47.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.0	5.6
25-30	0.0	3.4	186.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	190.3	32.5
30-35	0.0	0.0	103.8	34.4	0.0	0.0	0.0	0.0	0.0	0.0	138.2	39.0
35-40	0.0	0.0	32.8	35.7	1.3	0.0	0.0	0.0	0.0	0.0	69.8	30.3
40-45	0.0	0.0	4.6	30.8	1.5	0.2	0.0	0.0	0.0	0.0	37.1	23.4
45-50	0.0	0.0	1.2	21.3	15.9	0.3	0.0	0.0	0.0	0.0	38.7	34.0
50-55	0.0	0.0	0.0	6.2	34.4	4.3	0.0	0.0	0.0	0.0	44.9	53.4
55-60	0.0	0.0	0.0	1.1	29.3	17.6	0.5	0.0	0.0	0.0	48.5	75.7
60-65	0.0	0.0	0.0	0.0	8.2	27.4	2.3	0.0	0.0	0.0	37.9	76.0
65-70	0.0	0.0	0.0	0.0	0.4	14.6	5.4	0.3	0.0	0.0	20.6	52.1
70-75	0.0	0.0	0.0	0.0	0.0	2.3	6.0	0.7	0.0	0.0	9.0	28.2
75-80	0.0	0.0	0.0	0.0	0.0	0.6	3.1	1.3	0.1	0.0	5.2	19.9
80-85	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.3	0.1	0.0	2.2	9.9
85-90	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.9	0.2	0.0	1.4	7.8
>90	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.5	0.5	0.2	1.2	8.1
sum	2991.7	79.1	377.0	129.7	91.1	67.3	18.3	4.9	1.0	0.2	3760.3	
Biomass	41.9	6.5	86.0	73.8	118.6	133.3	54.3	22.9	6.8	2.2		546.2

Table 6.6. COD. Abundance indices from bottom trawl hauls for main areas of the Barents Sea winter 2003 (numbers in millions.)

	Age (year-class)										
Area	1 (02)	2 (01)	3 (00)	4 (99)	5 (98)	6 (97)	7 (96)	8 (95)	9 (94)	10+	Biomass
A	12.5	0.3	8.9	8.2	18.9	19.8	4.2	1.1	0.3	0.1	91.1
B	1.5	0.3	0.8	2.8	5.1	11.5	4.2	1.6	0.3	0.1	58.4
C	10.7	0.1	2.0	2.4	4.5	4.1	1.3	0.2	0.1	0.0	23.3
D	935.1	5.7	306.6	101.2	43.4	23.4	6.2	1.4	0.3	0.0	267.4
D'	1885.1	59.4	4.6	0.0	0.1	0.1	0.0	0.0	0.0	0.0	34.2
E	73.2	2.2	3.6	1.2	2.7	0.3	0.3	0.1	0.0	0.0	9.4
S	73.7	11.2	50.4	13.9	16.4	8.2	2.1	0.6	0.1	0.0	65.1
ABCD	959.7	6.4	318.4	114.5	71.8	58.7	15.9	4.2	1.0	0.2	440.2
Total	2991.7	79.1	377.0	129.7	91.1	67.3	18.3	4.9	1.0	0.2	546.3
BINW	54.1	3.9	7.7	0.5	0.4	0.0	0.0	0.1	0.0	0.0	3.9

Table 6.7. COD. Abundance indices from bottom trawl surveys in the Barents Sea winter 1981-2003 (numbers in millions). 1981-1992 includes only main areas A, B, C and D).

	Age											Biomass
Year	1	2	3	4	5	6	7	8	9	10+	Total	('000 t)
1981	4.6	34.3	16.4	23.3	40.0	38.4	4.8	1.0	0.3	0	163.1	203
1982	0.8	2.9	28.3	27.7	23.6	15.5	16.0	1.4	0.2	0	116.4	174
1983	152.9	13.4	25.0	52.3	43.3	17.0	5.8	3.2	1.0	0.1	314.0	220
1984	2755.0	379.1	97.5	28.3	21.4	11.7	4.1	0.4	0.1	0.1	3297.7	310
1985	49.5	660.0	166.8	126.0	19.9	7.7	3.3	0.2	0.1	0.1	1033.6	421
1986	665.8	399.6	805.0	143.9	64.1	8.3	1.9	0.3	0	0	2088.9	639
1987	30.7	445.0	240.4	391.1	54.3	15.7	2.0	0.5	0	0	1179.7	398
1988	3.2	72.8	148.0	80.5	173.3	20.5	3.6	0.5	0	0	502.4	285
1989	8.2	15.6	46.4	75.9	37.8	90.2	9.8	0.9	0.1	0.1	285.0	271
1990	207.2	56.7	28.4	34.9	34.6	20.6	27.2	1.6	0.4	0	411.6	246
1991	460.5	220.1	45.9	33.7	25.7	21.5	12.2	12.7	0.6	0	832.9	352
1992	126.6	570.9	158.3	57.7	17.8	12.8	7.7	4.3	2.7	0.2	959.0	383
1993	534.5	420.4	273.9	140.1	72.5	15.8	6.2	3.9	2.2	2.4	1471.9	565
1994	1035.9	535.8	296.5	310.2	147.4	50.6	9.3	2.4	1.6	1.3	2391.0	761
1995	5253.1	541.5	274.6	241.4	255.9	76.7	18.5	2.4	0.8	1.1	6666.0	943
1996	5768.5	707.6	170.0	115.4	137.2	106.1	24.0	2.9	0.4	0.5	7032.6	701
1997*	4815.5	1045.1	238.0	64.0	70.4	52.7	28.3	5.7	0.9	0.5	6321.1	495
1998*	2418.5	643.7	396.0	181.3	36.5	25.9	17.8	8.6	1.0	0.5	3729.8	429
1999	484.6	340.1	211.8	173.2	58.1	13.4	6.5	5.1	1.2	0.4	1294.4	318
2000	128.8	248.3	235.2	132.1	108.3	26.9	4.3	2.0	1.2	0.4	887.5	356
2001	657.9	76.6	191.1	182.8	83.4	38.2	8.9	1.1	0.4	0.2	1240.6	428
2002	35.3	443.9	88.3	135.0	109.6	42.5	15.1	2.4	0.3	0.2	872.6	441
2003	2991.7	79.1	377.0	129.7	91.1	67.3	18.3	4.9	1.0	0.2	3760.3	546

* Indices raised to also represent the Russian EEZ.

6.3 Growth

Table 6.8 and 6.10 show length and weight by age for each main area. In most years the largest fish at age has been observed in the south-western main areas (A, B and C). For age 8 there are few observations in main areas D' and E, and those mean lengths and weights are therefore more uncertain.

Tables 6.9 and 6.11 present the time series for mean length (1978-2003) and mean weight (1983-2003) at age for the entire investigated area. Weights at age were fairly low in the period 1995-2000, but increased somewhat in 2001. Mean length and weight for ages 3 and 4 in 2003 are less than in 2001 and 2002. For these ages the 2003 weights are well below the 1983-2001 average. For older fish the 2002 weights are at about the 1983-2001 average. The annual weight increments for ages 3-6 observed over the last year are less than in the two proceeding years (Table 6.12).

Table 6.8. COD. Length (cm) at age in main areas of the Barents Sea winter 2003.

Area	Age (year-class)							
	1 (02)	2 (01)	3 (00)	4 (99)	5 (98)	6 (97)	7 (96)	8 (95)
A	11.6	21.7	33.4	45.9	54.5	61.5	70.6	81.0
B	10.0	23.8	37.9	48.4	54.9	63.2	69.6	76.8
C	11.3	23.6	33.1	45.6	55.9	62.5	72.4	82.7
D	12.0	23.8	28.7	37.7	52.6	61.6	71.0	84.2
D'	12.0	21.3	27.7		61.0	65.0		
E	12.2	19.7	29.2	42.7	55.3	70.5	74.6	88.0
S	12.0	20.2	30.2	43.3	52.1	58.7	66.8	79.7
Total	12.0	21.2	29.1	39.2	53.3	61.6	70.3	80.7
BINW	11.7	19.0	31.6	43.3	51.3			76.0

Table 6.9. COD. Length (cm) at age in the Barents Sea from the investigations winter 1978 - 2003.

Year	Age							
	1	2	3	4	5	6	7	8
1978	14.2	23.1	32.1	45.9	54.2	64.6	67.6	76.9
1979	12.8	22.9	33.1	40.0	52.3	64.4	74.7	83.0
1980	17.6	24.8	34.2	40.5	52.5	63.5	73.6	83.6
1981	17.0	26.1	35.5	44.7	52.0	61.3	69.6	77.9
1982	14.8	25.8	37.6	46.3	54.7	63.1	70.8	82.9
1983	12.8	27.6	34.8	45.9	54.5	62.7	73.1	78.6
1984	14.2	28.4	35.8	48.6	56.6	66.2	74.1	79.7
1985	16.5	23.7	40.3	48.7	61.3	71.1	81.2	85.7
1986	11.9	21.6	34.4	49.9	59.8	69.4	80.3	93.8
1987	13.9	21.0	31.8	41.3	56.3	66.3	77.6	87.9
1988	15.3	23.3	29.7	38.7	47.6	56.8	71.7	79.4
1989	12.5	25.4	34.7	39.9	46.8	56.2	67.0	83.3
1990	14.4	27.9	39.4	47.1	53.8	60.6	68.2	79.2
1991	13.6	27.2	41.6	51.7	59.5	67.1	72.3	77.6
1992	13.2	23.9	41.3	49.9	60.2	68.4	76.1	82.8
1993	11.3	20.3	35.9	50.8	59.0	68.2	76.8	85.8
1994	12.0	18.3	30.5	44.7	55.4	64.3	73.5	82.4
1995	12.7	18.7	29.9	42.0	54.1	64.1	74.8	80.6
1996	12.6	19.6	28.1	41.0	49.3	61.4	72.2	85.3
1997[1]	11.4	18.8	28.0	40.4	49.9	59.3	69.1	80.6
1998[1]	10.9	17.4	28.7	40.0	50.5	58.9	67.5	76.3
1999	12.1	18.8	29.0	40.6	50.6	59.9	70.3	78.0
2000	13.0	21.0	28.7	39.7	51.5	61.6	70.5	75.7
2001	12.0	22.5	33.1	41.6	52.2	63.1	71.2	79.2
2002	12.2	19.9	30.1	43.6	52.2	61.7	71.6	79.1
2003	12.0	21.2	29.1	39.2	53.3	61.6	70.3	80.7

1) *Adjusted lengths*

Table 6.10. COD. Weight (g) at age in main areas of the Barents Sea winter 2003.

