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INVESTIGATIONS OF DEMERSAL FISH IN THE BARENTS SEA WINTER 2004

Detailed report

Institute of Marine Research - IMR

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Joint IMR-PINRO report

Investigations on demersal fish in the Barents Sea winter 2004

Detailed report

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CONTENTS

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-March 2004. The survey was performed with the Russian research vessel “Smolensk” and the Norwegian research vessels “G.O. Sars” and “Johan Hjort”. The total duration of the survey was from 29 January to 14 March. One scientist from PINRO, Murmansk, participated onboard ”G.O.Sars”.

SUMMARY

The main results in 2004 were:

- the abundance of the 2003 and 2001 year classes of **cod** are poor, the 2002 and 1999 year classes are below average, while the 2000 and 1998 year classes are near average.
- The abundance of older cod (7 years and older) is above average.
- Compared to the 2003 survey these results are more pessimistic for all the year classes 1998-2002, but more consistent for older fish. This tendency is most evident for the acoustic results.
- lengths and weights at age and weight increments are slightly less than those observed in the previous two years, for most age groups.
- the survey mortality calculated from the swept area results indicates that the mortality in 2003 for age 2 and for ages 6 and older was similar to the mortality in 2002, while it has increased for the remaining age groups.
- for **haddock** the 2003 year class appears to be below average, the 2002 year class to appears to be strong and the year classes 1998 to 2001 are indicated to be at or above average. The amount of age 7 and older is somewhat below average.
- length and weight at age and weight increments indicate slightly 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 2003-results the abundance indices of **Greenland halibut** for fish below 20 cm and fish in the size range 30 to 40 cm have increased slightly, while in the size range 20-30 cm and above 40 cm the indices have decreased.

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

Onboard R/V “G. O. Sars” in 2004 zooplankton was sampled at all bottom trawl stations. The results are described in the Appendix. 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. In the years 2001-2003 a Russian research vessel covered the areas where the Norwegian vessels did not have access. In 2004 the Norwegian vessels had full access to the Russian zone.

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:

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

$\overline{\rho}_A$ 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):

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

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:

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

$\overline{L^2}$ 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:

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

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 the Russian vessels and the hired vessels V-type doors (ca 7 m^2) have been used. In 2004, R/V "Johan Hjort" and R/V "G.O.Sars" also changed to a V-type door ("Steinshamn W-9", $7.1m^2$, 2050kg), the same type as used on R/V "Smolensk". 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 is then in most hauls restricted to the range 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 2.1) and 35 strata.

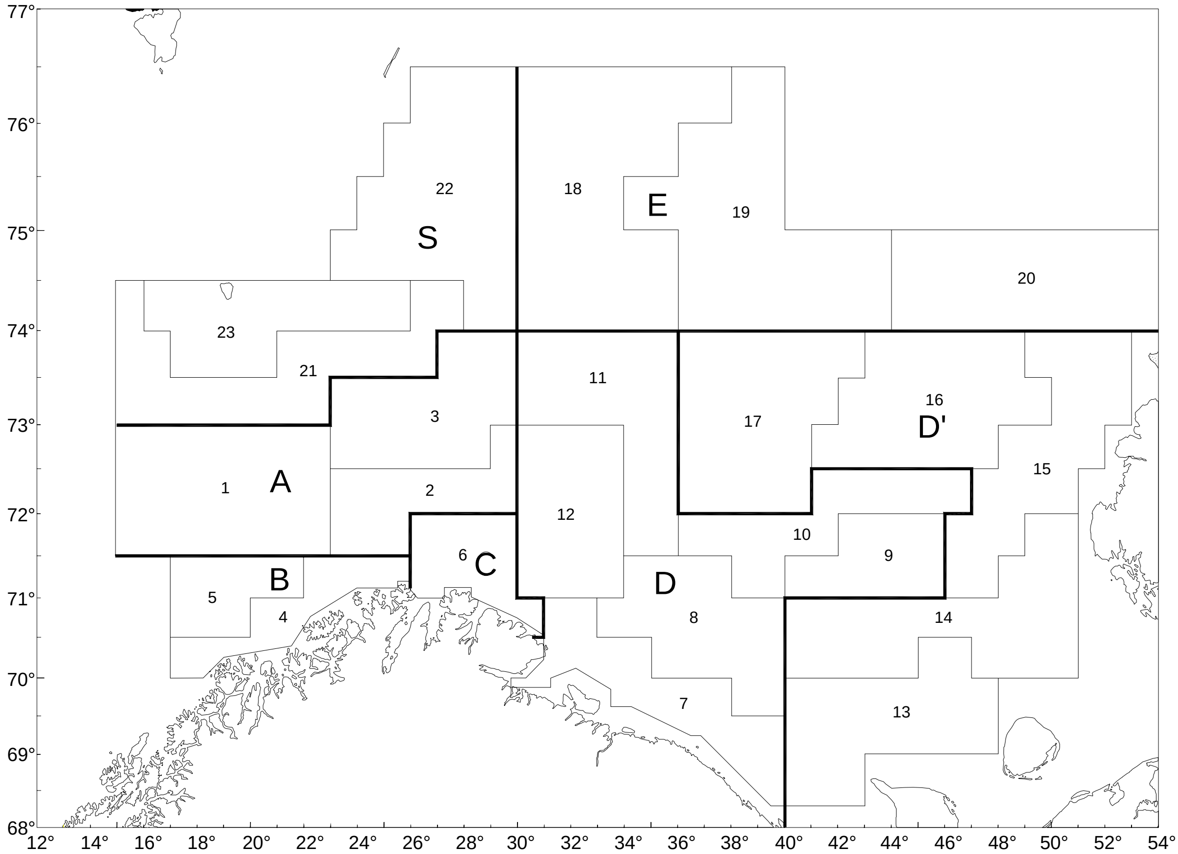

Figure 2.1 Strata (1-23) and Main Areas (A,B,C,D,D',E and S) used for swept area estimations. The Main Areas are also used for acoustic estimation.

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. 2.1 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 one cod per 5 cm length-group. All cod above 80 cm were sampled. The stomach samples were frozen and analysed after the survey. Haddock otoliths were sampled from one specimen per 5 cm length-group. Regarding the redfish species, *Sebastes marinus* and *S. mentella*, otoliths for age determination were sampled from two fish in every 5 cm length-group on every station. 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 2004 was conducted with R/V "G.O. Sars" 02.02-10.03 (IMR-BEI-survey no. 2004106, IMR-series no. 70301-70471), R/V "Johan Hjort" 31.01-14.03 (IMR-BEI-survey no. 2004203, IMR-series no. 70001-70256), and R/V “Smolensk” from PINRO 24.02-09.03. The catch data and biological samples from R/V “Smolensk” were converted to the IMR-format “Regfisk” (IMR-series no. 70501-70590). The acoustic data from R/V “Smolensk” 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).

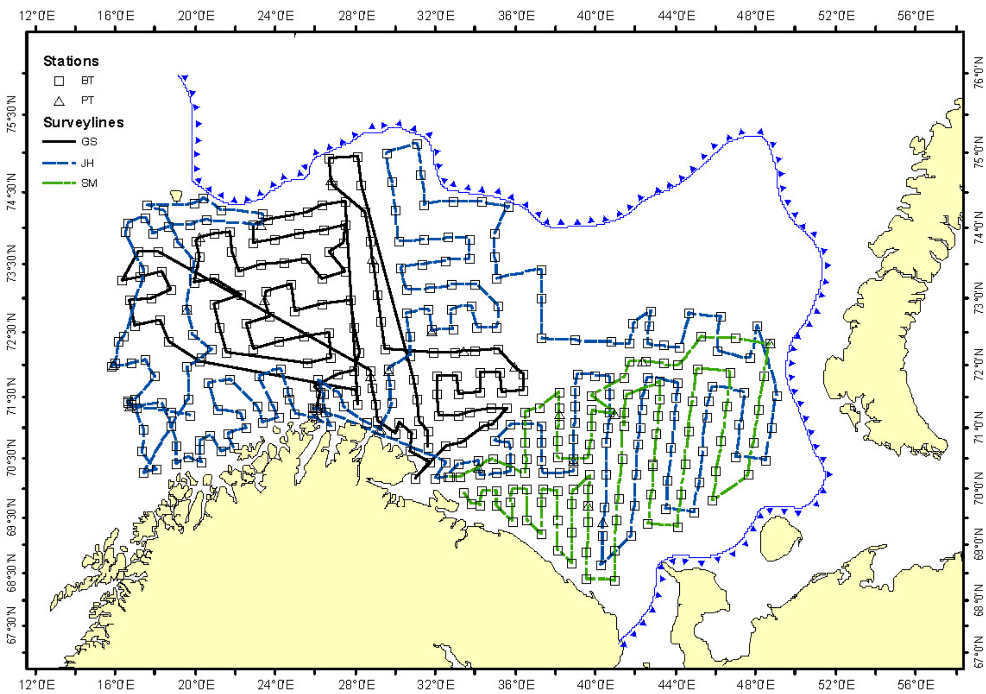

Figure 3.1. Survey tracks and trawl stations R/V "G.O. Sars" and R/V "Johan Hjort" and R/V "Smolensk" 29.1-14.3.2004.

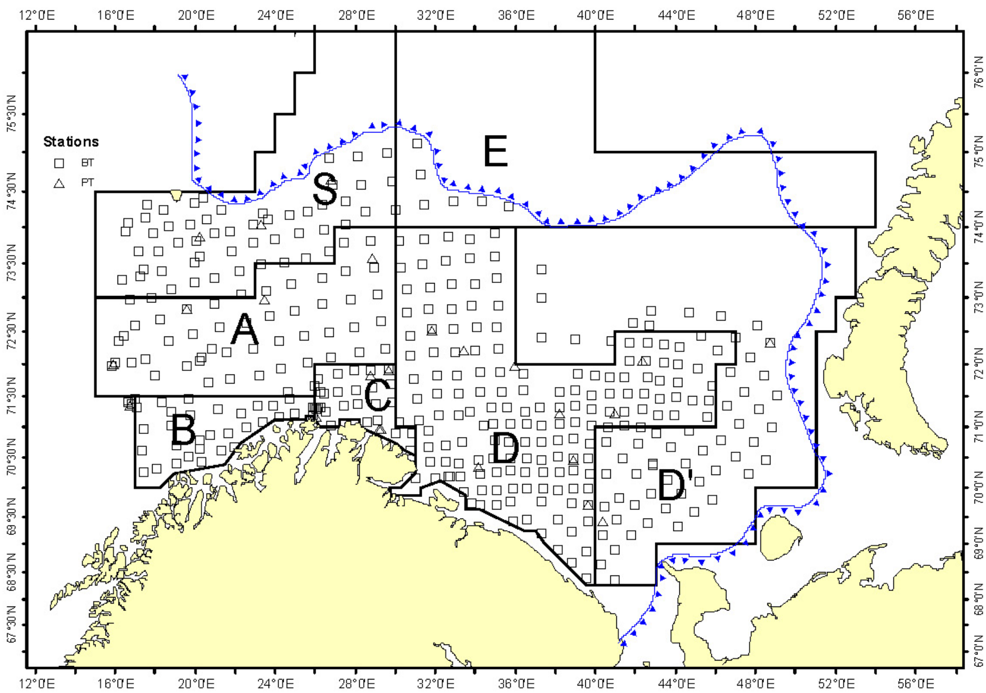

Figure 3.2. Bottom trawl stations used in the swept area estimation in 2004 and borders for the main areas.

Table 3.1 shows the area covered by the survey every year. In the 2004 survey 316 hydrographical (CTD) stations and 517 trawl stations were taken (fig. 3.1, table 3.2). 24 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 358 stations. Among the bottom trawl stations not used in the swept area calculation are; 106 stations taken for trawl comparisons, and 2 non-predefined hauls for identification of acoustic records. The rest was either outside the strata system defined in Figure 2.1 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. At the daytime bottom trawl hauls onboard "G.O. Sars" a plankton net was attached on top of the trawl to collect samles of zooplankton (see Appendix).

Table 3.1. Area (n.miles^2) covered in the bottom trawl surveys in the Barents Sea winter 1981-2004.

	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
2004	27976	9845	5162	53567	42903	4782	20415	96549	164649

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.

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 2004. B1=fixed bottom trawl, B2=other bottom trawl, P=pelagic trawl.

