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Fish investigations in the Barents Sea winter 2007-2012

By

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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 international landings statistics. The results from the demersal fish winter surveys in the Barents Sea are an important source of information for the annual stock assessment.

The development of the survey started in the early 1970s and 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 Jakobsen *et al*. (1997), Johannesen *et al*. (2009) and Appendix 2. 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 fish 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 main results from the surveys in February-March 2007-2012. The surveys were performed with the Norwegian research vessels "G.O. Sars", "Johan Hjort" and "Jan Mayen", Norwegian fishing vessel "Libas" and the Russian research vessels "Fridtjof Nansen", "Smolensk" and "Vilnyus". Annual survey reports since 1981 are listed in Appendix 1, and names of scientific participants are given in Appendix 3.

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 15 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
- Map the distribution of maturing/prespawning capelin

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 warmer climate and increasing stock size in the early 1990s, the cod distribution area increased. Consequently, 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, and since then the survey has aimed at covering the whole cod distribution area in open water. In most years since 1997 Norwegian research vessels have had limited access to the Russian EEZ, and in 1997, 1998 and 2007 the vessels were not allowed to work in the Russian EEZ. In 1999 the coverage was partly limited by a rather unusually wide ice-extension. Since 2001, except in 2006 and 2007, Russian research vessels have participated in the survey and the coverage has been better, but for various reasons not complete in most years. In 2008-2012 Norwegian vessels had access to major parts of the Russian EEZ. The coverage was more complete in these years, especially in 2008 and 2011. In 2009, 2010 and 2012 the coverage in east was more limited due to strict rules regarding handling of the catch, bad weather and vessel problems. Table 3.6 summarizes degree of coverage and main reasons for incomplete coverage in the Barents Sea winter 1981-2012.

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 1990s Simrad EK500 echo sounder and Bergen Echo Integrator (BEI, Knudsen 1990) have been used. The Simrad ER60 echo sounder and the Large Scale Survey System (LSSS, Korneliussen *et al*. 2006) has replaced the EK500 and BEI; on the new R/V "G.O. Sars" since the 2004 survey, on R/V "Johan Hjort" since the 2005 survey, on R/V "Jan Mayen" since the 2008 survey and on F/V "Libas" in the 2012 survey. On the Russian vessels EK 500 was used from 2000 to 2004 and ER60 since 2005.

In the mid 1990s the echo sounder transducers were moved from the hull to a retractable centreboard, on R/V "Johan Hjort" since the 1994 survey, on the old R/V "G.O. Sars" since the 1997 survey, on R/V "Jan Mayen" since the 2008 survey and on F/V "Libas" in the 2012 survey. This latter change has largely reduced the signal loss due to air bubbles in the close to surface layer. None of the Russian vessels have retractable centreboards.

On the Norwegian vessels acoustic backscattering values (s_A) are stored at high resolution in LSSS. After scrutinizing and allocating the values to species or species groups, the values are stored with 10 m vertical resolution and 1 nautical mile (NM) 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
- inspection of target frequency responses

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 10 m above bottom) and the pelagic zone (more than 10 m above bottom). Each of those acoustic densities by rectangle are then converted to fish densities by the equation:

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

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

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

Indices 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 the indices for cod and haddock were revised and some errors in the time series were discovered and corrected (Bogstad *et al.* 1999).

Combining equations 1 and 2 gives:

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

$\overline{L^2}$ 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. 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 1 cm length groups form the basis for calculating mean squared length. The bottom trawl catches are normalised to 1 NM towing distance and adjusted for length dependant fishing efficiency (Aglen and Nakken 1997, see below). Length distributions from pelagic catches are applied unmodified. Since 2001 the post processing program BEAM has been used for working out the acoustic estimates. This program provides an automatic allocation of trawl samples to strata (rectangles). The automatic allocation is modified by the user when considered necessary.

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, these 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 2.1). Estimates by length are converted to estimates by age using an age length key for each main area. The total biomass is estimated by multiplying the numbers at age by weight at age from the swept area estimates (see section 2.3).

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 12 m wire for connection to the doors.

Vaco doors ($6 m^2$, 1500kg), were previously standard trawl doors on board the Norwegian research vessels. On the Russian vessels and hired vessels V-type doors (ca $7\ m^2$) have been used. In 2004, R/V “Johan Hjort” and R/V “G.O. Sars” changed to a V-type door (Steinshamn W-9, $7.1 m^2$, 2050kg), the same type as used on the Russian research vessels. In 2010 the V-doors were replaced by 125” Thyborøn trawl doors. R/V “Jan Mayen” has used Thyborøn trawl doors since the 2008 survey and F/V “Libas” used such doors in the 2012 survey.