Area	Age (year-class)							
	1 (02)	2 (01)	3 (00)	4 (99)	5 (98)	6 (97)	7 (96)	8 (95)
A	12	85	316	828	1315	1881	2852	4317
B	9	135	490	1028	1504	2228	2969	4251
C	11	111	329	866	1491	1997	3198	4774
D	15	118	224	511	1286	2017	3116	5364
D'	15	80	185		1920	2445		
E	14	63	224	643	1371	2930	3564	6076
S	13	69	234	686	1204	1724	2576	4387
Total	14	82	228	569	1302	1980	2975	4666
BINW	13	53	265	664	1141			3614

Table 6.11. COD. Weight (g) at age in the Barents Sea from the investigations winter 1983-2003.

Year	Age							
	1	2	3	4	5	6	7	8
1983	-	190	372	923	1597	2442	3821	4758
1984	23	219	421	1155	1806	2793	3777	4566
1985	-	171	576	1003	2019	3353	5015	6154
1986	-	119	377	997	1623	2926	3838	7385
1987[1]	21	65	230	490	1380	2300	3970	-
1988	24	114	241	492	892	1635	3040	4373
1989	16	158	374	604	947	1535	2582	4906
1990	26	217	580	1009	1435	1977	2829	4435
1991	18	196	805	1364	2067	2806	3557	4502
1992	20	136	619	1118	1912	2792	3933	5127
1993	9	71	415	1179	1743	2742	3977	5758
1994	13	55	259	788	1468	2233	3355	4908
1995	16	54	248	654	1335	2221	3483	4713
1996	15	62	210	636	1063	1999	3344	5514
1997[2]	12	54	213	606	1112	1790	2851	4761
1998[2]	10	47	231	579	1145	1732	2589	3930
1999	13	55	219	604	1161	1865	2981	3991
2000	17	77	210	559	1189	1978	2989	3797
2001	14	103	338	664	1257	2188	3145	4463
2002	15	68	256	747	1234	2024	3190	4511
2003	14	82	228	569	1302	1980	2975	4666

[1)] Estimated weights
[2)] Adjusted weights

Table 6.12. COD. Yearly weightincrement (g) from the investigations in the Barents Sea winter 1983 - 2003.

Year	Age						
	1-2	2-3	3-4	4-5	5-6	6-7	7-8
1983-84	-	231	783	883	1196	1335	745
1984-85	148	357	582	864	1547	2222	2377
1985-86	-	206	421	620	907	485	2370
1986-87	-	111	113	383	677	1044	-
1987-88	93	176	262	402	255	740	403
1988-89	134	260	363	455	643	947	1866
1989-90	201	422	635	831	1030	1294	1853
1990-91	170	588	784	1058	1371	1580	1673
1991-92	118	423	313	548	725	1127	1570
1992-93	51	279	560	625	830	1185	1825
1993-94	46	188	373	289	490	613	931
1994-95	41	193	395	547	753	1250	1358
1995-96	46	156	388	409	664	1123	2031
1996-97	39	151	396	476	727	852	1417
1997-98	35	177	366	539	621	799	1079
1998-99	45	172	373	582	720	1249	1402
1999-00	64	155	340	585	817	1124	816
2000-01	86	261	454	698	999	1167	1474
2001-02	54	153	409	570	767	1002	1366
2002-03	67	160	313	555	746	951	1476

6.4 Considerations and conclusion

When using the abundance indices for stock assessment it is important to be aware of all the technical changes introduced during the time series. Better acoustic equipment after 1990 has increased the quality of the indices for all age groups. The survey area was enlarged in 1993. This led to higher indices, especially for the youngest age groups, and the indices also became more accurate all over. The introduction of more fine meshed cod-ends in 1994 and fish length dependent fishing width of the trawl (the time series is adjusted for this) did also lead to more small fish relative to larger fish. Over the past 8-10 years the acoustic and swept are indices of cod have been in reasonable agreement and indicated a similar development. The 2003 acoustic indices are substantially higher than the swept area indices for age 5 and older. Most likely the acoustic estimates are biased upwards due to over-representation of dense near-shore concentrations (Section 6.1).

Table 6.13 gives the time series of survey based mortalities (log ratios between survey indices of the same year class in two successive years) since 1993. These mortalities are influenced both by natural and fishing mortality, as well as the true catchability at age for the survey. In the period 1993-1999 there was an increasing trend in the survey mortalities. The trend appears most consistent for the age groups 3-7 in the swept area estimates. The three latest surveys indicate

that since 1999 the mortalities have decreased, for most ages. Presumably the mortality of the youngest age groups (ages 1-3) is mainly caused by predation, while for the older age groups it is mainly caused by the fishery. Before 2001 the survey mortalities for age 4 and older were well above the mortalities estimated in the ICES assessment. Decreasing survey catchability at increasing age could be one reason for this. Another possible reason could be that the assessment does not include all sources of mortality, like discards, unreported catches, or poorly quantified predation. The 2003 survey indicates reduced mortality also for ages 5 and 6.

The observed mortality rates in the acoustic investigations have been more variable. This is explained by changes in fish behaviour and how available the fish is for acoustic registration. During the winter survey 1998 the relative abundance of cod in the bottom channel was lower than the years before, and hence the fish were more available for acoustic registration. This led to lower mortality rates of all year classes from 1997 to 1998 in the acoustic series compared with the swept area series. A similar situation is observed in 2000 compared with 1999. The negative mortalities observed from 2002 to 2003 are probably to some extent caused by sampling errors; over-representation of dense near-shore concentrations.

Table 6.13. Total mortality observed for cod during the winter survey in the Barents Sea in 1993-2003

Year	Age							
	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9
	Acoustic investigations							
1993-94	0.62	0.35	-0.12	-0.01	0.53	0.54	0.78	1.08
1994-95	1.08	1.24	0.78	0.66	1.04	1.34	1.75	1.67
1995-96	2.04	1.15	0.86	0.62	1.03	1.21	1.79	1.95
1996-97	1.72	0.59	0.59	0.36	0.84	1.21	1.64	1.39
1997-98	0.94	0.01	0.03	0.20	0.39	0.32	0.49	0.86
1998-99	2.41	1.44	1.49	1.40	1.41	1.66	1.88	2.83
1999-00	0.48	0.22	-0.06	-0.39	-0.01	0.07	0.31	0.31
2000-01	0.88	0.47	0.36	0.72	1.28	1.35	1.93	2.24
2001-02	1.07	-0.08	0.21	0.52	0.50	0.79	1.37	1.25
2002-03	-1.22	-0.34	-0.50	-0.14	-0.12	0.31	0.85	0.47
	Bottom trawl investigations							
1993-94	0.00	0.35	-0.12	-0.05	0.36	0.53	0.95	0.89
1994-95	0.65	0.67	0.21	0.19	0.65	1.01	1.35	1.10
1995-96	2.00	1.16	0.87	0.57	0.88	1.16	1.85	1.79
1996-97	1.71	1.09	0.98	0.49	0.96	1.32	1.44	1.17
1997-98	2.01	0.97	0.27	0.56	1.00	1.09	1.19	1.74
1998-99	1.96	1.11	0.83	1.14	1.00	1.38	1.25	1.97
1999-00	0.67	0.37	0.47	0.47	0.77	1.14	1.18	1.45
2000-01	0.52	0.26	0.25	0.46	1.04	1.11	1.36	1.61
2001-02	0.42	-0.29	0.37	0.51	0.62	0.93	1.31	1.30
2002-03	-0.73	0.14	-0.24	0.37	0.49	0.89	1.12	0.88

7. DISTRIBUTION AND ABUNDANCE OF HADDOCK

7.1 Acoustic estimation

As for cod it is expected that the survey best covers the immature part of the stock. At this time of the year a large proportion of the mature haddock (age 6 and older) are on its spawning migration south-westwards out of the investigated area. There are indications that the distribution of age groups 1 and 2 in some years are concentrated in coastal areas not well covered by the survey. In 2003 small haddock was widely distributed, and was found unusually far to the north as in 2002. This might be caused by rather favourably hydrographic conditions (Figure 4.2).

Table 7.1 shows the acoustic abundance indices by length and age, and table 7.2 presents the indices by age within the main areas for the pelagic layer and the bottom layer. As in most of the previous years the highest abundance was observed in main area D. The time series (1981-2003), with adjusted indices for 1997 and 1998, is presented in table 7.3. The indices for ages 1-5 are above the 1993-2002 average, while the indices for age 6 and older are below this average.

Table 7.1. HADDOCK. Abundance indices at length and age from the acoustic survey in the Barents Sea winter 2003 (numbers in millions).

	Age (year-class)											
Length cm	1 (02)	2 (01)	3 (00)	4 (99)	5 (98)	6 (97)	7 (96)	8 (95)	9 (94)	10+	Sum	Biomass ('000 t)
5-9	0.5										0.5	0
10-15	632.7										632.7	10
15-20	1655.2	15.9									1671.2	75
20-25	106.0	130.8	8.0								244.8	23
25-30		131.7	60.2	1.4							193.3	34
30-35		0.2	62.0	35.5	0.7						98.4	28
35-40			12.0	80.1	12.1						104.2	46
40-45			3.0	65.2	26.5	1.1					95.7	62
45-50				14.7	81.7	4.9	0.2				101.5	92
50-55				0.8	44.2	7.0	2.5	+	+		54.5	66
55-60					3.7	4.0	1.6			0.4	9.6	15
60-65						0.2	0.8	0.1		0.3	1.4	3
65-70						+			+	0.2	0.2	0
70-75									+	0.2	0.3	1
sum	2394.5	278.6	145.2	197.6	168.8	17.2	5.0	0.2	0.1	1.1	3208.3	
Biomass	88	34	31	99	169	22	8	0	0	5		455

Table 7.2. HADDOCK. Acoustic abundance indices in the pelagic layer (P) and in the 10 m layer above the bottom (B) for the main areas of the Barents Sea winter 2003 (numbers in millions).