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	43	1755	409	3658	350	112	75	2417	269	45	43
	B2	7	59	11	78	16	1	0	110	12	1	1
	P	4	9	7	118	8	0	0	0	0	0	0
B	B1	28	1262	282	1982	234	387	120	180	21	1	1
	B2*	11	333	0	601	0	116	0	0	0	0	0
	P*	2	0	0	0	0	0	0	0	0	0	0
C	B1	22	1154	257	2470	196	68	47	469	73	4	4
	B2	103	6883	0	12843	0	458	0	17	0	0	0
	P	4	97	11	92	13	8	4	0	0	0	0
D	B1	155	21381	1530	26943	838	187	41	722	96	210	155
	B2	7	0	0	0	0	0	0	0	0	0	0
	P	7	31	0	143	0	0	0	0	0	0	0
D'	B1	57	3139	128	1246	56	2	0	1	0	0	0
	B2	0	0	0	0	0	0	0	0	0	0	0
	P	4	6	0	0	0	0	0	0	0	0	0
E	B1	5	241	22	51	5	1	0	0	0	4	3
	B2	1	0	0	0	0	0	0	0	0	0	0
	P	0	0	0	0	0	0	0	0	0	0	0
S	B1	48	4500	518	1476	158	98	73	1590	263	194	174
	B2	6	0	0	0	0	0	0	0	0	0	0
	P	3	1	0	4	0	0	0	1	0	0	0
Total	B1	358	33432	3146	37826	1837	855	356	5379	722	458	380
	B2	135	7275	11	13522	16	575	0	127	12	1	1
	P	24	144	18	357	21	8	4	1	0	0	0
Sum		517	40851	3175	51705	1874	1438	360	5507	736	459	381

*Includes two B2 and one P taken just west of the strata border for special studies on haddock

4. HYDROGRAPHY

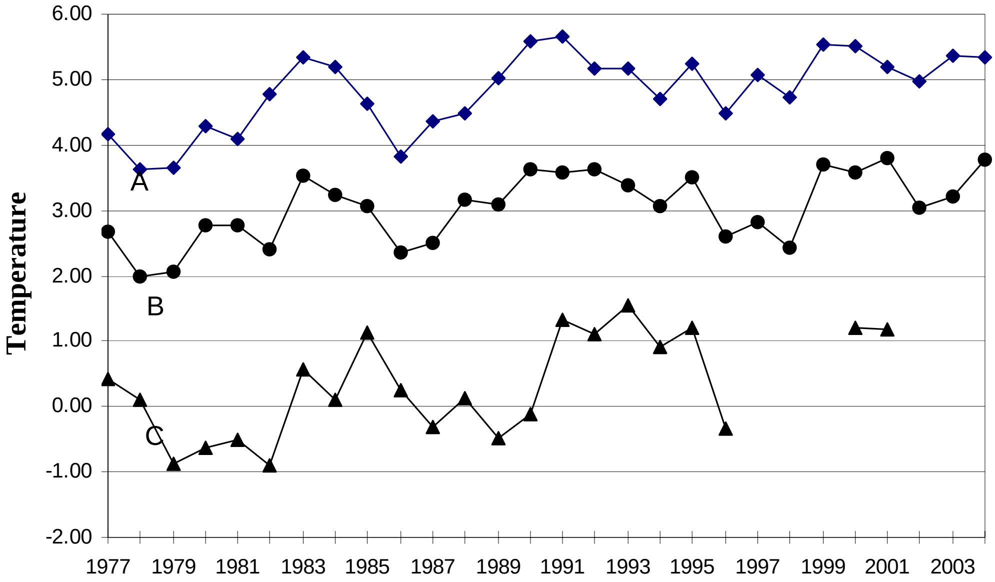

Figure 4.1. Mean temperatures in 50-200 m depth in 1977-2004. A) "Fugløya-Bjørnøya" in March, B) "Vardø-Nord" in March, C) Sem Islands in January-February

The standard hydrographical sections "Fugløya-Bjørnøya" and "Vardø-north" were covered during the last days of the survey. Figure 4.1 shows the observed mean temperature at 50-200 m depth, compared to the period 1999-2003. The Sem Islands section was not covered in 2004.

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. Since 1993 the acoustic values have been split between the two species. The 2004 value for cod is the lowest in this recent time series, only the values in 1997 and 1999 are of similar magnitude. The 2004 value for haddock is close to average, but somewhat lower than in 2003.

Compared to 2003 a decrease for cod was observed in all main areas in 2004. The decrease was most pronounced in the pelagic layer. The fraction of the total echo abundance recorded in the bottom layer in 2004 is the highest observed for cod (0.50), and the third highest for haddock (0.32).

Mean echo intensity (s_A) per statistical rectangle is shown for cod in Figure 5.1 and for haddock in Figure 5.2.

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 2004 (m^2 reflecting surface · 10^{-3}).

	Cod			Haddock		
Area	P	B	Total	P	B	Total
A	84	70	154	395	69	464
B	92	95	187	87	74	161
C	17	26	43	89	41	131
D	225	280	505	720	370	1090
D'	10	47	57	52	65	117
E	1	7	8	1	0	1
S	157	52	209	14	7	21
Total	586	576	1162	1359	626	1985

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 1981-2004 (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
2004	1162	1985	3147	576	626	1202	0.50	0.32	0.38

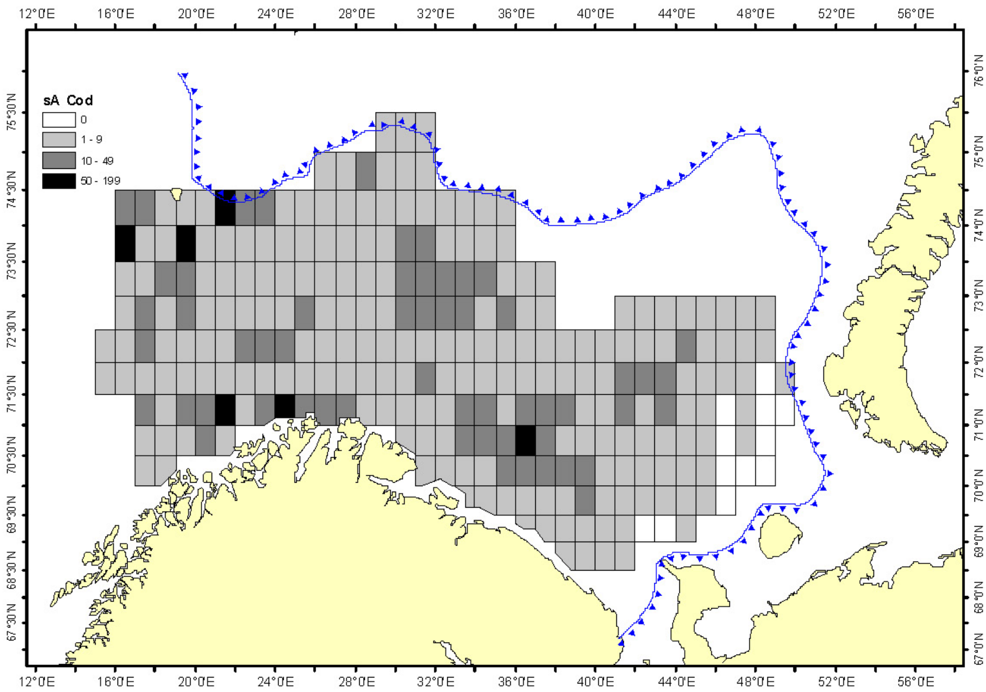

Figure 5.1. COD. Distribution of total echo abundance winter 2004. Unit is area back scattering surface (s_A) per square nautical mile (m^2/n.mile^2).

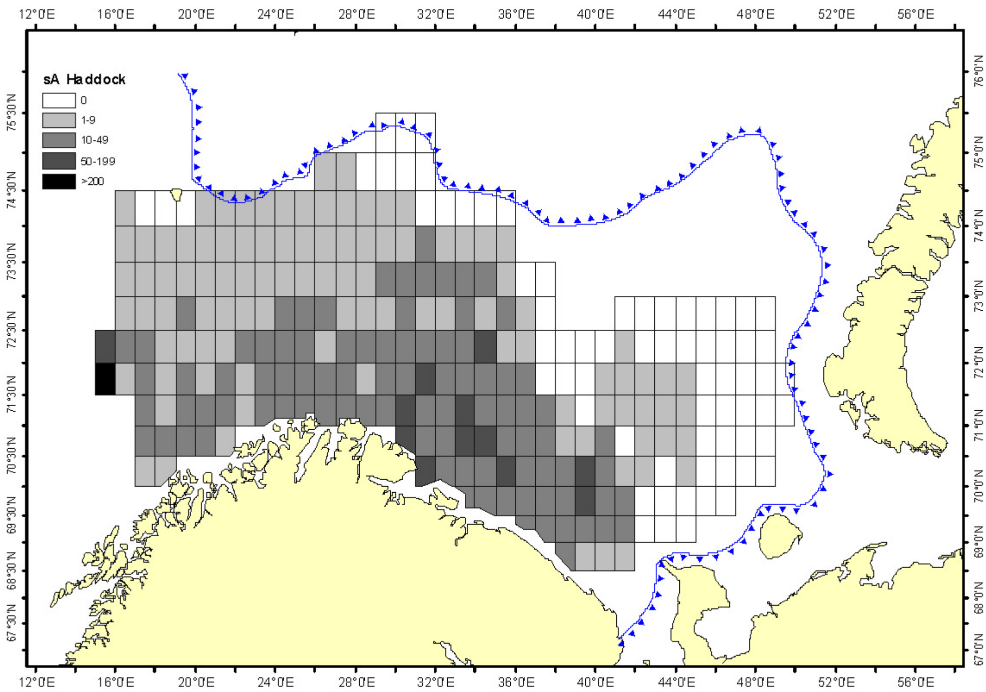

Figure 5.2. HADDOCK. Distribution of total echo abundance winter 2004. Unit is area back scattering surface (s_A) per square nautical mile (m^2/n.mile^2).

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 (1981-2004) is presented in table 6.3.

The acoustic estimates in 2004 are quite low compared to those in 2003, but more in line with what could be expected from the observations in 2002. The 2003 results show unexpectedly high indices of abundance for all age groups 2-7 as compared with the indices in 2002 and 2004. 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 between the 2002 and 2003 surveys and then decreased considerably. The 2003 index of age 6 being the highest in the time series, while the 2004 index of the same year class is number 8 in the 24 year time series. A significant contribution to the high estimates of 5 and 6 year olds in 2003 was from dense recordings along the coast between 21° and 25° east. These recordings might have led to over estimation due to unfavourable direction of the transects (parallel to the coast). In 2004 the transects were more perpendicular to the coast.

Table 6.1. COD. Abundance indices at length and age from the acoustic survey in the Barents Sea winter 2004 (numbers in millions).

Length cm	Age (year-class) 1 (03)	2 (02)	3 (01)	4 (00)	5 (99)	6 (98)	7 (97)	8 (96)	9 (95)	10+	Sum	Biomass ('000 t)
5-9	21.9										21.9	0
10-15	133.9	2.5									136.4	1
15-20	1.9	59.9									61.7	3
20-25		34.1	0.9								34.9	3
25-30		8.4	7.9	+							16.3	3
30-35		0.4	17.9	9.6							27.9	8
35-40			6.6	30.7							37.3	16
40-45			0.3	32.7	0.6	+					33.7	21
45-50			+	17.1	8.9	0.1					26.1	23
50-55				2.2	12.6	1.5	0.1				16.4	19
55-60				0.5	7.0	7.4	0.9				15.8	24
60-65					1.4	8.9	3.3				13.6	26
65-70					0.2	7.7	4.3	0.6		0.1	12.8	30
70-75						1.8	4.6	1.3		+	7.6	22
75-80					+	0.2	3.4	1.5	+		5.1	18
80-85							0.5	1.2	0.3	+	1.9	8
85-90						+	0.1	1.0	0.1	+	1.2	6
>90							0.1	0.3	0.8	0.2	1.3	11
sum	157.7	105.2	33.6	92.8	30.7	27.6	17.0	5.9	1.2	0.3	471.8	
Biomass	2	7	10	55	36	53	45	23	8	2		241

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 2004 (numbers in millions). BINW is the additional area covered North and West of Bear Island (not included in the total).