In order to achieve constant sampling width of a trawl haul independent of e.g. depth and wire length, a 10-14 m rope “locks” the distance between the trawl wires 80-150 m in front of the trawl doors on the Norwegian vessels. 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.

Strapping is not applied on the Russians vessels, but the normal distance between the doors is about 50 m (D. Prozorkevich, pers. comm.).

Standard tow duration is now 15 minutes (until 1985 the tow duration was 60 min. and from 1986 to 2010 30 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. In 2005-2008 sensors monitoring the roll and pitch angle of the doors were used due to problems with the Steinshamn W-9 doors. The data is logged on files, but have so far not been used for further evaluation of the quality of the trawl hauls.

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 and D, Fig 2.1) and 35 strata.

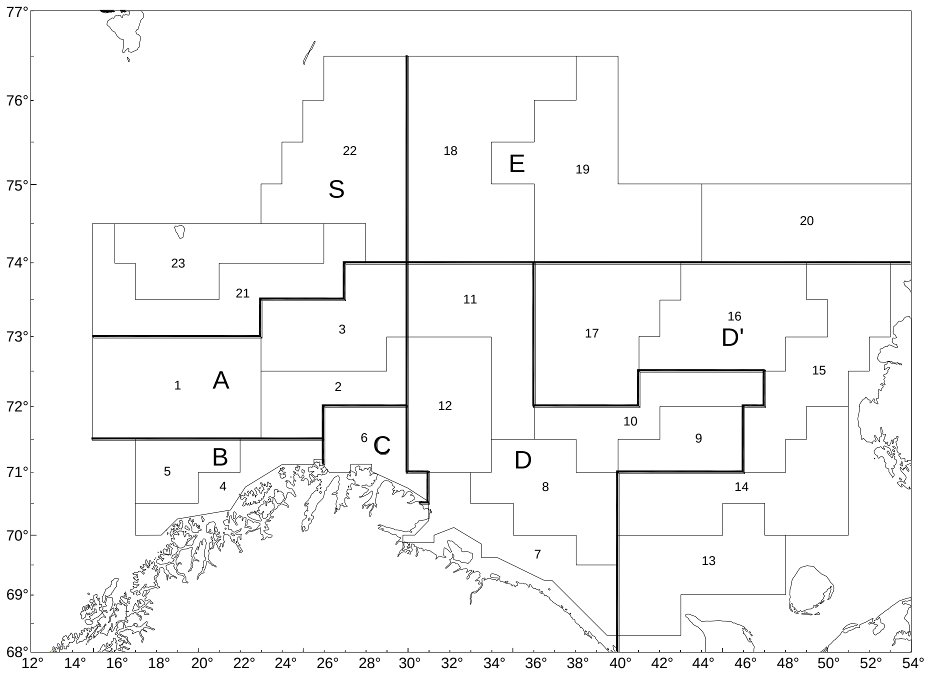


Figure 2.1. Strata (1-23) and main areas (A,B,C,D,D',E and S) used for swept area estimations. The main areas are also used for acoustic estimation.

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 1990s trawl stations have been spread out more evenly, yet the distance between stations in the most important cod strata is shorter (16 NM) compared to the less important strata (24 or 36 NM). During the 1990s 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 3.5), 28 strata altogether. In the 1993-1995 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. In later years a few pre-defined trawl stations have been performed north of the strata system (Figure 3.1) due to increased abundance of cod in these areas. However, the data are so far not included in the estimation of abundance indices.

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 (nm)

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 most northern and most eastern strata differs from year to year. The areas of these strata are therefore calculated according to the coverage each year (Table 3.5). 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 Mjanger *et al*. (2011). 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. In 2007-2009, all cod above 80 cm were sampled, and in 2010 all above 90 cm, limited to 10 per station. 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 otolith sampling. From this species otoliths were collected from 5 fish per 5 cm length group for each sex on all stations. Table 3.4 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*

2.4 Estimation of uncertainty

The swept area survey indices of cod and haddock are presented together with an estimate of uncertainty (coefficient of variation; CV). These estimates was made using a stratified bootstrap routine treating each trawl station as the primary sampling unit. The estimated CV (variance · 100/mean) is strongly dependent on the choice of estimator for the indices.