		Age (year-class)										
Area	Layer	1 (02)	2 (01)	3 (00)	4 (99)	5 (98)	6 (97)	7 (96)	8 (95)	9 (94)	10+	Biomass ('000 t)
A	P	550.7	43.5	19.1	23.6	31.5	2.8	1.2	0.0	0.0	0.2	81
	B	92.7	7.8	3.1	4.0	5.9	0.5	0.2	0.0	0.0	0.0	14
B	P	196.6	14.8	3.1	5.4	20.5	4.8	1.2	0.0	0.0	0.5	48
	B	90.5	7.2	1.4	1.8	6.4	1.6	0.4	0.0	0.0	0.2	17
C	P	130.5	8.8	2.6	10.8	15.8	2.6	0.6	0.0	0.0	0.0	33
	B	24.0	1.5	0.4	1.8	2.9	0.5	0.1	0.0	0.0	0.0	6
D	P	623.8	112.9	77.4	105.9	58.3	2.1	0.9	0.1	0.0	0.1	162
	B	250.4	50.1	32.5	37.8	18.3	0.7	0.3	0.0	0.0	0.0	59
D'	P	23.2	11.0	1.5	3.1	0.2	0.0	0.0	0.0	0.0	0.0	4
	B	15.6	6.1	0.8	1.7	0.1	0.0	0.0	0.0	0.0	0.0	3
E	P	5.2	0.5	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0
	B	1.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
S	P	361.5	13.3	3.0	1.3	8.6	1.6	0.0	0.0	0.0	0.0	26
	B	28.5	0.9	0.2	0.1	0.4	0.1	0.0	0.0	0.0	0.0	2
ABCD	P	1501.5	180.1	102.1	145.8	126.1	12.3	3.9	0.1	0.0	0.8	324
	B	457.5	66.7	37.4	45.4	33.4	3.3	1.1	0.0	0.0	0.2	96
Total	P	1891.4	204.9	106.8	150.4	134.9	13.8	3.9	0.1	0.0	0.8	355
	B	503.0	73.7	38.4	47.2	33.9	3.3	1.1	0.0	0.0	0.2	100
	sum	2394.5	278.6	145.2	197.6	168.8	17.2	5.0	0.2	0.1	1.1	455
BINW	P	13.8	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1
	B	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0

Table 7.3. HADDOCK. Abundance indices from acoustic surveys in the Barents Sea winter 1981-2003 (numbers in millions). 1981-1992 includes mainly areas A, B, C and D.

	Age											Biomass
Year	1	2	3	4	5	6	7	8	9	10+	Total	('000 t)
1981	7	14	5	21	60	18	1	+	+	+	126	166
1982	9	2	3	4	4	10	6	+	+	+	38	50
1983	0	5	2	3	1	1	4	2	+	+	18	25
1984	1685	173	6	2	1	+	+	+	+	+	1867	101
1985	1530	776	215	5	+	+	+	+	+	+	2526	259
1986	556	266	452	189	+	+	+	+	+	+	1463	333
1987	85	17	49	171	50	+	+	+	0	+	372	157
1988	18	4	8	23	46	7	+	0	0	+	106	56
1989	52	5	6	11	20	21	2	0	0	0	117	49
1990	270	35	3	3	4	7	11	2	+	+	335	51
1991	1890	252	45	8	3	3	3	6	+	0	2210	166
1992	1135	868	134	23	2	+	+	1	2	+	2165	239
1993	947	626	563	130	13	+	+	+	+	3	2282	385
1994	562	193	255	631	111	12	+	+	+	+	1764	573
1995	1379	285	36	111	387	42	2	+	+	+	2242	466
1996	249	229	44	31	76	151	8	+	0	+	788	280
1997*	693	24	51	17	12	43	43	2	+	+	885	155
1998*	220	122	20	28	12	5	13	16	1	+	437	92
1999	856	46	57	13	14	4	1	2	2	+	994	81
2000	1024	509	32	65	19	11	2	1	2	+	1664	185
2001	976	316	210	23	22	1	1	+	+	1	1549	175
2002	2062	282	216	149	14	12	1	+	+	1	2737	264
2003	2394	279	145	198	169	17	5	+	+	1	3208	455

* Indices raised to also represent the Russian EEZ.

7.2 Swept area estimation

Figs. 7.1 - 7.4 show the geographic distribution of bottom trawl catch rates (number of fish per 3 n.mile, corresponding to 1 hours towing) for haddock for each of the size groups < 20 cm, 20-34 cm, 35-49 cm and > 50 cm. As in the two previous years, the distribution extends further to the north than usual, especially for the size groups <20 cm.

Table 7.4 presents the abundance indices by 5 cm length groups for each main area. Standard error and coefficient of variation (CV) are also given.

Table 7.5 shows the abundance indices by age- and length groups, and table 7.6 presents the indices for each age group by main areas. The time series (1981-2003) is shown in table 7.7. The indices for 1997 and 1998 are adjusted the same way as for cod to also represent the Russian EEZ. The swept area index of age 1 is at the level of the 1983 year class which was the highest in the time series, while the abundance of ages 2-4 are comparable to the 2002 results and are above the 10 years mean (1993-2002). Also the value for age 5 is above that mean.

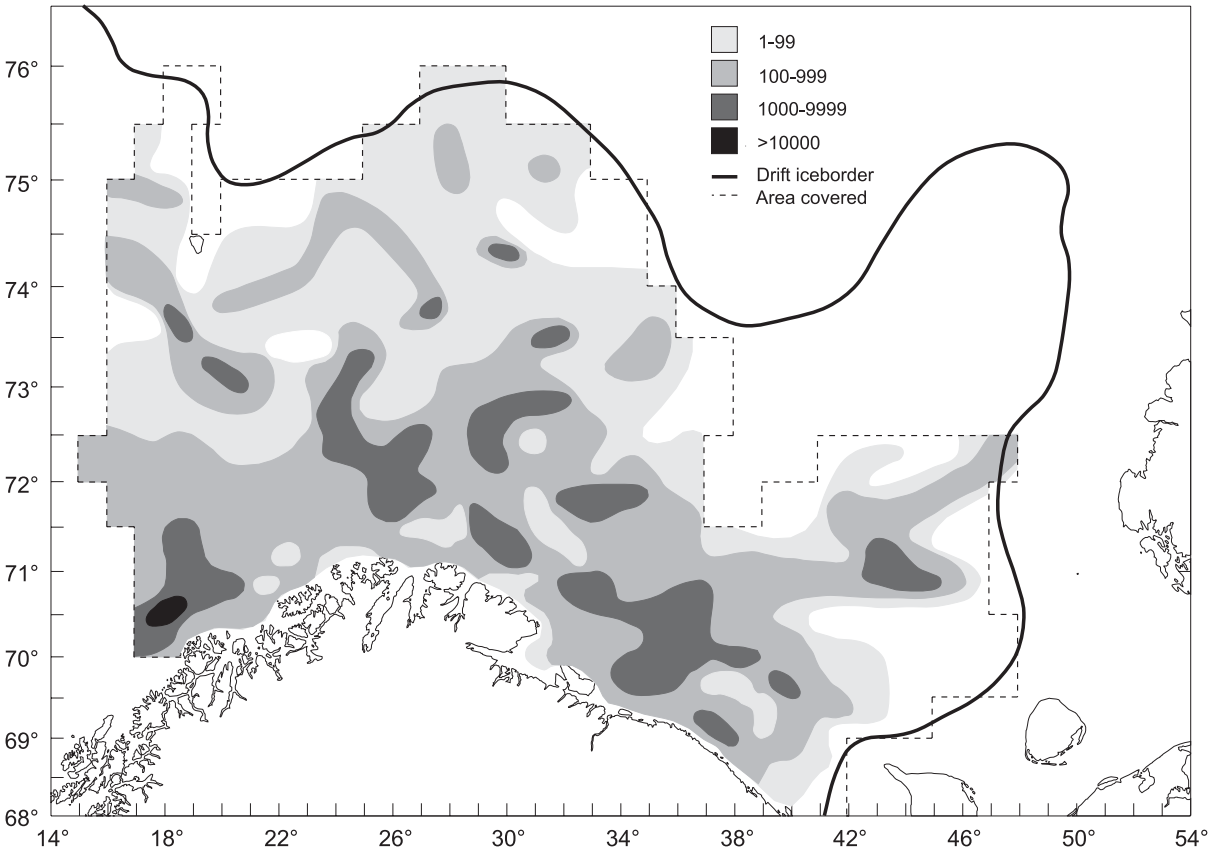

Figure 7.1. HADDOCK < 20 cm. Distribution in the trawl catches winter 2003 (number per hour trawling).

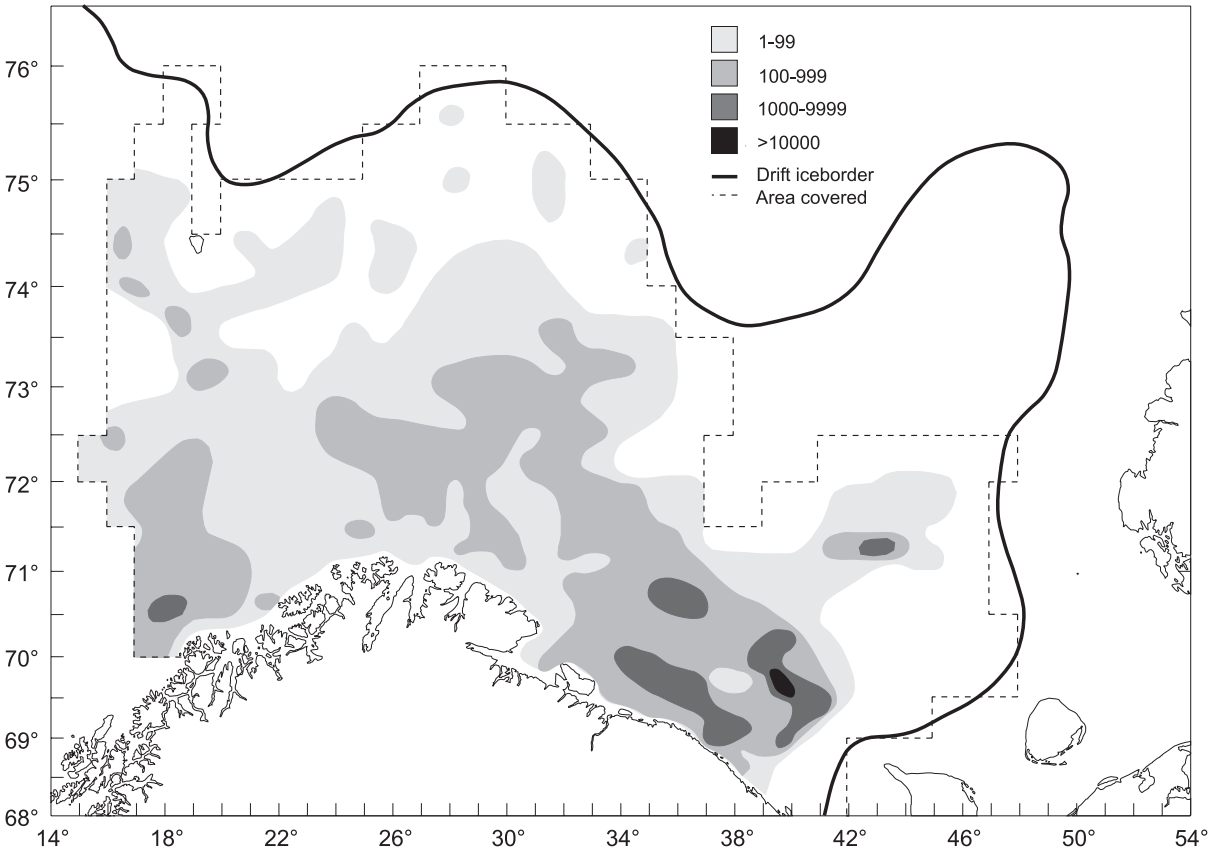

Figure 7.2. HADDOCK 20-34 cm. Distribution in the trawl catches winter 2003 (number per hour trawling).