Area	Layer	Age (year-class) 1 (03)	2 (02)	3 (01)	4 (00)	5 (99)	6 (98)	7 (97)	8 (96)	9 (95)	10+	Biomass ('000 t)
A	P	1.4	0.8	0.4	3.0	2.8	2.7	2.3	0.8	0.1	0.0	20.6
	B	0.9	0.6	0.3	2.3	2.2	2.3	2.0	0.6	0.1	0.0	17.1
B	P	0.3	0.3	0.4	1.7	1.3	3.7	2.4	1.2	0.3	0.1	24.8
	B	0.3	0.3	0.5	1.9	1.4	3.9	2.4	1.1	0.3	0.0	25.3
C	P	0.2	0.1	0.1	0.4	0.5	0.5	0.6	0.1	0.0	0.0	4.4
	B	0.5	0.2	0.1	0.8	0.9	0.8	0.8	0.2	0.0	0.0	6.5
D	P	32.0	29.6	12.3	22.9	5.7	3.7	1.9	0.6	0.2	0.0	41.9
	B	43.6	35.6	14.5	29.2	7.3	4.5	2.3	0.7	0.2	0.0	52.1
D'	P	8.1	5.1	0.3	0.5	0.1	0.1	0.1	0.0	0.0	0.0	1.2
	B	40.0	23.7	1.5	3.4	0.4	0.4	0.2	0.0	0.0	0.0	5.4
E	P	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
	B	4.3	1.4	0.3	0.1	0.2	0.2	0.1	0.0	0.0	0.0	1.3
S	P	19.3	5.4	2.3	20.2	5.9	3.6	1.6	0.3	0.0	0.0	29.9
	B	6.5	1.9	0.7	6.2	1.9	1.2	0.6	0.1	0.0	0.0	10.0
ABCD	P	33.9	30.8	13.1	28.0	10.3	10.5	7.1	2.7	0.6	0.1	91.7
	B	45.3	36.8	15.3	34.2	11.8	11.5	7.4	2.7	0.6	0.1	100.9
Total	P	61.5	41.3	15.8	48.8	16.4	14.3	8.8	3.0	0.6	0.1	123.0
	B	96.1	63.8	17.8	44.0	14.4	13.4	8.2	2.8	0.6	0.1	117.6
	sum	157.7	105.2	33.6	92.8	30.7	27.6	17.0	5.9	1.2	0.3	240.6

Table 6.3. COD. Abundance indices from acoustic surveys in the Barents Sea winter 1981-2004 (numbers in millions). 1981-1992 includes mainly areas A, B C and D.

Year	Age										Total	Biomass ('000 t)
	1	2	3	4	5	6	7	8	9	10+		
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
2004	157.6	105.2	33.6	92.8	30.7	27.6	17.0	5.9	1.2	0.2	471.8	241

* 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 were found in the eastern part of the survey area within the Russian EEZ.

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. 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 ages 1-4 the swept area indices are somewhat higher than the acoustic indices (Table 6.3), while for older fish the swept area indices are slightly below the acoustic indices.

The time series (1981-2004) 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 7 year and older fish has increased substantially, while the indices for younger fish have shown large fluctuations, and the values for 2004 are low. In particular the index of the 2000 year class is low in 2004 compared to the index in 2003. The amount of 1 year olds (2003 year class) in 2004 is also rather low. The overall impression from table 6.7 is that survival has improved for most age groups since 1999, but the latest survey indicate reduced survival.

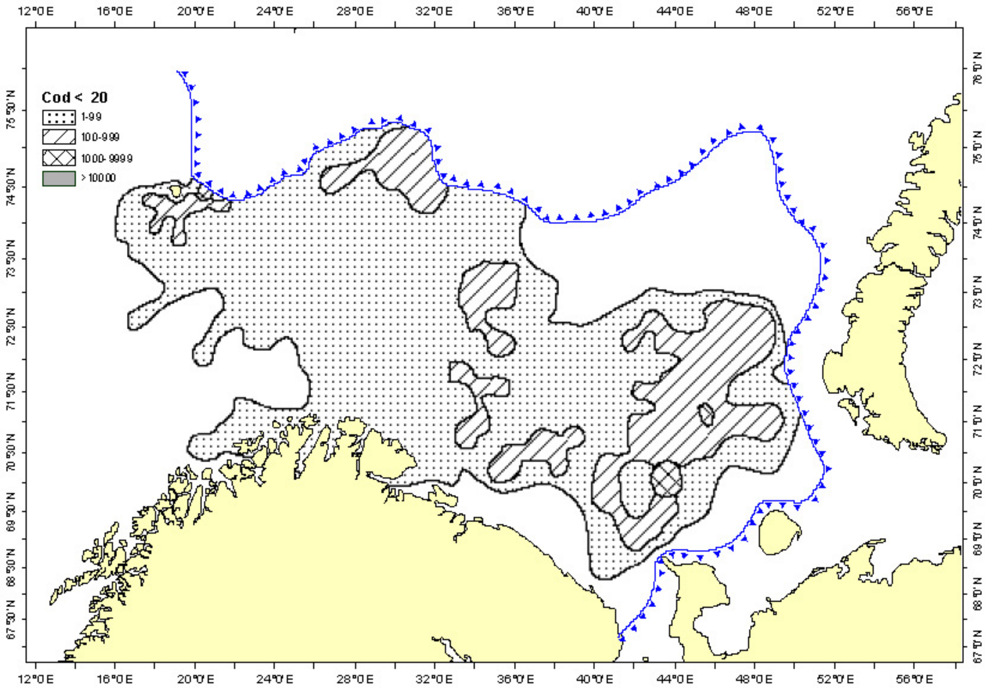

Figure 6.1. COD < 20 cm. Distribution in the trawl catches winter 2004 (number per hour trawling).

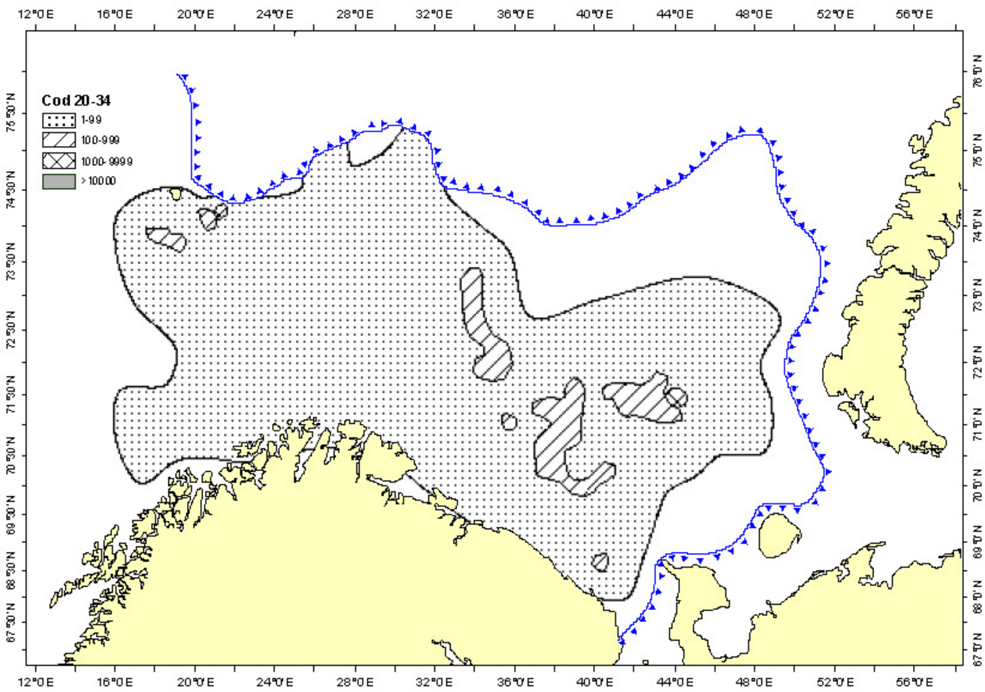

Figure 6.2. COD 20-34 cm. Distribution in the trawl catches winter 2004 (number per hour trawling).

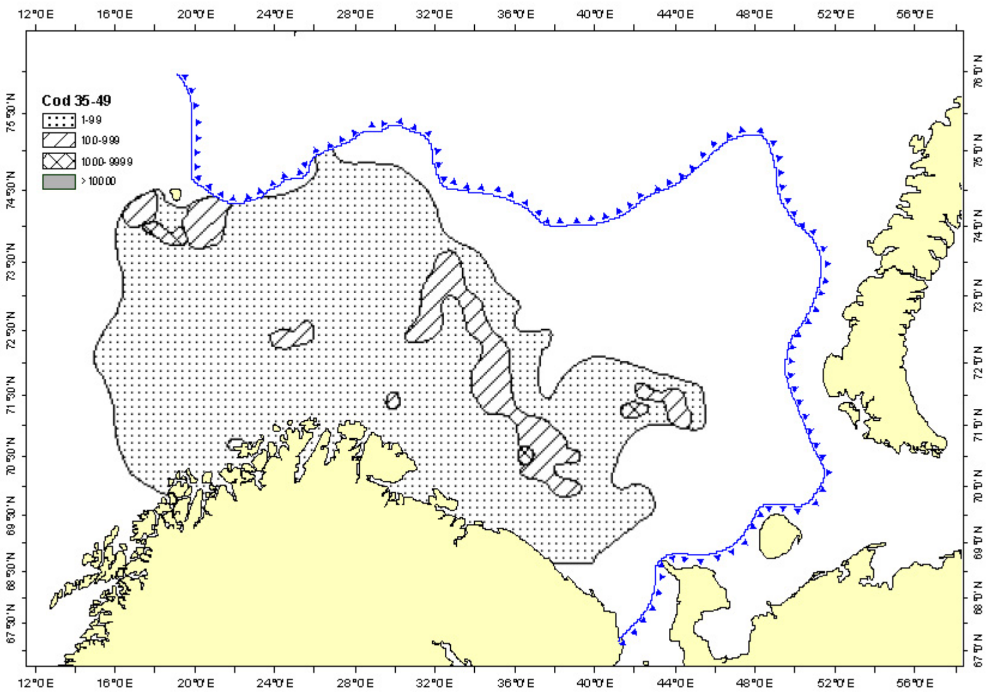

Figure 6.3. COD 35-49 cm. Distribution in the trawl catches winter 2004 (number per hour trawling).

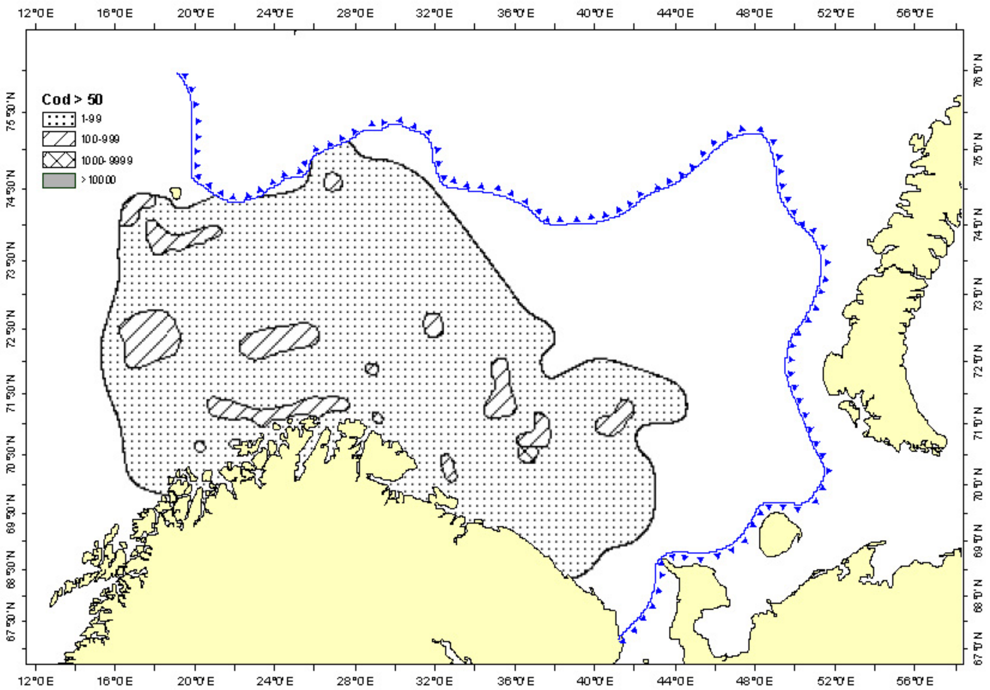

Figure 6.4. COD > 50 cm. Distribution in the trawl catches winter 2004 (number per hour trawling).