3 Survey operation and material

Table 3.1 presents the vessels participating in the survey in 2007 – 2012 and IMR trawl station series numbers are given in Table 3.2. Catch data and biological samples from the Russian vessels were converted to the IMR SPD-format. The acoustic data from the Russian vessels was reported to IMR as allocated values by species at 5 nm intervals, split on a bottom layer (<10m from bottom) and a pelagic layer (>10m above bottom).

Table 3.1. Norwegian and Russian vessel participation by time period for the winter surveys 2007-2012.

Vessel	Year					
	2007	**2008**	**2009[1]**	**2010**	**2011**	**2012**
G.O. Sars	12.02-14.03					
Johan Hjort	04.02-11.03	02.02-13.03	08.02-12.03	07.02-16.03	05.02-13.03	
Jan Mayen[2]		02.02-05.03	02.02-06.03	03.02-04.03	01.02-28.02	24.01-20.02
Libas						24.02-14.03
Fridtjof Nansen		05.02-24.02	26.02-04.03	27.02-10.03	03.02-18.02	02.05-17.02
Smolensk		27.01-11.02				
Vilnyus			27.02-12.03			

[1] Pelagic stations from capelin survey with “Libas” and “Eros” were included in the acoustic estimates
[2] Renamed “Helmer Hanssen” autumn 2011

Table 3.2. Norwegian trawl station series numbers by vessel for the winter surveys 2007-2012

Vessel	Year					
	2007	**2008**	**2009**	**2010**	**2011**	**2012**
G.O. Sars	70301-70464					
Johan Hjort	70001-70182	70001-70174	70001-70152	70001-70159	70001-70154	
Jan Mayen		70301-70471	70301-70474	70301-70480	70301-70486	70301-70473
Libas						70001-70073
Fridtjof Nansen		70701-70791	70701-70737	00001-00064	70501-70585	70501-70573
Smolensk		00001-00045				
Vilnyus			70801-70844			

Table 3.3 presents the number of swept area trawl stations, other bottom trawl stations and pelagic trawl stations taken in the different main areas. For the calculation of swept area indices, only the successful pre-defined bottom trawl stations within the strata system were used. The number of stations outside the strata system and trawl experiments are also given.

Table 3.4 gives an account of the sampled length- and age material from bottom hauls and pelagic hauls. Figure 3.1 shows survey tracks and trawl stations for each survey in 2007-2012.

Table 3.3. Number of trawl stations by main area in the Barents Sea winter 2007-2012. B1= swept area bottom trawl (quality=1 and condition<3), B2=other bottom trawl, P=pelagic trawl, O=trawl stations outside the strata system, T=trawl experiments and testing.

		Year					
Main area	Trawl type	2007[1]	2008	2009	2010	2011	2012[2]
	B1	48	38	41	44	35	40
A	B2	7	-	6	-	1	-
	P	8	2	1	2	1	2
	B1	27	29	32	31	25	29
B	B2	3	-	1	-	1	-
	P	5	2	1	3	1	1
	B1	20	21	15	22	22	19
C	B2	-	2	-	-	-	-
	P	3	3	-	-	-	2
	B1	55	138	124	148	156	94
D	B2	4	9	3	3	7	2
	P	4	16	17	11	7	2
	B1	10	43	35	13	54	11
D'	B2	-	-	-	-	2	1
	P	1	6	6	0	1	-
	B1	28	23	24	27	26	27
E	B2	1	-	1	1	1	-
	P	4	3	1	3	4	3
	B1	74	55	63	66	66	65
S	B2	1	-	11	-	1	1
	P	12	-	5	1	5	3
	B1	262	347	334	351	384	285
Inside strata	B2	16	11	22	4	13	4
system	P	37	32	31	20	19	13
	B	13	-	1	2	2	15
O	P	3	1	-	2	-	1
T	B	15	90	19	4	7	1
Total	B+B1 +B2+P	346	481	407	403	425	319

[1]REZ not covered [2]REZ(Area D') not completely covered

Table 3.4. Number of fish measured for length (L) and age (A) in the Barents Sea winter 2007-2012.