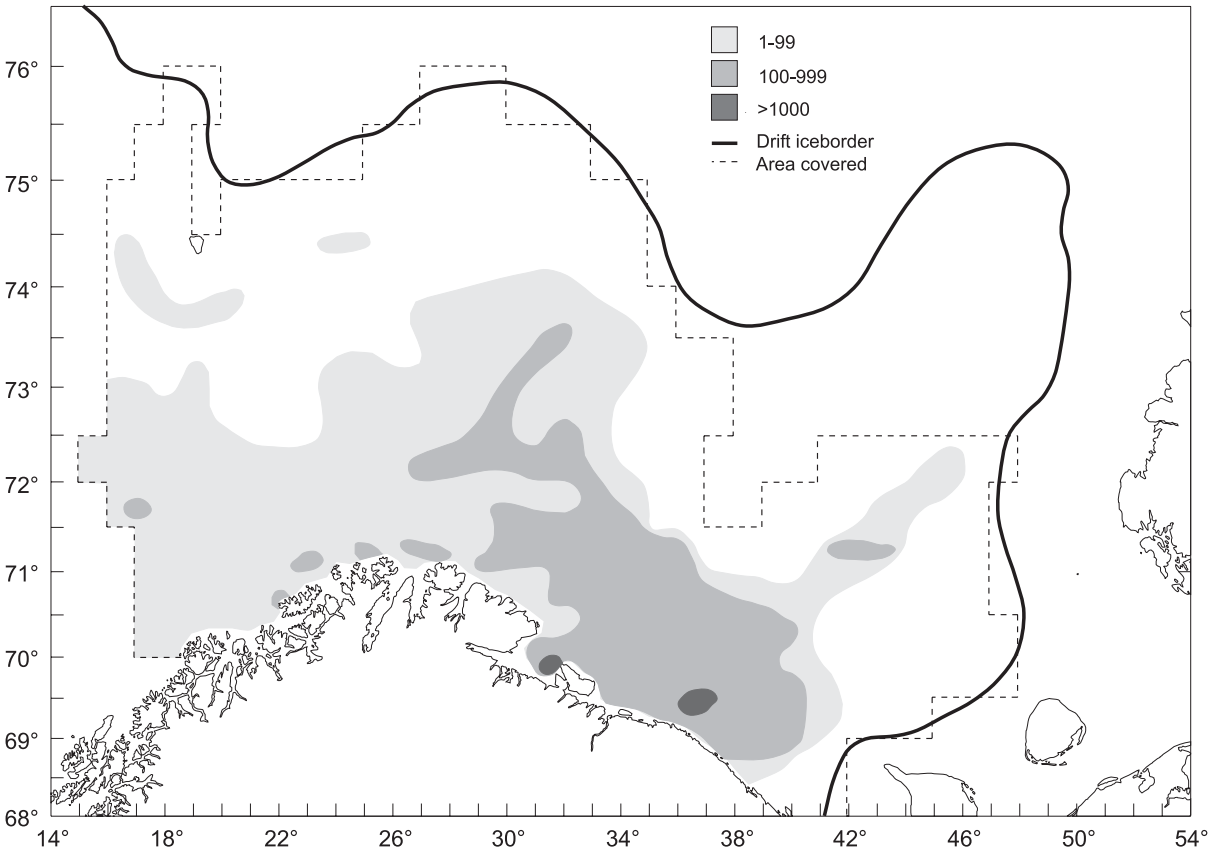

Figure 7.3. HADDOCK 35-49 cm. Distribution in the trawl catches winter 2003 (number per hour trawling).

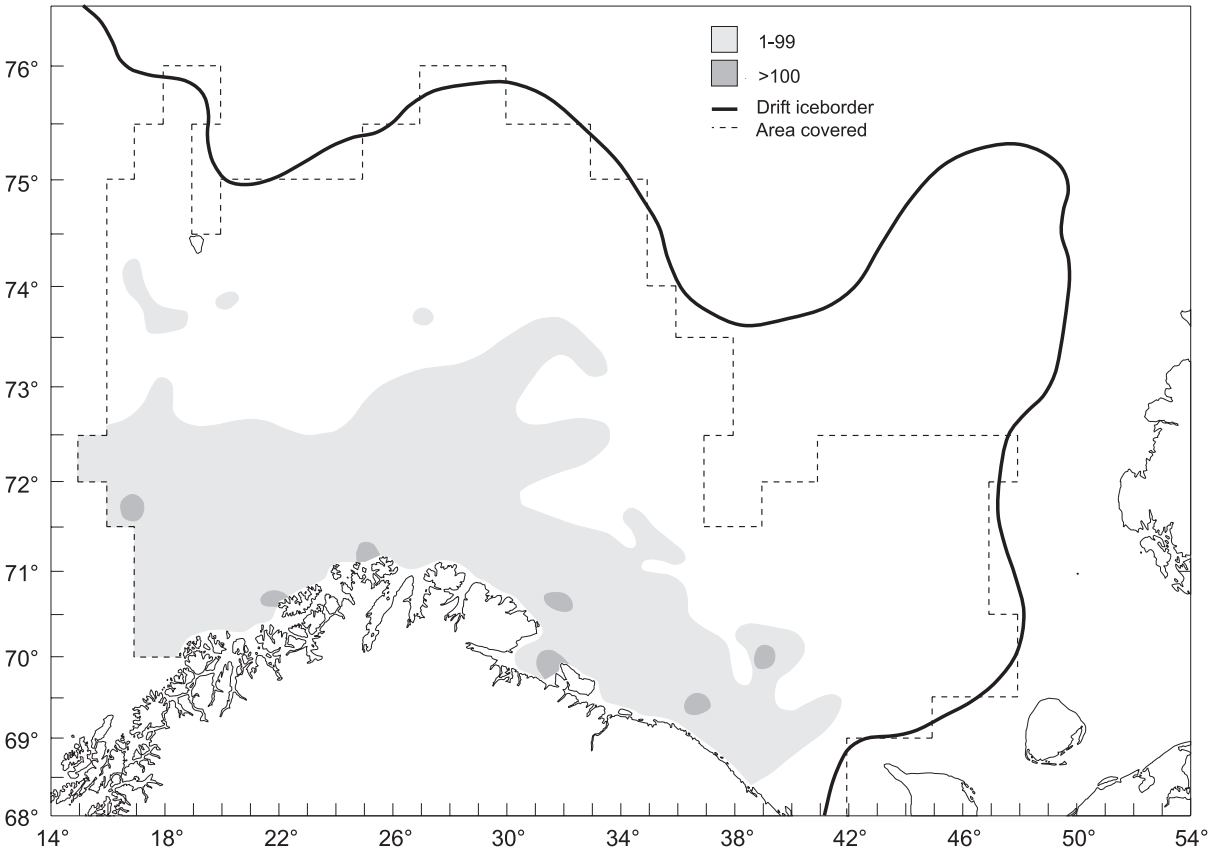

Figure 7.4. HADDOCK > 50 cm. Distribution in the trawl catches winter 2003 (number per hour trawling).

Table 7.4. HADDOCK. Abundance indices (I) at length with standard error of mean (S) from bottom trawl hauls for main areas of the Barents Sea winter 2003 (no. in mill).

Length	Area																
	A		B		C		D		D'		E		S		Total		
cm	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	CV (%)
5-9							0.1	0.1							0.1	0.1	100.0
10-14	175.8	37.6	36.9	24.7	61.9	31.2	431.2	65.6	157.5	99.9	1.7	1.3	63.1	18.3	928.0	132.7	14.3
15-19	423.8	66.9	478.7	280.7	136.7	54.0	993.2	128.9	158.1	123.3	2.3	1.3	146.8	38.9	2339.5	345.8	14.8
20-24	50.6	10.2	99.1	49.9	11.2	3.6	227.4	48.6	5.5	5.2	0.6	0.4	11.8	3.9	406.2	70.8	17.4
25-29	15.2	2.9	3.7	1.5	4.8	1.7	369.7	134.1	9.7	9.5			2.3	0.8	405.3	134.4	33.2
30-34	8.0	1.5	1.1	0.4	1.2	0.3	125.3	30.2	3.6	3.6			0.7	0.3	139.7	30.5	21.8
35-39	5.7	1.2	0.9	0.3	1.3	0.3	73.1	7.4	1.0	0.9			0.5	0.2	82.5	7.5	9.1
40-44	5.6	1.2	1.5	0.5	2.4	0.5	50.2	4.6	0.3	0.3			0.3	0.2	60.3	4.9	8.1
45-49	6.8	1.4	5.3	1.6	3.3	0.7	27.7	3.0	0.0	0.0			0.1	0.1	43.3	3.8	8.7
50-54	5.0	1.7	4.2	1.2	1.5	0.3	7.5	1.3	0.0	0.0			0.1	0.0	18.3	2.4	13.2
55-59	0.7	0.2	1.2	0.4	0.2	0.1	0.4	0.1					0.0	0.0	2.5	0.5	18.2
60-64	0.2	0.1	0.2	0.1	0.0	0.0	0.1	0.1							0.5	0.1	23.9
65-69	+	+	0.1	+	0.0		0.1	0.0							0.1	0.1	45.3
70-74	+	+	+	+	+	+	+	+							0.1	0.1	53.3
75-79																	
80-84																	
85-89																	
>90																	
Sum	697.4	77.5	633.0	286.2	224.5	62.5	2305.7	205.5	335.7	159.1	4.6	1.9	225.7	43.1	4426.4	401.6	9.1

Table 7.5. HADDOCK. Abundance indices at length and age from the bottom trawl survey in the Barents Sea winter 2003 (numbers in millions).