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 2004 (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	0.9	0.3	0.1	0.1	0.2	0.1	15.4	2.1	25.8	10.2	2.8	1.1	10.3	4.5	55.5	11.4	20.5
10-14	4.2	1.0	0.5	0.3	1.3	0.5	127.6	15.2	95.5	17.2	13.6	4.6	49.1	18.9	291.8	30.1	10.3
15-19	1.5	0.4	0.1	0.1	0.3	0.1	89.3	25.5	34.0	8.4	2.1	1.0	9.1	1.6	136.3	26.9	19.8
20-24	0.6	0.2	0.1	0.0	0.2	0.1	46.5	7.6	15.8	6.2	0.3	0.2	5.3	1.3	68.9	9.9	14.4
25-29	0.7	0.2	0.3	0.2	0.2	0.1	23.2	3.6	1.9	0.8	0.1	0.1	3.3	1.7	29.6	4.1	13.8
30-34	1.0	0.2	0.2	0.2	0.1	0.0	39.7	10.1	0.8	0.4	0.1	0.1	12.0	6.0	53.9	11.8	21.9
35-39	2.1	0.4	0.4	0.2	0.2	0.1	53.1	11.2	1.4	1.0	0.1	0.1	17.9	5.8	75.2	12.7	16.8
40-44	4.7	1.0	1.0	0.4	0.6	0.2	38.1	6.9	0.6	0.4	0.0	0.0	20.6	5.6	65.6	8.9	13.6
45-49	6.0	1.2	1.5	0.6	1.2	0.3	27.2	6.3	0.1	0.1	0.0	0.0	14.3	3.0	50.3	7.1	14.1
50-54	5.0	1.3	1.8	0.6	1.3	0.3	13.1	3.6	0.1	0.0	0.1	0.1	8.9	1.9	30.2	4.3	14.2
55-59	6.3	1.5	2.4	0.8	1.6	0.4	8.7	2.3	0.1	0.1	0.1	0.1	7.8	1.8	27.0	3.4	12.7
60-64	6.1	1.2	2.5	0.7	1.4	0.4	6.8	2.0	0.1	0.0	0.1	0.1	6.2	1.3	23.2	2.8	12.0
65-69	5.3	1.2	2.4	0.7	1.5	0.5	6.8	1.8	0.1	0.1	0.3	0.3	3.6	0.8	19.8	2.4	12.2
70-74	3.3	0.8	1.8	0.5	0.9	0.3	3.9	1.1	0.1	0.1	0.1	0.1	1.6	0.3	11.6	1.5	12.9
75-79	2.0	0.6	1.4	0.4	0.5	0.1	2.4	0.5	0.0	0.0	0.0	0.0	0.4	0.1	6.8	0.9	12.8
80-84	0.9	0.3	0.5	0.2	0.2	0.1	0.9	0.2	0.1	0.0	0.0	0.0	0.3	0.1	2.8	0.4	14.8
85-89	0.4	0.1	0.2	0.1	0.2	0.1	0.6	0.1	0.0	0.0	0.0	0.0	0.2	0.1	1.6	0.3	16.2
>90	0.4	0.1	0.3	0.1	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.2	13.0
Sum	51.2	3.4	17.4	1.8	11.9	1.1	504.0	36.0	176.5	22.6	19.8	4.8	170.8	22.4	951.6	48.5	5.1

Table 6.5. COD. Abundance indices at length and age from the bottom trawl survey in the Barents Sea winter 2004 (numbers in millions).

Length cm	Age (year-class) 1 (03)	2 (02)	3 (01)	4 (00)	5 (99)	6 (98)	7 (97)	8 (96)	9 (95)	10+	Sum	Biomass ('000 t)
5-9	55.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	55.5	0.2
10-15	270.2	21.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	291.8	4.5
15-20	2.7	133.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	136.3	5.8
20-25	0.0	66.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	68.9	6.3
25-30	0.0	13.3	16.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	29.6	4.9
30-35	0.0	1.1	40.2	12.6	0.0	0.0	0.0	0.0	0.0	0.0	53.9	14.7
35-40	0.0	0.0	15.7	59.5	0.0	0.0	0.0	0.0	0.0	0.0	75.2	31.6
40-45	0.0	0.0	1.3	62.3	1.9	0.1	0.0	0.0	0.0	0.0	65.6	40.2
45-50	0.0	0.0	0.2	33.3	16.7	0.1	0.0	0.0	0.0	0.0	50.3	43.0
50-55	0.0	0.0	0.0	4.3	22.1	3.5	0.2	0.0	0.0	0.0	30.2	34.8
55-60	0.0	0.0	0.0	0.4	13.3	12.0	1.4	0.0	0.0	0.0	27.0	41.0
60-65	0.0	0.0	0.0	0.0	2.6	15.5	5.1	0.0	0.0	0.0	23.2	45.1
65-70	0.0	0.0	0.0	0.1	0.3	11.1	7.9	0.4	0.0	0.1	19.8	48.6
70-75	0.0	0.0	0.0	0.0	0.0	2.1	7.7	1.7	0.1	0.1	11.6	35.4
75-80	0.0	0.0	0.0	0.0	0.0	0.4	4.2	2.1	0.0	0.0	6.8	25.1
80-85	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.9	0.3	0.0	2.8	12.7
85-90	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.1	0.3	0.0	1.6	8.3
>90	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4	1.1	0.2	1.7	11.1
sum	328.5	235.4	76.6	172.5	56.9	44.7	27.3	7.6	1.7	0.4	951.6	
Biomass	3.6	13.7	22.5	103.5	66.4	86.5	72.6	30.4	11.1	2.9		413.3

Table 6.6. COD. Abundance indices from bottom trawl hauls for main areas of the Barents Sea winter 2004 (numbers in millions.)

Area	Age (year-class) 1 (03)	2 (02)	3 (01)	4 (00)	5 (99)	6 (98)	7 (97)	8 (96)	9 (95)	10+	Biomass
A	4.7	2.8	1.5	12.1	9.8	9.4	7.9	2.4	0.4	0.0	73.4
B	0.6	0.4	1.0	2.6	3.2	4.6	3.4	1.1	0.4	0.1	35.1
C	1.5	0.6	0.2	2.1	2.4	2.3	2.2	0.5	0.1	0.1	18.9
D	138.7	149.6	60.1	101.8	26.1	15.9	8.5	2.6	0.7	0.1	189.3
D'	109.2	62.8	2.2	1.7	0.1	0.2	0.1	0.1	0.0	0.0	6.8
E	16.4	2.5	0.2	0.0	0.1	0.5	0.1	0.0	0.0	0.0	1.9
S	57.4	16.7	11.4	52.2	15.2	11.8	5.1	0.8	0.2	0.0	87.9
ABCD	145.5	153.5	62.8	118.6	41.5	32.2	22.1	6.6	1.5	0.4	316.7
Total	328.5	235.4	76.6	172.5	56.9	44.7	27.3	7.5	1.7	0.4	413.3

Table 6.7. COD. Abundance indices from bottom trawl surveys in the Barents Sea winter 1981-2004 (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
2004	328.5	235.4	76.6	172.5	56.9	44.7	27.3	7.6	1.7	0.4	951.6	413

* 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 (1978-2004) and mean weight (1983-2004) at age for the entire investigated area. Weights and lengths at age were fairly low in the period 1995-2000, but increased somewhat in 2001. Since then there has been moderate fluctuations. The same pattern is reflected in the tabulated annual weight increments (Table 6.12).

Table 6.8. COD. Length (cm) at age in main areas of the Barents Sea winter 2004.

Area	Age (year-class)							
	1 (03)	2 (02)	3 (01)	4 (00)	5 (99)	6 (98)	7 (97)	8 (96)
A	10.9	19.5	32.5	44.5	53.8	62.2	68.7	79.2
B	11.7	24.2	40.2	46.2	55.7	64.5	70.7	79.1
C	11.3	20.4	32.7	46.1	54.5	63.0	69.6	80.7
D	11.1	19.5	32.0	40.4	50.5	61.6	70.4	79.2
D’	10.8	17.5	31.2	38.0	54.7	60.4	68.2	78.0
E	10.8	18.1	33.3		50.4	64.4	74.0	84.0
S	11.5	18.3	31.2	40.6	52.1	60.3	65.4	76.6
Total	11.0	18.9	32.0	40.9	52.0	61.8	69.0	79.0

Table 6.9. COD. Length (cm) at age in the Barents Sea from the investigations winter 1978 - 2004.

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
2004	11.0	18.9	32.0	40.9	52.0	61.8	69.0	79.0

1) *Adjusted lengths*

Table 6.10. COD. Weight (g) at age in main areas of the Barents Sea winter 2004.

Area	Age (year-class)							
	1 (03)	2 (02)	3 (01)	4 (00)	5 (99)	6 (98)	7 (97)	8 (96)
A	11	66	301	749	1290	1947	2606	3905
B	14	136	622	855	1386	2220	2797	4079
C	11	76	301	821	1350	1978	2632	4228
D	11	64	298	591	1087	1945	2858	4180
D’	10	47	243	464	1415	1964	2684	4458
E	10	52	327		1022	2072	3745	3965
S	12	50	253	567	1149	1782	2295	3634
Total	11	58	294	600	1167	1934	2657	4025

Table 6.11. COD. Weight (g) at age in the Barents Sea from the investigations winter 1983-2004.

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
2004	11	58	294	600	1167	1934	2657	4025

1) Estimated weights
2) Adjusted weights

Table 6.12. COD. Yearly weightincrement (g) from the investigations in the Barents Sea winter 1983 - 2004.

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
2003-04	44	212	372	598	632	677	1050

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. Over the most recent 5 year period the acoustic indices have fluctuated more than the swept area indices.

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 later surveys show lower mortalities, but the 2004 survey indicate a new increase. 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 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 possibly 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 1993-2004

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	0,32	0,85	0,46
2003-04	2,78	0,60	1,18	1,32	1,54	1,91	1,76	1,86
	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	0,39	-0,14	0,35	0,51	0,67	0,93	1,31	1,30
2002-03	-0,81	0,16	-0,38	0,39	0,49	0,84	1,13	0,88
2003-04	2,54	0,03	0,78	0,82	0,71	0,90	0,89	1,05

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 the three latest surveys small haddock has been widely distributed, and haddock has been found unusually far to the north. This might be caused by rather favourably hydrographic conditions.

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 (1981-2004), is presented in table 7.3. The indices for ages 2, 5 and 6 are above the 1993-2002 average, and the remaining age groups are fairly close to this average.

Table 7.1. HADDOCK. Abundance indices at length and age from the acoustic survey in the Barents Sea winter 2004 (numbers in millions).

Length cm	Age (year-class) 1 (03)	2 (02)	3 (01)	4 (00)	5 (99)	6 (98)	7 (97)	8 (96)	9 (95)	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	440.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	440.4	9.0
15-20	311.3	36.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	347.8	11.0
20-25	0.0	336.3	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	338.5	32.5
25-30	0.0	101.1	49.4	1.6	0.0	0.0	0.0	0.0	0.0	0.0	152.0	25.2
30-35	0.0	0.4	67.2	22.9	2.7	0.0	0.0	0.0	0.0	0.0	93.1	28.3
35-40	0.0	0.0	7.8	33.5	12.9	0.1	0.0	0.0	0.0	0.0	54.4	25.2
40-45	0.0	0.0	0.1	15.1	28.4	4.3	0.0	0.0	0.0	0.0	47.9	33.5
45-50	0.0	0.0	0.0	1.9	23.5	25.2	3.6	0.0	0.0	0.0	54.3	52.4
50-55	0.0	0.0	0.0	0.8	8.2	26.7	1.5	0.2	0.0	0.0	37.5	46.7
55-60	0.0	0.0	0.0	0.0	0.2	8.7	1.0	0.4	0.0	0.0	10.3	16.4
60-65	0.0	0.0	0.0	0.0	0.0	0.7	0.5	1.4	0.1	0.0	2.8	5.6
65-70	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.2	0.4	1.0
70-75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.4
sum	751.8	474.3	126.7	75.9	76.0	65.9	6.6	2.0	0.1	0.3	1579.5	
Biomass	18.7	50.3	32.7	36.2	60.2	76.2	8.1	3.8	0.2	1.0		287.4

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 2004 (numbers in millions).