Year	**Cod**		**Haddock**		***S .marinus***		***S. mentella***		**Greenland halibut**	**Blue whiting**
	L	A	L	A	L	A	L	A	L	L
2007[1]	16556	2954	22610	2023	798	393	4544	668	973	4657
2008	26844	3809	50195	2490	897	229	8568	769	1020	1350
2009	22528	3486	40872	2433	455	200	9205	1004	807	891
2010	30209	4085	35881	2367	429	198	8564	1450	984	626
2011	26913	3959	29180	2260	286	119	6885	1217	607	105
2012[2]	17139	3020	33524	1854	574	162	5721	1093	354	2441

[1]REZ not covered [2]REZ(Area D') not completely covered

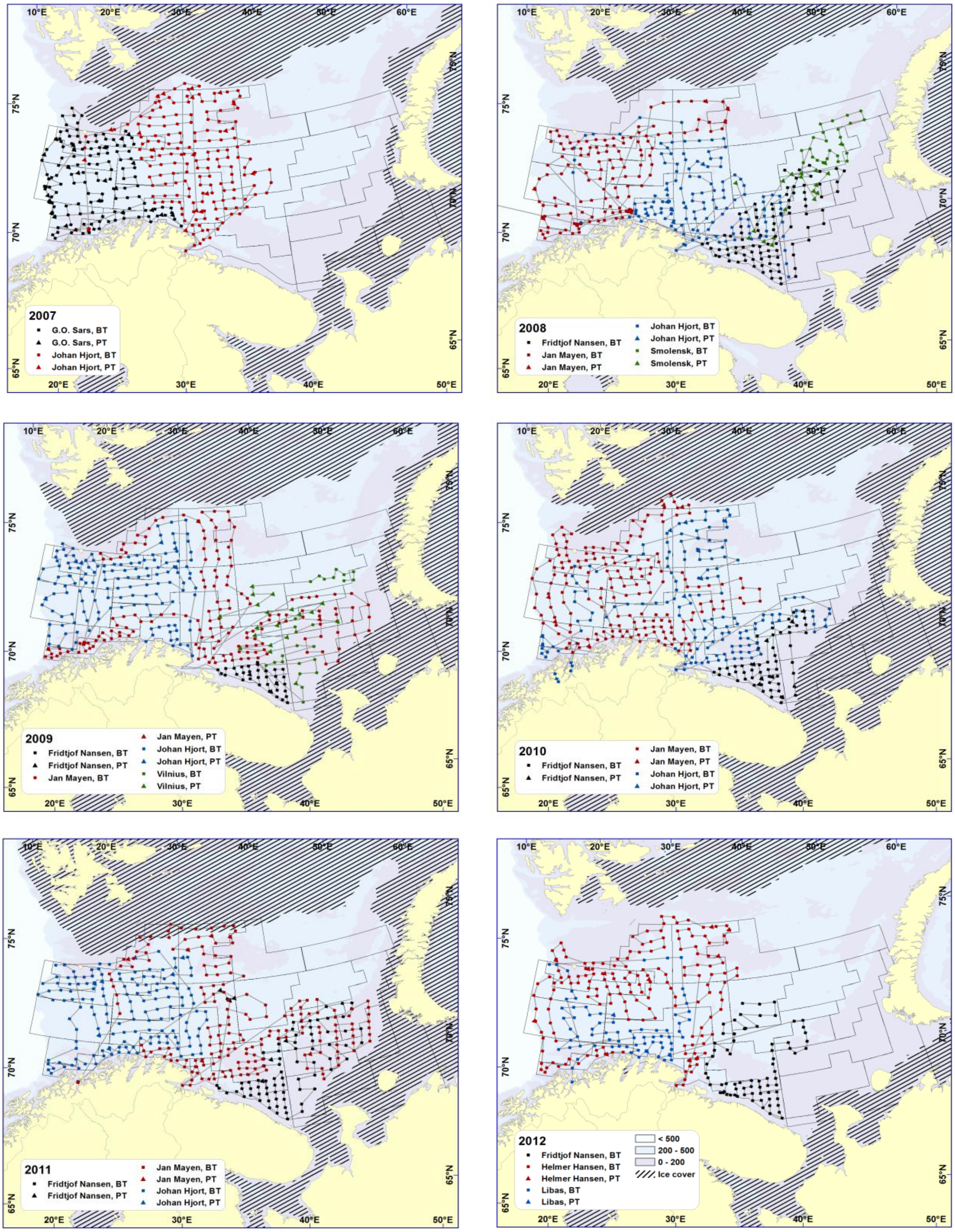


Figure 3.1. Survey tracks and all trawl stations in the winter survey 2007-2012. (BT denote bottom trawl stations and PT pelagic trawl stations). Data source for the monthly ice cover: ftp://sidads.colorado.edu/DATASETS/NOAA/G02135/shapefiles/

Table 3.5 gives the area covered by the survey every year since 1981, while Table 3.6 summarizes the degree of coverage and main reasons for incomplete coverage in the whole period.