	Age (year-class)											
Length cm	1 (02)	2 (01)	3 (00)	4 (99)	5 (98)	6 (97)	7 (96)	8 (95)	9 (94)	10+	Sum	Biomass ('000 t)
5-9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
10-15	928.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	928.0	15.8
15-20	2300.6	39.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2339.5	109.5
20-25	103.4	251.2	51.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	406.2	40.4
25-30	0.0	222.8	181.7	0.8	0.0	0.0	0.0	0.0	0.0	0.0	405.3	73.6
30-35	0.0	0.1	77.4	62.1	0.2	0.0	0.0	0.0	0.0	0.0	139.7	41.9
35-40	0.0	0.0	6.4	71.0	5.1	0.0	0.0	0.0	0.0	0.0	82.5	38.0
40-45	0.0	0.0	0.3	41.2	18.4	0.5	0.0	0.0	0.0	0.0	60.3	40.4
45-50	0.0	0.0	0.0	6.4	33.9	2.9	0.1	0.0	0.0	0.0	43.3	40.5
50-55	0.0	0.0	0.0	0.6	15.0	1.2	1.3	0.1	0.1	0.0	18.3	23.1
55-60	0.0	0.0	0.0	0.0	1.1	0.9	0.5	0.0	0.0	0.0	2.5	4.1
60-65	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.1	0.0	0.1	0.5	1.2
65-70	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.4
70-75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.3
75-80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80-85	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
85-90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
>90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
sum	3332.1	513.1	317.4	182.0	73.6	5.5	2.3	0.2	0.1	0.2	4426.4	
Biomass	126.6	65.2	64.1	89.7	72.2	6.6	3.7	0.3	0.3	0.5		429.1

Table 7.6 HADDOCK. Abundance indices from bottom trawl hauls for main areas of the Barents Sea winter 2003 (numbers in millions).

	Age (year-class)										
Area	1 (02)	2 (01)	3 (00)	4 (99)	5 (98)	6 (97)	7 (96)	8 (95)	9 (94)	10+	Biomass
A	610.1	50.2	11.0	10.8	12.8	1.5	0.9	0.0	0.1	0.0	52.9
B	572.0	34.6	12.0	2.8	9.3	1.2	1.0	0.0	0.0	0.1	47.4
C	201.3	13.1	1.1	3.5	4.6	0.8	0.1	0.0	0.0	0.0	17.1
D	1435.0	370.5	288.0	163.1	46.5	2.0	0.3	0.1	0.0	0.1	283.3
D'	299.8	31.0	3.6	1.2	0.0	0.0	0.0	0.0	0.0	0.0	16.6
E	4.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
S	209.9	13.1	1.8	0.6	0.3	0.0	0.0	0.0	0.0	0.0	9.4
ABCD	2818.4	468.4	312.0	180.2	73.3	5.5	2.3	0.1	0.1	0.2	400.7
Total	3332.0	513.1	317.4	182.0	73.6	5.5	2.3	0.1	0.2	0.2	426.8
BINW	124.3	2.4	0.5								5.1

Table 7.7. HADDOCK. Abundance indices from bottom trawl surveys in the Barents Sea winter 1981-2003 (numbers in millions). 1981-1992 includes only main areas A, B, C and D.

	Age											Biomass
Year	1	2	3	4	5	6	7	8	9	10+	Total	('000 t)
1981	3.1	7.3	2.3	7.8	1.8	5.3	0.5	0.2	0.0	0.0	28.3	26
1982	3.9	1.5	1.7	1.8	1.9	4.8	2.4	0.2	0.0	0.0	18.2	23
1983	2919.3	4.8	3.1	2.4	0.9	1.9	2.5	0.7	0.0	0.0	2935.6	170
1984	3832.6	514.6	18.9	1.5	0.8	0.2	0.1	0.4	0.1	0.0	4369.2	249
1985	1901.1	1593.8	475.9	14.7	0.5	0.5	0.1	0.1	0.4	0.3	3987.4	507
1986	665.0	370.3	384.6	110.8	0.6	0.2	0.1	0.1	0.1	0.1	1531.9	271
1987	163.8	79.9	154.4	290.2	52.9	0.0	0.0	0.0	0.0	0.3	741.5	261
1988	35.4	15.3	25.3	68.9	116.4	13.8	0.1	0.0	0.0	0.0	275.2	142
1989	81.2	9.5	14.1	21.6	34.0	32.7	3.4	0.1	0.0	0.0	196.6	82
1990	644.1	54.6	4.5	3.4	5.0	9.2	11.8	1.8	0.0	0.0	734.4	72
1991	2006.0	300.3	33.4	5.1	4.2	2.7	1.7	4.2	0.0	0.0	2357.6	165
1992	1659.4	1375.5	150.5	24.4	2.1	0.6	0.7	1.6	2.3	0.0	3217.1	337
1993	727.9	599.0	507.7	105.6	10.5	0.6	0.4	0.3	0.4	1.1	1953.5	336
1994	603.2	228.0	339.5	436.6	49.7	3.4	0.2	0.1	0.2	0.6	1661.5	417
1995	1463.6	179.3	53.6	171.1	339.5	34.5	2.8	0.0	0.1	0.0	2244.5	444
1996	309.5	263.6	52.5	48.1	148.6	252.8	11.6	0.9	0.0	0.1	1087.7	461
1997*	1268.0	67.9	86.1	28.0	19.4	46.7	62.2	3.5	0.1	0.0	1581.9	226
1998*	212.9	137.9	22.7	33.2	13.2	3.4	8.0	8.1	0.7	0.1	440.2	78
1999	1244.9	57.6	59.8	12.2	10.2	2.8	1.0	1.7	1.1	0.0	1391.3	86
2000	847.2	452.2	27.2	35.4	8.4	4.0	0.8	0.3	0.7	0.2	1376.4	126
2001	1220.5	460.3	296.0	29.3	25.1	1.7	0.9	0.1	0.1	0.3	2034.3	232
2002	1680.3	534.7	314.7	185.3	17.6	8.2	0.8	0.3	+	0.3	2742.2	316
2003	3332.1	513.1	317.4	182.0	73.6	5.5	2.3	0.2	0.1	0.2	4426.5	429

[1)] Indices raised to also represent the Russian EEZ.

7.3 Growth

Mean length and weight at age for each main area are shown in table 7.8 and 7.10.

The time series (1983-2003, tables 7.9 and 7.11) shows that the slightly increasing trend over the years 1997-2000 has stopped, and for several age groups a decrease is observed in recent years along with the increase in abundance.

Table 7.8. HADDOCK. Length (cm) at age in main areas of the Barents Sea winter 2003.

Area	Age (year-class)							
	1 (02)	2 (01)	3 (00)	4 (99)	5 (98)	6 (97)	7 (96)	8 (95)
A	16.4	22.5	30.4	37.2	47.4	48.9	55.8	
B	17.8	22.6	24.4	38.3	48.8	53.0	54.8	64.0
C	16.3	23.8	32.3	39.9	47.1	49.2	57.6	74.0
D	16.1	24.6	28.0	37.1	45.7	48.2	51.0	58.7
D'	24.9	39.3	53.0					
E	14.9	21.0						
S	15.9	22.1	29.0	38.6	45.3	50.0	57.0	
Total	16.5	24.1	28.0	37.2	46.5	49.6	54.7	59.4
BINW	16.4	23.4	29.0					

Table 7.9. HADDOCK. Length (cm) at age in the Barents Sea from the investigations winter 1983 – 2003.

Year	Age						
	1	2	3	4	5	6	7
1983	16.8	25.2	34.9	44.7	52.5	58.0	62.4
1984	16.6	27.5	32.7	-	56.6	62.4	61.8
1985	15.7	23.9	35.6	41.9	58.5	61.9	63.9
1986	15.1	22.4	31.5	43.0	54.6	-	-
1987	15.4	22.4	29.2	37.3	46.5	-	-
1988	13.5	24.0	28.7	34.7	41.5	47.9	54.6
1989	16.0	23.2	31.1	36.5	41.7	46.4	52.9
1990	15.7	24.7	32.7	43.4	46.1	50.1	52.4
1991	16.8	24.0	35.7	44.4	52.4	54.8	55.6
1992	15.1	23.9	33.9	45.5	53.1	59.2	60.6
1993	14.5	21.4	31.8	42.4	50.6	56.1	59.4
1994	14.7	21.0	29.7	38.5	47.8	54.2	56.9
1995	15.4	20.1	28.7	34.2	42.8	51.2	55.8
1996	15.4	21.6	28.6	37.8	42.0	46.7	55.3
1997[1]	16.1	21.1	27.7	35.4	39.7	47.5	50.1
1998[1]	14.4	22.9	29.2	35.8	41.3	48.4	50.9
1999	14.7	20.8	32.3	39.4	45.5	52.3	54.6
2000	15.8	22.5	30.3	41.6	47.7	50.8	51.1
2001	14.6	22.2	32.2	37.8	47.2	51.2	58.7
2002	15.5	21.1	29.6	40.2	44.2	50.9	58.4
2003	16.5	24.1	28.0	37.2	46.5	49.6	54.7

[1)] Adjusted lengths

Table 7.10. HADDOCK. Weight (g) at age in main areas of the Barents Sea winter 2003.

Area	Age (year-class)							
	1 (02)	2 (01)	3 (00)	4 (99)	5 (98)	6 (97)	7 (96)	8 (95)
A	37	98	272	514	1052	1112	1696	
B	46	101	135	604	1137	1500	1678	2801
C	36	119	311	594	1018	1153	1869	
D	35	134	201	487	925	1077	1135	1796
D'	*35*	151	*201*	499				
E	26	86						
S	33	100	244	553	1012	1642	1668	
Total	38	127	202	493	981	1189	1613	1925
BINW	38	107	229					

Table 7.11. HADDOCK. Weight (g) at age in the Barents Sea from the investigations winter 1983 - 2003.

	Age						
Year	1	2	3	4	5	6	7
1983	52	133	480	1043	1641	2081	2592
1984	36	196	289	964	1810	2506	2240
1985	35	138	432	731	1970	2517	-
1986	47	100	310	734	-	-	-
1987[1]	24	91	273	542	934	-	-
1988	23	139	232	442	743	1193	1569
1989	43	125	309	484	731	1012	1399
1990	34	148	346	854	986	1295	1526
1991	41	138	457	880	1539	1726	1808
1992	32	136	392	949	1467	2060	2274
1993	26	93	317	766	1318	1805	2166
1994	25	86	250	545	1041	1569	1784
1995	30	71	224	386	765	1286	1644
1996	30	93	220	551	741	1016	1782
1997[2]	35	88	200	429	625	1063	1286
1998[2]	25	112	241	470	746	1169	1341
1999	27	85	333	614	947	1494	1616
2000	32	108	269	720	1068	1341	1430
2001	28	106	337	556	1100	1429	2085
2002	30	84	144	623	848	1341	2032
2003	38	127	202	493	981	1189	1613

1) Estimated weights
2) Adjusted weights

Table 7.12. HADDOCK. Yearly weight increment (g) from the investigations in the Barents Sea winter 1983 - 2003.