		Age (year-class)										
Area	Layer	1 (03)	2 (02)	3 (01)	4 (00)	5 (99)	6 (98)	7 (97)	8 (96)	9 (95)	10+	Biomass ('000 t)
A	P	105.7	75.9	5.4	10.1	17.4	23.2	1.9	1.1	0.0	0.1	68.6
	B	27.7	13.4	1.0	2.0	2.9	3.6	0.3	0.1	0.0	0.0	11.2
B	P	33.1	9.9	1.9	0.7	2.4	6.9	1.0	0.2	0.0	0.0	14.9
	B	25.8	10.4	2.0	0.6	1.9	5.6	0.8	0.2	0.0	0.0	12.6
C	P	38.3	6.1	1.6	2.7	3.6	7.7	0.3	0.2	0.0	0.0	15.1
	B	19.0	3.0	0.7	1.2	1.6	3.4	0.1	0.1	0.0	0.0	6.8
D	P	316.4	181.8	64.5	33.7	30.8	11.1	1.7	0.1	0.0	0.0	94.7
	B	158.4	108.1	35.1	17.2	14.0	4.1	0.6	0.0	0.0	0.0	46.5
D'	P	4.8	26.0	6.0	3.2	0.5	0.0	0.0	0.0	0.0	0.0	6.3
	B	9.1	31.1	7.5	4.1	0.6	0.0	0.0	0.0	0.0	0.0	7.9
E	P	1.4	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	B	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S	P	8.1	5.4	0.7	0.3	0.2	0.1	0.0	0.0	0.0	0.0	1.7
	B	3.9	2.6	0.4	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.8
ABCD	P	493.5	273.6	73.4	47.1	54.2	48.9	4.8	1.6	0.0	0.2	193.3
	B	230.9	134.8	38.7	21.0	20.4	16.7	1.8	0.4	0.0	0.1	77.1
Total	P	507.8	305.6	80.1	50.6	54.9	49.1	4.8	1.6	0.1	0.2	201.4
	B	244.0	168.6	46.6	25.3	21.1	16.8	1.8	0.4	0.0	0.1	85.8
	sum	751.8	474.3	126.7	75.9	76.0	65.9	6.6	2.0	0.1	0.3	287.2

Table 7.3. HADDOCK. Abundance indices from acoustic surveys in the Barents Sea winter 1981-2004 (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
2004	752	474	127	76	76	66	7	2	+	+	1580	287

* 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.

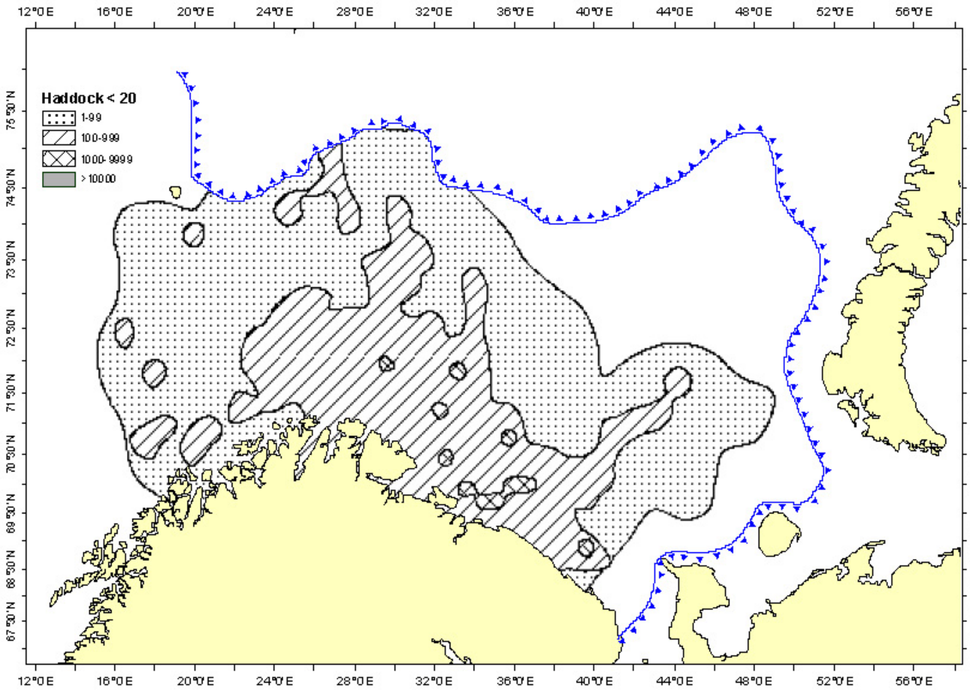

Figure 7.1. HADDOCK < 20 cm. Distribution in the trawl catches winter 2004 (number per hour trawling).

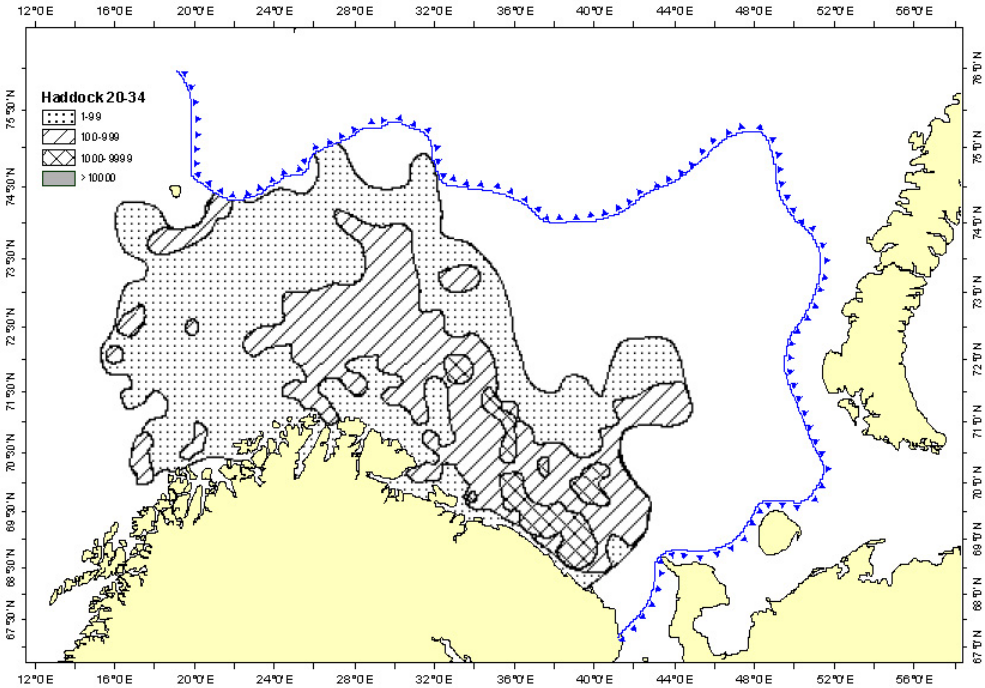

Figure 7.2. HADDOCK 20-34 cm. Distribution in the trawl catches winter 2004 (number per hour trawling).

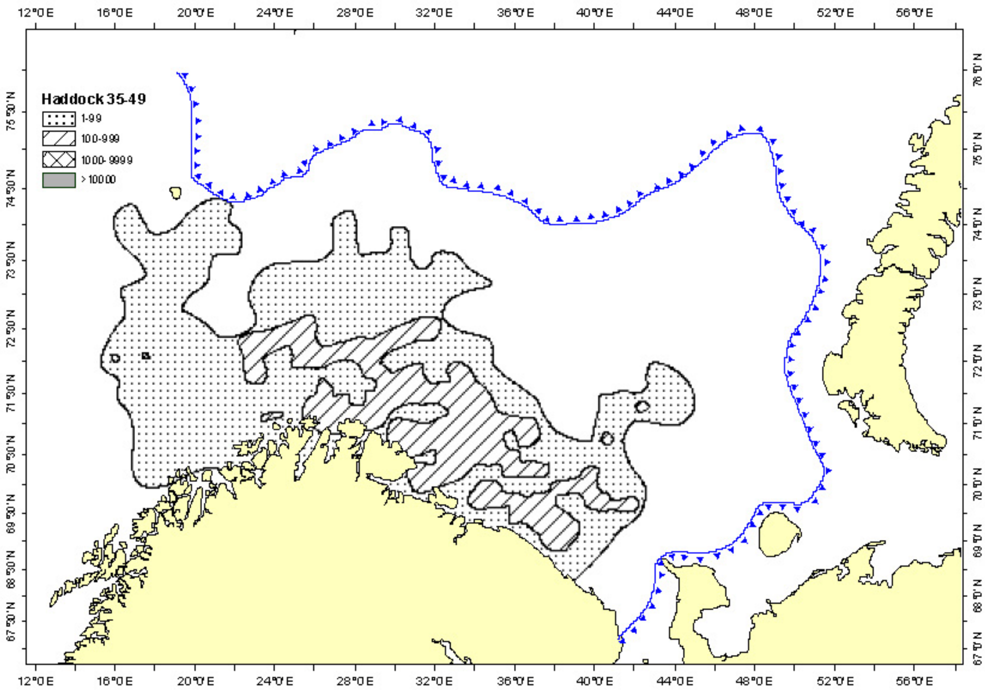

Figure 7.3. HADDOCK 35-49 cm. Distribution in the trawl catches winter 2004 (number per hour trawling).

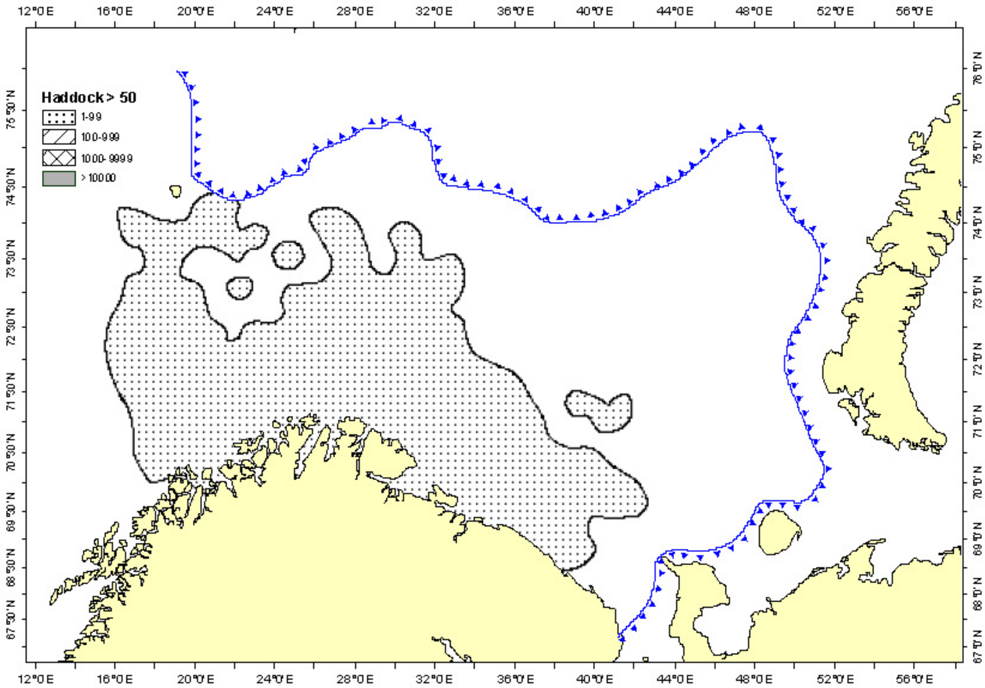

Figure 7.4. HADDOCK > 50 cm. Distribution in the trawl catches winter 2004 (number per hour trawling).

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 (1981-2004) is shown in table 7.7. The swept area index of ages 2, 5 and 6 are the third highest in the 24 year time series.

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 2004 (no. in mill).