	Age					
Year	1-2	2-3	3-4	4-5	5-6	6-7
1983-84	144	156	484	767	865	159
1984-85	102	236	442	1006	707	-
1985-86	65	172	302	-	-	-
1986-87	44	173	232	200	-	-
1987-88	115	141	169	201	259	-
1988-89	102	170	252	289	269	206
1989-90	105	221	545	502	564	514
1990-91	104	309	534	685	740	513
1991-92	95	254	492	587	521	548
1992-93	61	181	374	369	338	106
1993-94	60	157	228	275	251	-
1994-95	46	138	136	220	245	75
1995-96	63	149	327	355	251	496
1996-97	58	107	209	74	322	270
1997-98	77	153	270	317	544	278
1998-99	60	221	373	477	748	447
1999-00	81	184	387	454	394	-64
2000-01	74	229	287	380	371	744
2001-02	56	138	286	292	241	603
2002-03	97	118	249	358	341	272

7.4 Conclusion

Survey mortalities based on the acoustic indices (tables 7.13) have varied between years, and for most age groups there is no obvious trend. However, as for cod, negative mortalities were experienced from 2002 to 2003 for some age groups (the 1998 and 1999 year classes). Mortalities based on the swept area indices show a decreasing trend since 1998 (table 7.13).

Concerning the abundance indices it can be concluded that the recruitment to the stock is improving. All the year classes 1998-2003 are above average. The indices for the oldest age groups (6 and older) are, however, rather low. Mean lengths and weights at age are close to previous year's values.

Table 7.13. Total mortality observed for haddock during the winter survey in the Barents Sea for the period 1993-2003.

Year	Age						
	1-2	2-3	3-4	4-5	5-6	6-7	7-8
	Acoustic investigations						
1993-94	1.59	0.90	-0.11	0.16	0.08	-	-
1994-95	0.68	1.68	0.83	0.49	0.97	1.79	-
1995-96	1.80	1.87	0.15	0.38	0.94	1.66	-
1996-97	2.34	1.50	0.95	0.95	0.57	1.26	1.39
1997-98	1.74	0.18	0.60	0.35	0.88	1.20	0.99
1998-99	1.56	0.76	0.43	0.69	1.10	1.61	1.87
1999-00	0.52	0.36	-0.13	-0.38	0.24	0.69	0.00
2000-01	1.18	0.89	0.33	1.10	2.68	2.50	2.96
2001-02	1.24	0.38	0.34	0.54	0.61	0.24	1.57
2002-03	2.00	0.66	0.09	-0.12	-0.24	0.85	1.68
	Bottom trawl investigations						
1993-94	1.16	0.57	0.15	0.75	1.13	1.10	1.39
1994-95	1.21	1.45	0.69	0.25	0.37	0.19	-
1995-96	1.71	1.23	0.11	0.14	0.29	1.09	1.13
1996-97	1.52	1.12	0.63	0.91	1.16	1.40	1.20
1997-98	2.22	1.10	0.95	0.75	1.74	1.76	2.04
1998-99	1.31	0.84	0.62	1.18	1.55	1.22	1.55
1999-00	1.01	0.75	0.52	0.37	0.94	1.25	1.20
2000-01	0.61	0.42	-0.07	0.34	1.60	1.49	2.08
2001-02	0.83	0.38	0.47	0.51	1.12	0.75	1.10
2003-03	1.19	0.52	0.55	0.92	1.16	1.27	1.39

8. DISTRIBUTION AND ABUNDANCE OF REDFISH

8.1 Acoustic estimation

Earlier reports from this survey has presented distribution maps and abundance indices based on acoustic observations of redfish. In recent years blue whiting has dominated the acoustic records in some of the main redfish areas. Due to incomplete pelagic trawl sampling the splitting of acoustic records between blue whiting and redfish has been very uncertain. The uncertainty relates mainly to the redfish, since it only make up a very minor proportion of the total value. This was also the case in 2003, and the acoustic results for redfish are therefore not included in the report.

8.2 Swept area estimation

The swept area time series for redfish (tables 8.3 and 8.4) are based on catch data from trawls with bobbins gear until 1988 inclusive, and rockhopper gear since 1989. The time series has not been adjusted for this change.

Fig. 8.1 shows the geographical distribution of ***S. marinus*** based on the catch rates in bottom trawl. The distribution is very similar to 2002. Table 8.1 presents swept area indices by 5 cm length groups with standard error for each main area in addition to the coefficient of variation for the total area.

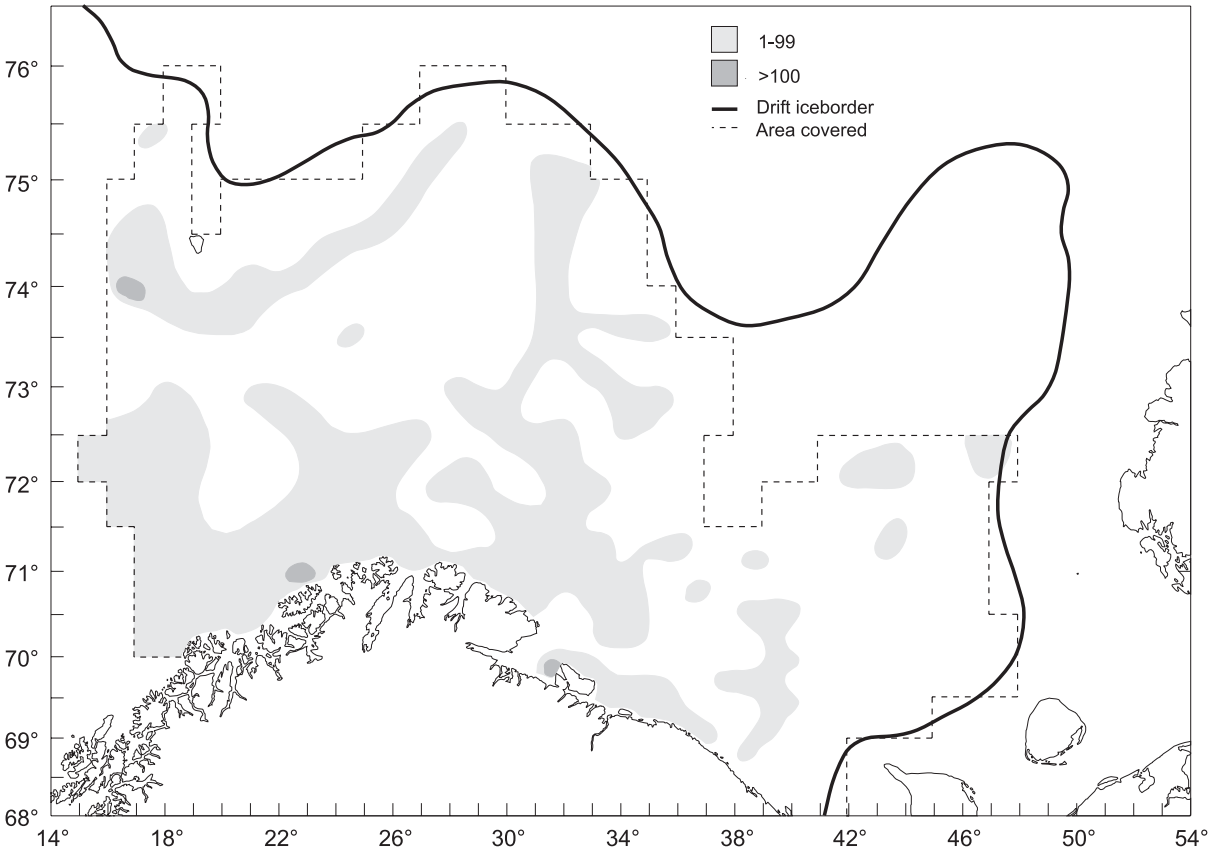

Figure 8.1. *Sebastes marinus*. Distribution in the trawl catches winter 2003 (no. per hour trawling).

The time series for 1986-2003 (table 8.3), with adjusted indices for 1997 and 1998, shows historic low indices for most of the length-groups, and the lowest total index ever observed. There are no signs of improved recruitment.

Table 8.1. SEBASTES MARINUS. Abundance indices (I) at length with standard error of mean (S) from bottom trawl hauls for main areas of the Barents Sea winter 2003 (numbers in millions).

	Area															
Length	A		B		C		D		D'		E		S		Total		
cm	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	CV (%)
5-9																	
10-14					0.05	0.02	0.33	0.12	0.06	0.06					0.45	0.14	30.3
15-19	0.05	0.04	0.45	0.37	0.04	0.03	0.56	0.22					0.15	0.08	1.24	0.45	35.9
20-24	0.12	0.06	0.77	0.46	0.01	0.01	0.40	0.12			0.08	0.05	0.16	0.07	1.54	0.49	31.8
25-29	0.14	0.07	1.15	0.76	0.07	0.03	1.03	0.32			0.65	0.50	1.25	0.44	4.29	1.06	24.8
30-34	0.20	0.09	1.09	0.56	0.26	0.14	0.72	0.25			0.24	0.20	1.32	0.60	3.82	0.89	23.4
35-39	0.47	0.19	1.19	0.26	0.25	0.11	0.34	0.10					0.42	0.19	2.68	0.4	15.1
40-44	0.54	0.33	1.84	0.42	0.49	0.29	0.26	0.08					0.13	0.05	3.26	0.61	18.8
45-49	0.64	0.25	0.89	0.47	0.08	0.03	0.13	0.06					0.05	0.03	1.79	0.54	30.2
50-54	0.37	0.21	0.21	0.12	0.02	0.02	0.02	0.02					0.04	0.03	0.66	0.24	36.8
55-59	0.13	0.10													0.13	0.10	74.0
60-64	0.32	0.21													0.32	0.21	65.0
>65													0.02	0.02	0.02	0.02	100.0
Sum	3.00	0.57	7.59	1.32	1.26	0.35	3.78	0.51	0.06	0.06	0.97	0.55	3.55	0.77	20.20	1.83	9.05

Table 8.2. SEBASTES MENTELLA.[1] Abundance indices (I) at length with standard error of mean (S) from bottom trawl hauls for main areas of the Barents Sea winter 2003 (numbers in millions).

	Area															
Length	A		B		C		D		D'		E		S		Total		
cm	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	CV (%)
5-9	3.7	2.3	0.2	0.2	+	+	0.0				0.1	0.1			3.9	2.3	58.3
10-14	1.0	0.4	0.0		0.1	0.1	1.1	0.3			0.1	0.1	1.6	0.3	3.9	0.6	16.1
15-19	2.4	0.6	0.0		0.2	0.1	4.1	1.5					3.2	0.7	10.0	1.8	17.8
20-24	5.7	1.8	0.0		0.3	0.1	2.8	1.2					3.7	0.9	12.4	2.3	18.7
25-29	43.0	9.7	0.0		1.4	0.8	2.4	1.0					23.9	7.9	70.8	12.5	17.7
30-34	125.5	50.2	0.1	0.1	3.3	1.5	4.8	3.3					66.1	29.9	199.8	58.5	29.3
35-39	33.1	13.4	0.3	0.3	0.9	0.4	1.3	0.9					11.2	4.8	46.9	14.2	30.3
40-44	5.0	2.8	0.1	0.1	+	+	0.1	0.1					0.9	0.5	6.0	2.8	46.9
>45	0.3	0.3											+	+	0.3	0.3	92.6
Sum	219.7	53.0	0.7	0.4	6.3	1.7	16.6	4.0	0.0	0.0	0.3	0.1	110.6	31.3	354.1	61.7	17.4

[1] Includes unidentified Sebastes specimens, mostly less than 15 cm.

Table 8.3. SEBASTES MARINUS. Abundance indices from bottom trawl surveys in the Barents Sea winter 1986-2003 (numbers in millions). 1986-1992 includes only main areas A, B, C and D.

	Length group (cm)									
Year	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	> 45	Total
1986	3.0	11.7	26.4	34.3	17.7	21.0	12.8	4.4	2.6	134
1987	7.7	12.7	32.8	7.7	6.4	3.4	3.8	3.8	4.2	83
1988	1.0	5.6	5.5	14.2	12.6	7.3	5.2	4.1	3.7	59
1989	48.7	4.9	4.3	11.8	15.9	12.2	6.6	4.8	3.0	114
1990	9.2	5.3	6.5	9.4	15.5	14.0	8.0	4.0	3.4	75
1991	4.2	13.6	8.4	19.4	18.0	16.1	14.8	6.0	4.0	105
1992	1.8	3.9	7.7	20.6	19.7	13.7	10.5	6.6	5.8	92
1993	0.1	1.2	3.5	6.9	10.3	14.5	12.5	8.6	6.3	64
1994	0.7	6.5	9.3	11.7	11.5	19.4	9.1	4.4	2.8	75
1995	0.6	5.0	13.1	11.5	9.1	15.9	17.2	10.9	4.7	88
1996	+	0.7	3.5	6.4	9.4	11.7	16.6	7.9	3.9	60
1997[1]	-	0.5	1.5	3.2	6.6	21.4	28.0	8.4	3.3	73
1998[1]	0.2	6.0	2.5	10.5	49.5	25.2	13.1	6.9	2.3	116
1999	0.2	0.9	2.1	4.0	4.6	6.4	6.0	5.3	3.3	33
2000	0.5	1.1	1.5	4.2	4.7	5.0	3.5	1.8	1.2	24
2001	0.1	0.4	0.4	2.4	5.7	5.5	4.5	3.2	1.6	24
2002	0.1	1.0	2.0	1.8	3.8	4.1	3.3	3.6	2.5	22
2003	-	0.5	1.2	1.5	4.3	3.8	2.7	3.3	2.9	20

1) Indices raised to also represent the Russian EEZ.

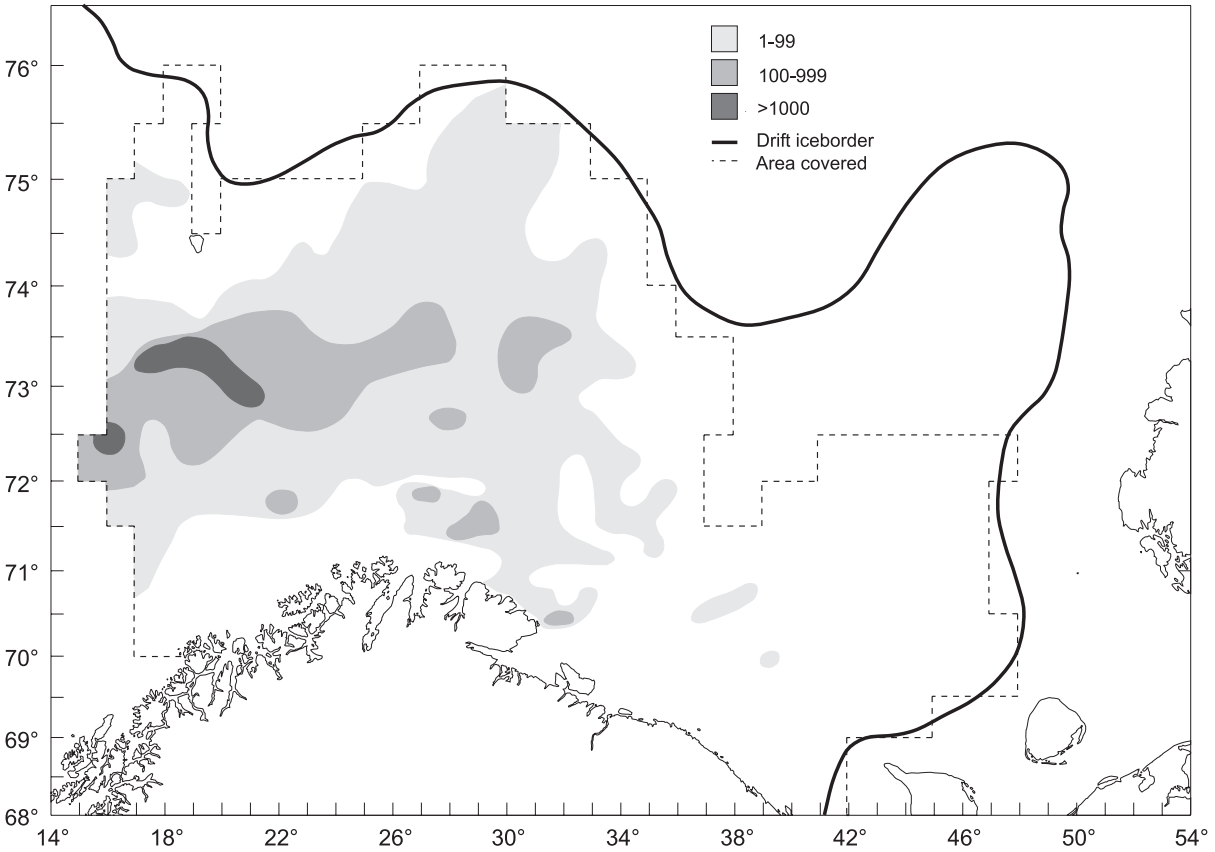

Figure 8.2. *Sebastes mentella* SEBASTES MENTELLA. Distribution in the trawl catches winter 2003 (no. per hour trawling).

The mapping of the distribution of ***S. mentella*** (fig. 8.2) is not complete in the north western part of the surveyed area due to this species' extensive distribution further north in the Svalbard area, west and north of Spitsbergen.

Table 8.2 presents the swept area indices by 5 cm length groups with corresponding standard errors for each main area in addition to the coefficient of variation for the total area.

The time series (1986-2003) of swept area indices for *S. mentella* is presented in table 8.4. Compared to the previous year the values in 2003 show a decrease for most size groups. The total index for fish below 30 cm are among the lowest observed. The future of the *S. mentella* stock is relying on the survival of the last good year classes born in 1989-1990 before the recruitment collapse in 1991. These year classes, at present above 30 cm, compose the bulk of the stock, and should be protected as much as possible to improve the recruitment to maintain a fishery on this resource in the future.

Table 8.4. SEBASTES MENTELLA.[1] Abundance indices from bottom trawl surveys in the Barents Sea winter 1986-2003 (numbers in millions). 1986-1992 includes only main areas A. B. C and D.

	Length group (cm)									
Year	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	> 45	Total
1986	81.3	151.9	205.4	87.7	169.2	129.8	87.5	23.6	13.8	951
1987	71.8	25.1	227.4	56.1	34.6	11.4	5.3	1.1	0.1	433
1988	587.0	25.2	132.6	182.1	39.6	50.1	47.9	3.6	0.1	1070
1989	622.9	55.0	28.4	177.1	58.0	9.4	8.0	1.9	0.3	962
1990	323.6	304.5	36.4	55.9	80.2	12.9	12.5	1.5	0.2	830
1991	395.2	448.8	86.2	38.9	95.6	34.8	24.3	2.5	0.2	1123
1992	139.0	366.5	227.1	34.6	55.2	34.4	7.5	1.8	0.5	867
1993	30.8	592.7	320.2	116.3	24.2	25.0	6.3	1.0	+	1117
1994	6.9	258.6	289.4	284.3	51.4	69.8	19.9	1.4	0.1	979
1995	263.7	71.4	637.8	505.8	90.8	68.8	31.3	3.9	0.5	1674
1996	213.1	100.2	191.2	337.6	134.3	41.9	16.6	1.4	0.3	1037
1997[2]	63.2	120.9	24.8	278.2	271.8	70.9	39.8	5.2	0.1	875
1998[2]	1.3	88.2	62.5	101.0	203.2	40.4	12.9	1.1	0.2	511
1999	2.2	6.8	68.2	36.8	167.4	71.3	21.0	3.1	0.1	374
2000	9.0	12.7	39.4	76.8	141.9	97.1	26.6	6.9	1.5	412
2001	9.3	22.5	7.0	54.9	77.4	73.2	9.4	0.6	0.1	254
2002	16.1	7.2	19.1	41.7	103.9	113.7	22.9	1.4	+	326
2003	3.9	3.9	10.0	12.4	70.8	199.8	46.9	6.0	0.3	354

1) Includes unidentified Sebastes specimens, mostly less than 15 cm.
2) Indices raised to also represent the Russian EEZ.

9. DISTRIBUTION AND ABUNDANCE OF OTHER SPECIES

9.1 Greenland halibut

Fig. 9.1 shows the distribution of bottom trawl catch rates of Greenland halibut. Important parts of this species' distribution along the continental slope, are not covered by the survey. The observed distribution pattern was similar to those observed in previous years' surveys, i.e., mainly in the Bear Island channel towards the Hopen Deep.

Table 9.1 presents the swept area indices by 5 cm length groups, with corresponding standard errors for each main area, in addition to the coefficient of variation for the total area. Most of the Greenland halibut was found in the main area S. For most length groups the coefficient of variation is higher than for cod and haddock.

The time series for 1990-2003, with indices adjusted for 1997 and 1998, is presented in table 9.2. Compared to the 2002 values the indices for fish less than 45 cm are lower, while for fish larger than 45 cm the indices are at the 2002 level.