	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							0.1	0.1	0.2	0.2					0.2	0.2	75.4
10-14	83.7	10.8	12.8	5.2	32.4	12.3	320.0	41.3	5.2	2.4	4.7	2.9	16.5	5.3	475.2	45.2	9.5
15-19	66.1	11.4	30.7	9.0	30.5	12.4	213.0	28.1	14.1	6.2	1.0	0.4	10.9	3.4	366.2	34.7	9.5
20-24	47.6	6.6	12.3	4.7	4.9	1.2	308.7	45.3	78.6	35.4	0.2	0.1	10.6	2.9	462.8	58.1	12.6
25-29	22.3	3.3	4.9	2.1	4.1	1.9	122.5	16.2	47.7	23.7			5.3	1.4	206.8	29.1	14.0
30-34	8.6	2.0	1.7	0.5	1.4	0.4	88.8	13.4	31.7	14.4			1.1	0.3	133.3	19.8	14.8
35-39	6.8	1.3	0.9	0.3	2.2	0.5	50.7	6.1	10.0	5.7			0.3	0.1	71.0	8.4	11.9
40-44	9.3	1.6	1.7	0.3	5.6	1.6	32.5	3.3	1.3	0.7			0.5	0.2	51.0	4.1	8.0
45-49	10.5	2.3	6.9	1.9	8.7	2.6	20.4	3.1	0.6	0.4			0.4	0.2	47.5	5.0	10.6
50-54	8.4	2.0	7.7	1.8	4.7	1.6	7.8	1.6	0.5	0.4			0.4	0.1	29.3	3.5	12.1
55-59	2.2	0.6	2.4	0.7	0.8	0.3	1.0	0.3	0.0	0.0			0.2	0.1	6.7	1.0	14.8
60-64	0.9	0.2	0.5	0.1	0.2	0.1	0.1	0.0	0.0				0.0	0.0	1.7	0.3	15.5
65-69	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.3	0.1	24.3
70-74	0.0	0.0	0.0	0.0					0.0						0.1	0.0	65.2
75-79	0.0	0.0	0.0	0.0					0.0						0.0	0.0	61.0
80-84	0.0	0.0	0.0	0.0					0.0						0.0	0.0	75.6
85-89																	
>90																	
Sum	266.6	17.9	82.5	11.9	95.5	18.0	1165.5	71.0	189.7	45.8	5.9	2.9	46.3	7.1	1851.9	89.4	4.8

Table 7.5. HADDOCK. Abundance indices at length and age from the bottom trawl survey in the Barents Sea winter 2004 (numbers in millions).

Length	Age (year-class)										Sum	Biomass
cm	1 (03)	2 (02)	3 (01)	4 (00)	5 (99)	6 (98)	7 (97)	8 (96)	9 (95)	10+		('000 t)
5-9	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
10-15	475.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	475.2	8.1
15-20	240.5	125.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	366.2	17.0
20-25	0.0	458.7	4.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	462.8	45.8
25-30	0.0	126.2	77.4	3.2	0.0	0.0	0.0	0.0	0.0	0.0	206.8	37.3
30-35	0.0	0.5	94.7	32.9	5.1	0.0	0.0	0.0	0.0	0.0	133.3	39.7
35-40	0.0	0.0	11.6	45.4	13.8	0.2	0.0	0.0	0.0	0.0	71.0	32.5
40-45	0.0	0.0	0.3	16.8	29.8	3.6	0.5	0.0	0.0	0.0	51.0	34.0
45-50	0.0	0.0	0.0	4.2	22.8	18.7	1.9	0.0	0.0	0.0	47.5	44.2
50-55	0.0	0.0	0.0	0.3	8.5	18.2	2.2	0.2	0.0	0.0	29.3	36.8
55-60	0.0	0.0	0.0	0.0	0.4	4.9	0.8	0.4	0.1	0.0	6.7	11.0
60-65	0.0	0.0	0.0	0.0	0.1	0.6	0.5	0.4	0.1	0.0	1.7	3.6
65-70	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.1	0.3	0.7
70-75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2
75-80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2
80-85	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
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	715.9	711.2	188.1	102.7	80.4	46.2	5.9	1.1	0.2	0.2	1852.0	
Biomass	16.5	69.7	50.0	47.2	62.7	53.9	7.8	2.0	0.5	0.9		311.2

Table 7.6 HADDOCK. Abundance indices from bottom trawl hauls for main areas of the Barents Sea winter 2004 (numbers in millions).

Area	Age (year-class)										Biomass
	1 (03)	2 (02)	3 (01)	4 (00)	5 (99)	6 (98)	7 (97)	8 (96)	9 (95)	10+	
A	126.5	88.8	11.0	11.6	15.8	11.4	1.1	0.2	0.1	0.1	52.3
B	37.9	21.0	3.4	1.9	3.7	11.7	2.4	0.5	0.1	0.1	27.1
C	57.1	13.2	2.5	5.3	6.7	9.5	0.8	0.3	0.0	0.0	24.1
D	456.1	439.0	140.0	63.5	52.1	13.0	1.6	0.1	0.0	0.0	170.9
D'	9.3	129.8	29.1	19.5	1.8	0.3	0.0	0.0	0.0	0.0	31.8
E	5.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
S	23.2	19.2	2.1	0.9	0.4	0.4	0.1	0.0	0.0	0.0	5.0
ABCD	677.6	562.0	156.9	82.4	78.3	45.5	5.8	1.1	0.2	0.2	274.5
Total	715.9	711.2	188.1	102.7	80.4	46.2	5.9	1.1	0.2	0.1	311.5

Table 7.7. HADDOCK. Abundance indices from bottom trawl surveys in the Barents Sea winter 1981-2004 (numbers in millions). 1981-1992 includes only main areas A, B, C and D.

Year	Age										Total	Biomass
	1	2	3	4	5	6	7	8	9	10+		('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
2004	715.9	711.2	188.1	102.7	80.4	46.2	5.9	1.1	0.2	0.1	1852.0	311

1) Indices raised to also represent the Russian EEZ.

7.3 Growth

Mean length and weight at age for each main area in 2004 are shown in table 7.8 and 7.10. The time series (1983-2004) is shown in tables 7.9 and 7.11.

Table 7.8. HADDOCK. Length (cm) at age in main areas of the Barents Sea winter 2004.

Area	Age (year-class)							
	1 (03)	2 (02)	3 (01)	4 (00)	5 (99)	6 (98)	7 (97)	8 (96)
A	14.3	22.2	30.8	38.3	45.3	50.8	55.2	61.5
B	15.1	21.4	29.7	40.0	47.4	50.3	52.0	58.8
C	14.4	21.4	29.8	40.3	45.7	48.8	51.6	53.9
D	14.0	22.1	30.4	36.3	42.1	48.9	48.0	62.3
D'	14.2	22.8	31.9	33.8	44.3	53.2		
E	12.9	21.5						
S	14.1	22.7	30.0	41.8	47.1	54.3	49.5	
Total	14.2	22.3	30.6	36.3	43.4	49.8	51.4	58.0

Table 7.9. HADDOCK. Length (cm) at age in the Barents Sea from the investigations winter 1983 – 2004.

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	16.1	27.7	27.7	35.4	39.7	47.5	50.1
1998	14.4	29.2	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	22.2	22.2	32.2	37.8	47.2	51.2	58.7
2002	21.1	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
2004	14.2	22.3	30.6	36.3	43.4	49.8	51.4

[1] Adjusted lengths

Table 7.10. HADDOCK. Weight (g) at age in main areas of the Barents Sea winter 2004.

Area	Age (year-class)							
	1 (03)	2 (02)	3 (01)	4 (00)	5 (99)	6 (98)	7 (97)	8 (96)
A	24	100	271	544	904	1228	1684	2134
B	26	83	250	620	972	1213	1369	1950
C	24	86	252	607	887	1086	1293	1608
D	23	96	260	448	713	1112	1054	2237
D’	27	105	300	373	826	1513		
E	21	100						
S	25	108	257	760	990	1581	1244	
Total	23	98	266	459	780	1167	1328	1894

Table 7.11. HADDOCK. Weight (g) at age in the Barents Sea from the investigations winter 1983 - 2004.

Year	Age						
	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*	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**	35	88	200	429	625	1063	1286
1998**	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
2004	23	98	266	459	780	1167	1328

* Estimated weights **Adjusted weights

Table 7.12. HADDOCK. Yearly weight increment (g) from the investigations in the Barents Sea winter 1983 - 2004.

Year	Age					
	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	-21
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	361	744
2001-02	56	38	286	292	241	603
2002-03	97	118	349	358	341	272
2003-04	60	139	257	287	186	139

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. Mortalities based on the swept area indices show a decreasing trend since 1998 (table 7.13), but signs of a new increase according to the latest survey.

Table 7.13. Total mortality observed for haddock during the winter survey in the Barents Sea for the period 1993-2004.

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	1.63
2003-04	1.62	0.79	0.65	0.96	0.94	0.96	0.92
	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
2002-03	1.19	0.52	0.55	0.92	1.16	1.27	1.39
2003-04	1.54	1.00	1.13	0.82	0.47	-0.07	0.74

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 2004, 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 in 2004 is very similar to those observed in the two previous years. 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.

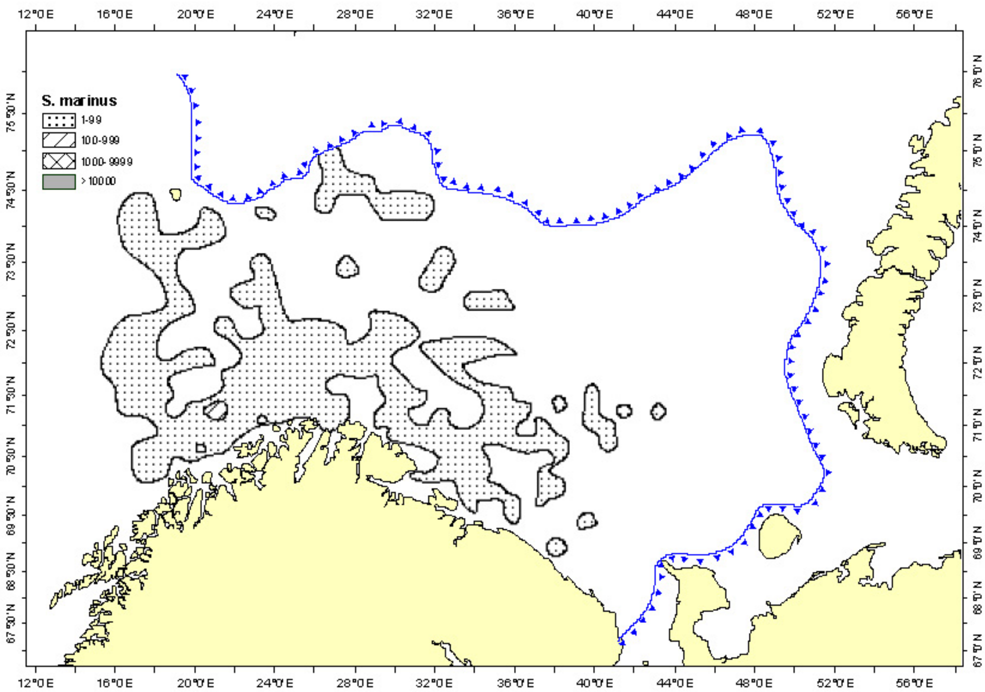

Figure 8.1. *Sebastes marinus*. Distribution in the trawl catches winter 2004 (no. per hour trawling).

The time series for 1986-2004 (table 8.3), shows historic low indices for all the length-groups below 30 cm. Thus, 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 2004 (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	0.15	0.15			0.03	0.03	0.52	0.52							0.70	0.54	77.2
10-14					0.01	0.01	0.10	0.05					0.08	0.06	0.19	0.08	40.8
15-19	0.10	0.08	0.09	0.06	0.02	0.02	0.18	0.07	0.03	0.03					0.42	0.12	30.0
20-24	0.12	0.07	0.30	0.23	0.03	0.02	0.25	0.07	0.03	0.03			0.22	0.07	0.95	0.27	27.8
25-29	0.14	0.06	1.42	0.97	0.03	0.02	0.88	0.19					0.40	0.14	2.86	1.00	34.9
30-34	0.29	0.14	2.98	2.46	0.07	0.03	0.43	0.10					0.61	0.20	4.42	2.47	56.0
35-39	0.64	0.21	3.96	2.89	0.18	0.05	0.46	0.21			0.04	0.04	0.29	0.09	5.53	2.90	52.5
40-44	1.23	0.51	1.99	0.83	0.16	0.06	0.39	0.14					0.24	0.11	4.02	1.00	24.2
45-49	0.88	0.27	1.09	0.53	0.23	0.07	0.17	0.08					0.10	0.05	2.47	0.61	24.7
50-54	0.23	0.11	0.23	0.11	0.06	0.03	0.03	0.02					0.04	0.03	0.59	0.16	26.7
55-59	0.12	0.07											0.02	0.02	0.14	0.07	52.9
60-64			0.02	0.02											0.02	0.02	100.0
>65			0.02	0.02											0.02	0.02	100.0
Sum	3.90	0.67	12.09	4.05	0.81	0.14	3.42	0.63	0.07	0.04	0.04	0.04	1.99	0.30	22.32	4.16	18.7

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 2004 (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	0.78	0.20	0.69	0.32	0.03	0.02	0.26	0.11	0.03	0.03			0.42	0.18	2.22	0.44	19.7
10-14	0.87	0.21	0.08	0.05	0.07	0.06	0.53	0.15					1.40	0.40	2.96	0.48	16.4
15-19	2.17	0.55			0.01	0.01	1.79	0.61					2.92	0.79	6.89	1.14	16.5
20-24	6.24	1.19			0.44	0.15	7.94	3.38					3.86	1.03	18.48	3.73	20.2
25-29	18.01	3.20	0.03	0.03	0.42	0.17	2.09	1.13					12.30	3.56	32.86	4.92	15.0
30-34	51.21	10.04	1.81	1.55	4.13	1.81	2.91	1.28					26.63	7.42	86.70	12.77	14.7
35-39	20.44	5.18	0.63	0.42	1.19	0.59	0.77	0.36					8.80	2.69	31.84	5.89	18.5
40-44	1.00	0.30	0.26	0.12	0.14	0.07	0.09	0.05					0.45	0.19	1.95	0.39	19.9
>45			0.06	0.04	0.02	0.02									0.09	0.08	67.0
Sum	100.74	11.82	3.59	1.64	6.45	1.92	16.38	3.86	0.03	0.03			56.79	8.76	183.98	15.42	8.4

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 1986-2004 (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
2004	0.7	0.2	0.4	1.0	2.9	4.4	5.5	4.0	3.2	22

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

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 to the west and of Spitsbergen.

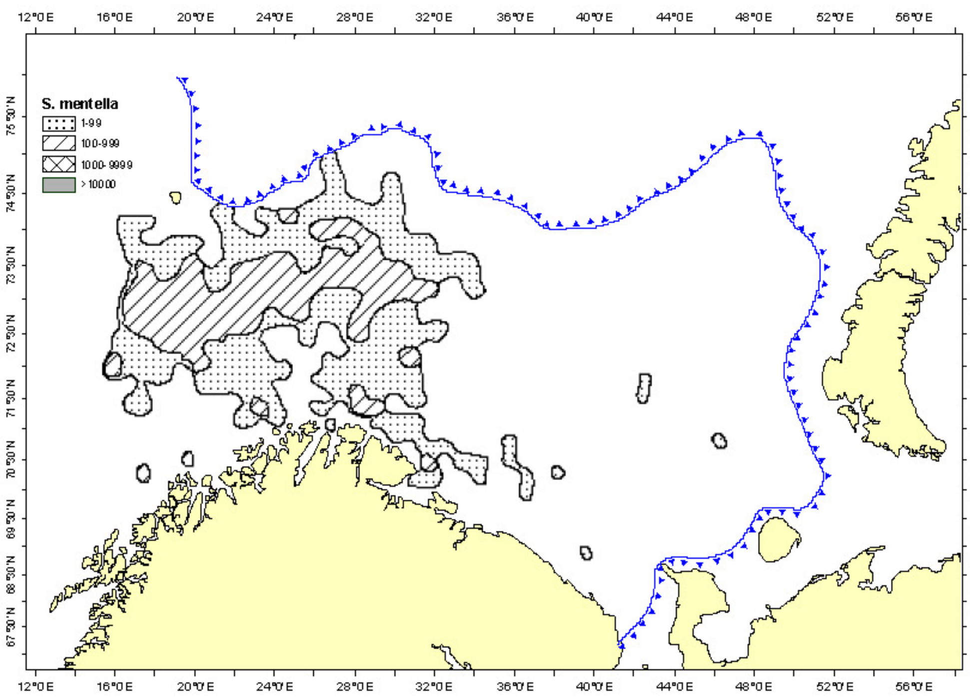

Figure 8.2. *Sebastes mentella*. Distribution in the trawl catches winter 2004 (no. per hour trawling).

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 (1986-2004) of swept area indices for *S. mentella* is presented in table 8.4. Compared to the previous year the values in 2004 show a decrease for all size groups. 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.

This index for *S. mentella* may be an underestimate compared to those in recent years, since some of the important redfish stations south-east of Bear Island were not covered.

Table 8.4. SEBASTES MENTELLA.[1] Abundance indices from bottom trawl surveys in the Barents Sea winter 1986-2004 (numbers in millions). 1986-1992 includes only main areas A. B. C and D.

Year	Length group (cm)									Total
	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	> 45	
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
2004	2.2	3.0	6.9	18.5	32.9	86.7	31.8	2.0	0.1	184

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 1990-2004 is presented in table 9.2. Compared to the 2003 values the indices for fish less than 40 cm are higher, while those for larger fish are lower.

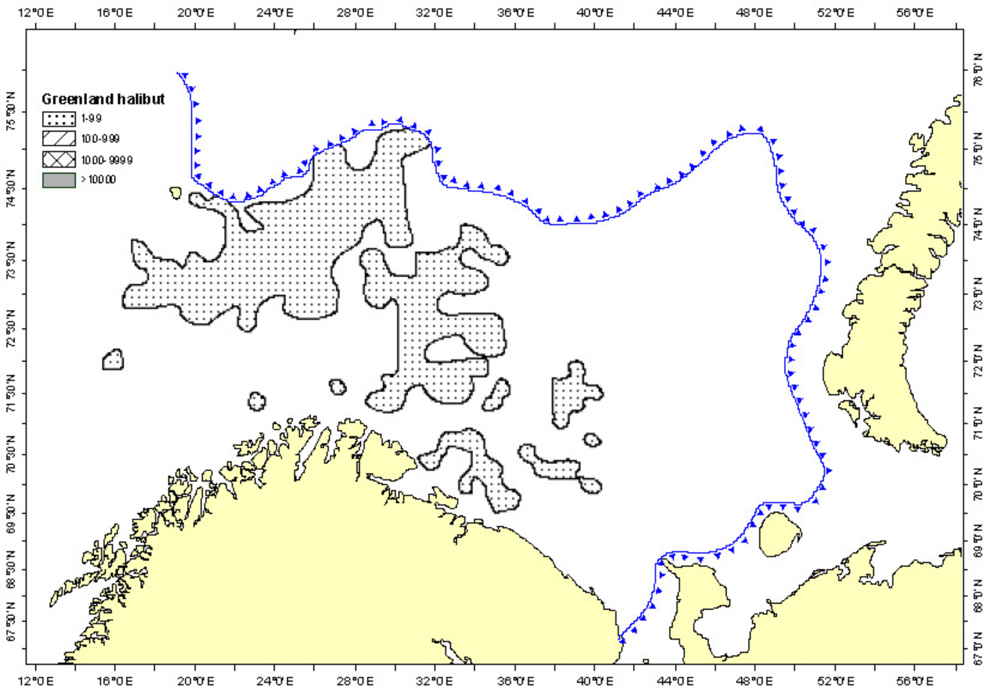

Figure 9.1. GREENLAND HALIBUT. Distribution of bottom trawl catch rates (number per hour) winter 2004.

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 2004 (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	25	25													25	25	100
10-14							22	22					20	20	42	30	71
15-19							22	22					81	50	103	54	53
20-24							15	15							15	15	100
25-29																	
30-34							103	42			37	37	176	54	316	78	25
35-39	98	55					369	127			37	37	734	185	1238	234	19
40-44	163	80					408	121			75	75	578	119	1224	202	17
45-49	149	85	13	13			776	229					775	179	1714	303	18
50-54	480	147			20	14	908	250					870	266	2278	394	17
55-59	283	135					555	126					389	100	1227	211	17
60-64	77	40			11	11	286	66					417	105	791	131	17
65-69	58	42					105	54					135	53	298	87	29
70-74							41	30					105	45	146	54	37
75-79					11	11	66	37					18	18	95	43	45
80-84	26	26													26	26	100
Sum	1358	248	13	13	42	21	3675	418			149	91	4299	428	9537	654	7

Table 9.2. GREENLAND HALIBUT. Abundance indices from the bottom trawl surveys in the Barents Sea winter 1990-2004 (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.

Year	Length group (cm)															
	<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
2004	67	103	15	0	316	1238	1224	1714	2278	1227	791	298	146	95	26	9537

9.2 Blue whiting

Since 2000 the blue whiting has shown a wider distribution than usual. The echo recordings in 2001 and 2002 indicated unusual high abundance in the Barents Sea, while in 2003 it had decreased considerably. In the 2004 survey the echo abundance increased again. Figure 9.2 shows the geographical distribution of the bottom trawl catch rates of blue whiting in 2004. Compared to the 2003 results, the distribution of catch rates in 2004 extended further to the north, and the areas with highest catch rates have increased. 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 15-30 cm.

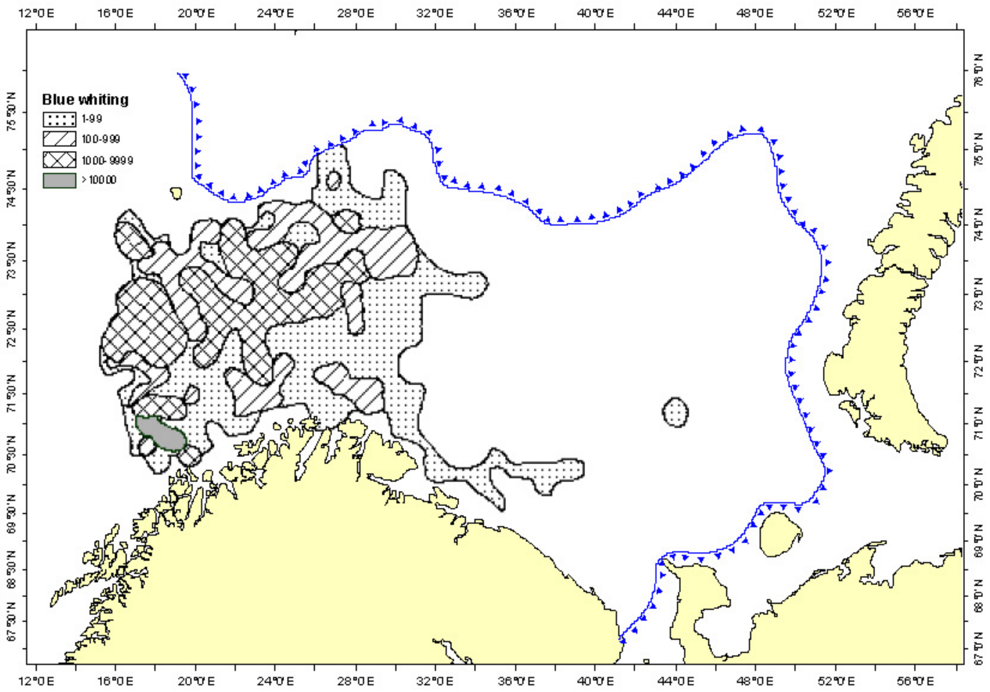

Figure 9.2. BLUE WHITING. Distribution in the trawl catches winter 2004 (no. per hour trawling).

10. COMPARISONS BETWEEN RESEARCH VESSELS

"G.O.Sars" and "Johan Hjort" worked 53 parallel bottom trawl tows. The reason for these rather extensive comparison was to have a proper basis for testing whether the new "G. O. Sars" fished equal to "Johan Hjort". In addition it was important to optimise the use of the new type of trawl doors. The results will be given in a separate report.

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Appendix

Results from macroplankton research
in the Barents Sea in autumn-winter 2003/04
by Natalia Zhukova

Summary
Regular macroplankton surveys have been conducted by PINRO in the Barents Sea since 1952. These researches are executed, most of all, with the purpose to study a relative abundance and distribution of euphausiids (krill), which represent one of the central rings in the trophic chain and serve as an important component in feeding of commercial fishes. Macroplankton surveys involve annual monitoring of the abundance and distribution of crustaceans in the period of autumn-winter trawl-acoustic survey for demersal fishes. The trawl net (50 cm diameter of opening, sieve mesh size – 564 µm) attached to the upper headline of bottom trawl and taking macroplankton in 5-10 layer from the bottom was used as a sampling gear. Since in winter crustaceans are concentrated in the near-bottom layer and have no pronounced daily migrations, the results from the catches of euphausiids during autumn-winter survey are applied to estimate year-to-year dynamics of their abundance in the Barents Sea.