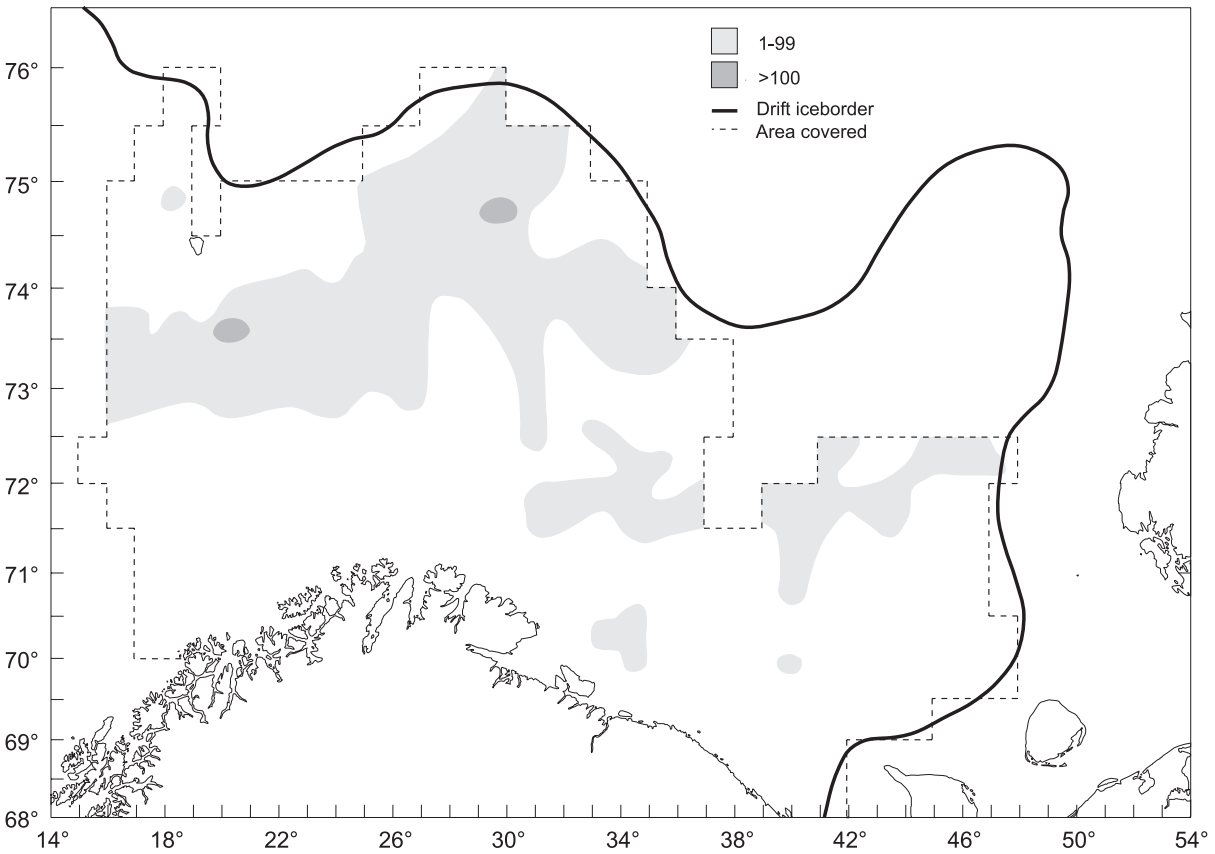

Figure 9.1. GREENLAND HALIBUT. Distribution in the trawl catches winter 2003 (no. per hour trawling).

Table 9.1. GREENLAND HALIBUT. Abundance indices (I) at length with standard error of mean (S) from bottom trawl hauls for main areas of the Barents Sea winter 2003 (numbers in thousands).

Length	A		B		C		D		D'		E		S		Total		
cm	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	CV (%)
5-9																	
10-14	27	27											23	23	50	36	71
15-19																	
20-24							18	18			34	34	19	19	71	43	60
25-29							17	17							17	17	100
30-34							54	40			102	72	139	79	295	114	39
35-39	145	115					117	46			102	72	310	112	674	182	27
40-44	425	230					447	145			170	90	751	282	1793	402	22
45-49	138	66					458	161					2320	1387	2916	1398	48
50-54	451	175					801	182					3396	1807	4647	1825	39
55-59	201	107					480	109			34	34	1471	730	2186	747	34
60-64	111	89					77	39					520	299	708	314	44
65-69	63	45					151	62					395	160	609	177	29
70-74							96	42					135	79	231	90	39
75-79	50	34											75	39	125	52	42
80-84																	
Sum	14322	2489	0	0	0	0	2717	322	0	0	441	144	9553	2438	14322	2489	17

Table 9.2.GREENLAND HALIBUT. Abundance indices from the bottom trawl surveys in the Barents Sea winter 1990-2003 (numbers in thousands). 1990-1992 includes only main areas A, B, C and D. Indices for 1997 and 1998 are raised to also represent the Russian EEZ.

	Length group (cm)															
Year	<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	Total
1990	21	199	777	785	1205	1657	1829	2043	1349	479	159	160	40	40	0	10800
1991	0	42	262	618	655	868	954	1320	1875	1577	847	165	34	34	0	9270
1992	14	35	64	149	509	843	1096	1072	1029	827	633	108	31	31	26	6500
1993	0	0	17	67	265	959	2310	4004	3374	1911	1247	482	139	139	34	14840
1994	0	0	16	99	142	1191	2625	3866	2885	1796	753	440	25	25	0	13838
1995	42	0	0	0	83	149	3228	9240	7438	2811	2336	909	468	468	0	26761
1996	3149	0	0	0	61	124	1163	3969	4425	1824	1041	593	346	73	12	16781
1997	0	65	0	0	173	227	858	4344	5500	2725	1545	632	282	66	22	16439
1998	80	217	1006	444	532	403	1064	3888	6331	2977	1725	633	337	76	43	19765
1999	41	82	261	427	576	264	757	1706	3069	1640	1077	483	109	74	28	10594
2000	122	184	322	859	1753	3841	2190	1599	2143	1715	1163	564	242	75	0	16769
2001	68	49	129	178	663	1470	3674	3258	2263	1990	1081	522	204	48	40	15720
2002	268	0	71	33	408	996	1927	3702	3188	2210	1110	975	230	157	96	15383
2003	50	0	71	17	295	674	1793	2916	4647	2186	708	609	231	125	0	14322

9.2 Blue whiting

Since 2000 the blue whiting has shown a wider distribution than usual, and the echo recordings in 2001 and 2002 also indicated unusual high abundance in the Barents Sea, while in 2003 it has decreased considerably. Figure 9.2 shows the geographical distribution of the bottom trawl catch rates of blue whiting in 2003. Compared to the 2002 results, the distribution of catch rates in 2003 extended less to the east and north, and the areas with highest catch rates have decreased. Since the fish was mainly found pelagic the bottom trawl do not reflect the real density distribution, but gives some indication of the distribution limits. Acoustic observations would better reflect the relative density distribution.

The catches of blue whiting were dominated by fish in the length interval 20-25 cm.

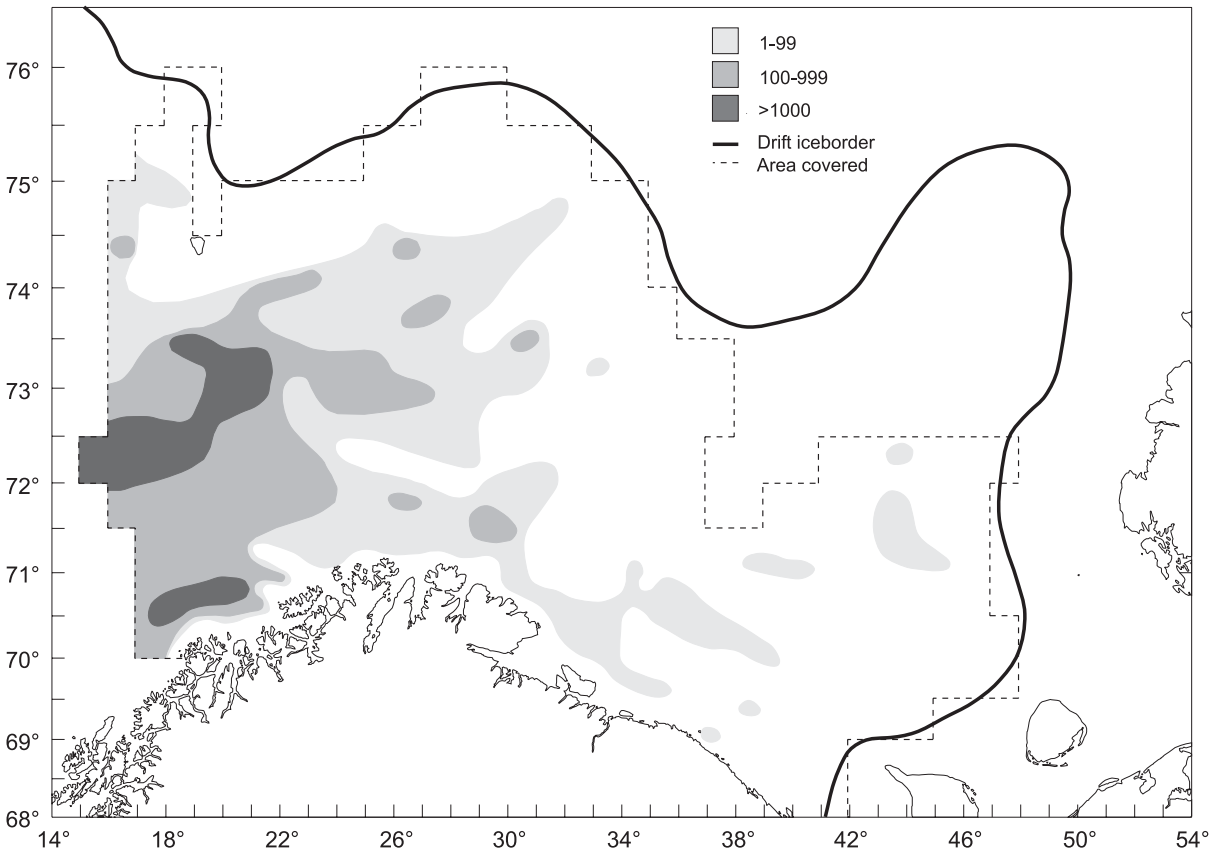

Figure 9.2. BLUE WHITING. Distribution in the trawl catches winter 2003 (no. per hour trawling).

10. COMPARISONS BETWEEN RESEARCH VESSELS

"G.O.Sars" and "Johan Hjort" worked 16 parallel bottom trawl tows. "Persey 3" and "Johan Hjort" worked 10 parallel bottom trawl tows and 16 miles parallel acoustic observations. The results will be given in a separate report.

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