Material and methods
In autumn-winter 2003/04, the samples of macroplankton were collected during the three cruises by the Russian R/Vs ("Smolensk" 16.10.03-30.12.03; "Fritjof Nansen" 14.11.03-25.12.03; "Smolensk" 20.02.04-13.03.04) and by the Norwegian one "G.O.Sars" (07.02.04-01.03.04). In all, 373 macroplankton samples were collected.

Samples were preserved in 10 % formaldehyde. The indices of euphausiids abundance expressed in ind./1000 m^3 are calculated by the results from catches euphausiids by trawl net. These indices are derived as an arithmetic mean from the sum of all the catches taken in some fishing areas corresponding to the scheme of the Barents Sea divisioning. Length of krill was measured from the tip of rostrum to the end of telson. Specific and size composition of the euphausiids were determined *in vitro* on land.

By the results of the processing of samples collected in autumn-winter period of 2003/04, the mean annual indices of euphausiids abundance exceeded the long-term mean in 1.6 times both in the northwest and southern areas (Table 1). However, a considerable reduction of these indices as compared to the previous year was noticed. The decrease in the total abundance of euphausiids was, possibly, caused by the diminished portion of brought species as a result of the reduction in the Atlantic water inflow.

Table 1. Mean annual indices of krill abundance, ind./1000 m^3

Year	Mean annual indices of krill abundance	
	southern sea	northwestern sea
2002/03	1159	1354
2003/04	689	689
Mean for 1952-2002	411	464

The densest concentrations of euphausiids (> 5000 ind./1000 m^3) were registered in the area of the Hopen Island, in the eastern slope of the Bear Island bank and in the eastern sea (Fig.1). They were space-saving and distributed in the limited area. The dense concentrations of the euphausiids (1000-5000 ind./1000 m^3) were located along the Western Spitsbergen Shelf, in the northwest and southeastern sea. The bottom concentrations of crustaceans with the density of over 1000 ind./1000 m^3 were recorded in the central and coastal areas. The concentrations of euphausiids with the mean density (500-1000 ind./1000 m^3) were registered in the wide area both in the southern and northwestern areas.

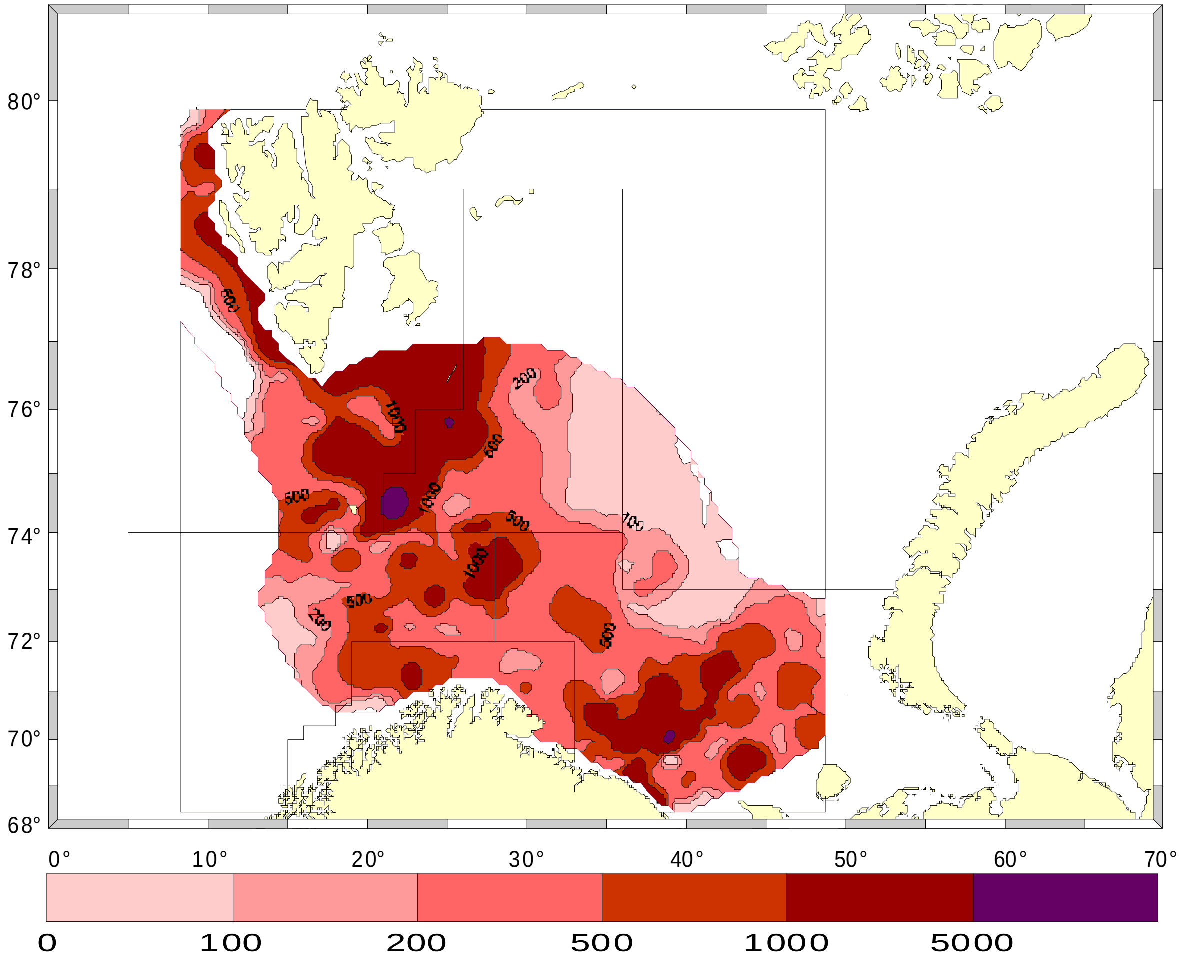

Fig.1. Distribution of krill abundance in October-February 2003/04, ind./1000 m^3.

Specific composition of euphausiids in the Barents Sea in October-February 2003/04 is given in Fig.2. In the samples *Thysanoessa raschii* prevailed and made up 49 %. The relative abundance of *T. inermis* was 26 %, of *Meganyctiphanes norvegica* – 22 % and of *T. longicaudata* – 3 %. Only single specimens of *Nematoscelis megalops* were found in the catches by trawl net in the western sea (0.21 % of the total abundance of euphausiids in samples). On the whole, in October-February 2003/04, the predominance of *T. raschii* was noticed in the eastern sea while of *T. inermis* – in the western areas (Table 2).

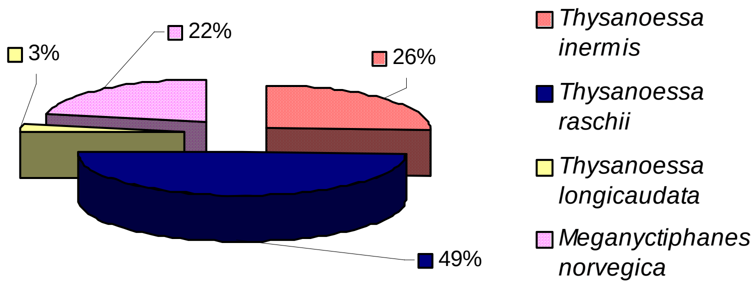

Fig.2. Relative amount of krill species in the southern sea in 2003/04 (% from the total number of krill in samples).

Table 2. Species composition of krill in 2003/04 in the separated areas of the Barents Sea (% from the total number of krill in samples).

Area	Species			
	T. inermis	*T. raschii*	*T. longicaudata*	*M.norvegica*
Eastern	5	81	0.1	14
Central	33	52	2	13
Coastal	38	41	1	21
Western	40	1	14	45
Mean for the southern sea	26	49	3	22

Besides the euphausiids, the abundant representatives of macroplankton in the trawl net samples were hyperiids and arrowworms (fig.3 A, B). The abundance of hyperiids in the near-bottom layer was low – the indices of abundance fluctuated from 1 to 880 ind./1000 m^3, the mean index of abundance of *Themisto spp.* amounted to 40 ind./1000 m^3. The indices of the arrowworms abundance varied from 12 to 10336 ind./1000 m^3. In the period of the cruise the mean index of abundance of *Sagitta spp*. was 637 ind./1000 m^3.

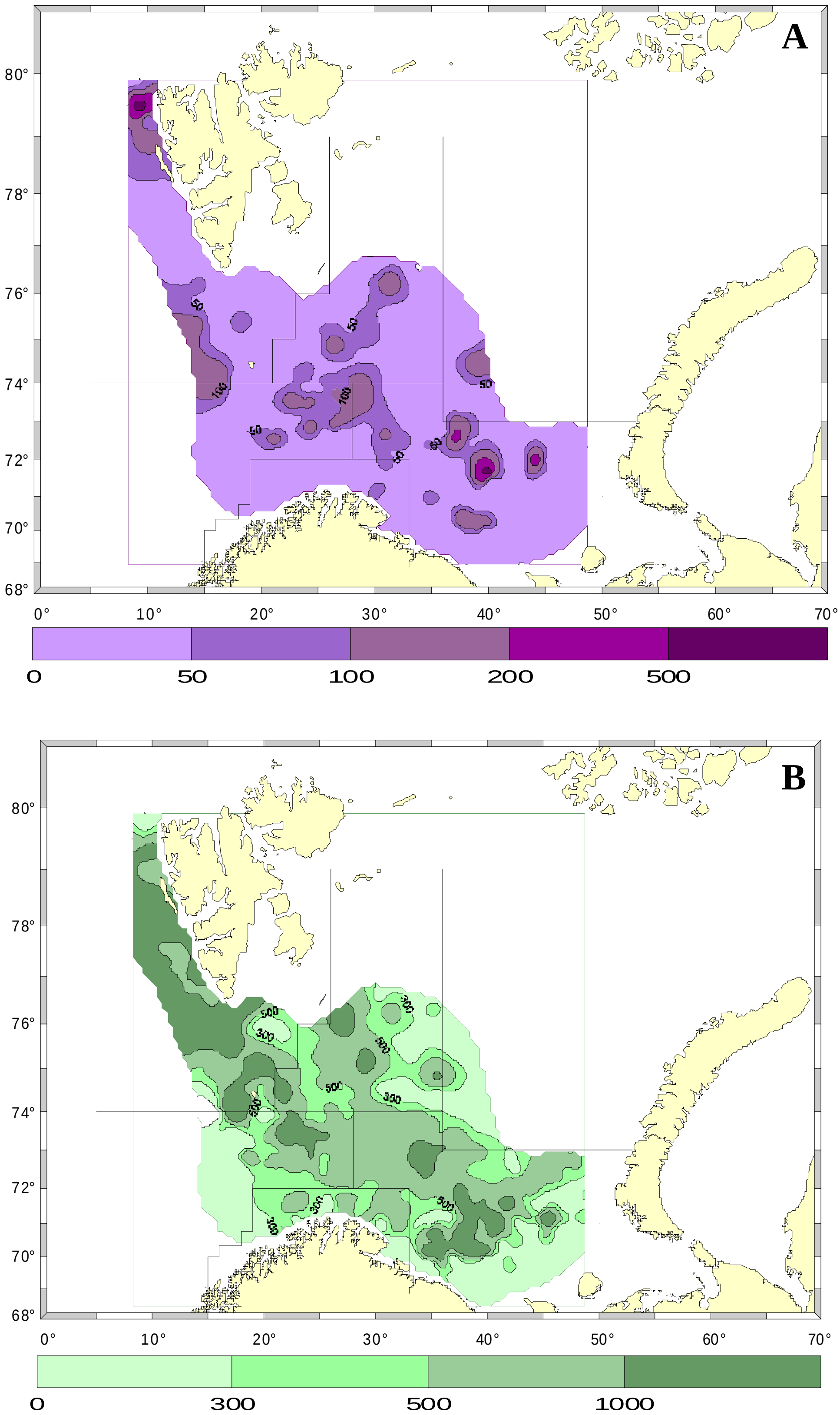

Fig.3. Distribution of hyperiids (A) and arrowworms (B) abundance in October-February 2003/04, ind./1000 m^3.

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