Table 3.5. Area (n.miles^2) covered in the bottom trawl surveys in the Barents Sea winter 1981-2012

	Main Area							Sum		
Year	**A**	**B**	**C**	**D**	**D'**	**E**	**S**	**ABCD**	**Total**	**Added area**
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[1]	27581	9701	5048	23592	2684	1954	16989	65922	87549	56200
1998[1]	27581	9701	5048	23592	5886	3819	23587	65922	99214	51100
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	
2005	27581	9701	5048	53932	38716	19720	24194	96263	178893	
2006	27581	9701	5048	53932	34980	13687	24194	96263	169123	18100
2007[1]	27581	9701	5048	23428	8420	20621	27416	65759	122216	56700
2008	27581	9701	5048	53932	23711	18557	25905	96263	164436	
2009	27581	9701	5048	53932	31691	15505	27416	96263	170874	
2010	27581	9701	5048	53932	17896	18330	27416	96263	159904	
2011	27581	9701	5048	53932	32937	16467	27416	96263	173082	
2012[2]	27581	9701	5048	53932	9831	16970	27416	96263	150480	16700

[1]REZ not covered

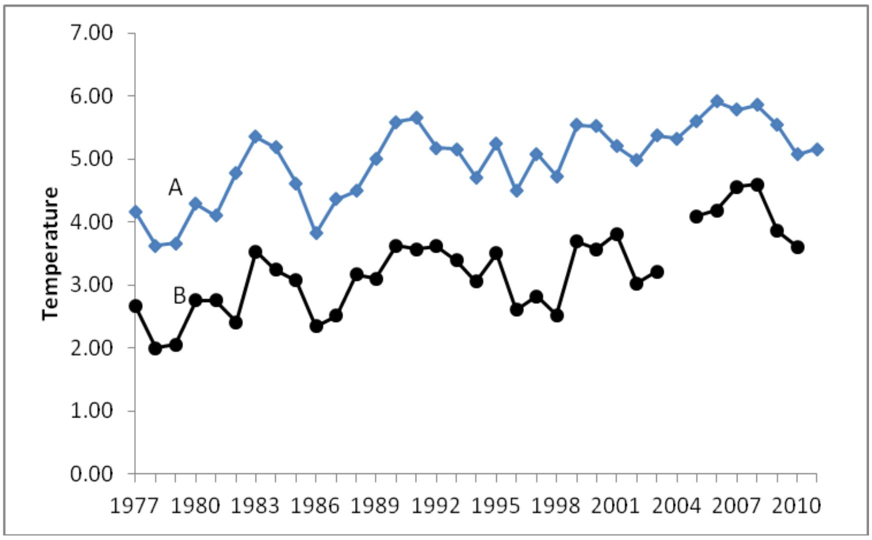
[2]REZ(Area D') not completely covered

Table 3.6. Degree of coverage and main reasons for incomplete coverage in the Barents Sea winter 1981-2012

Year	Coverage	Comments
1981-1992	ABCD	
1993-1996	ABCDD'ES	
1997	NEZ, S	Not allowed access to REZ
1998	NEZ, S, minor part of REZ	Not allowed access to most of REZ
1999	ABCDD'ES	Partly limited coverage due to westerly ice extension
2000	ABCDD'ES	
2001-2005	ABCDD'ES	Russian vessel covered where Norwegians had no access
2006	ABCDD'ES	Not access to Murman coast, no Russian vessel
2007	NEZ, S	Not allowed access to REZ, no Russian vessel
2008	ABCDD'ES	Russian vessel covered where Norwegians had no access
2009	ABCDD'ES	Reduced Norwegian coverage of REZ due to catch handling
2010	ABCDD'ES	Reduced Norwegian coverage of REZ due to bad weather
2011	ABCDD'ES	Russian vessel covered where Norwegians had no access
2012	ABCDD'ES	No Norwegian coverage of REZ due to vessel problems

4 Hydrography

The standard hydrographical sections ”Fugløya-Bjørnøya” and “Vardø-nord” are taken during the later part of the surveys. Figure 4.1 shows the observed mean temperature at 50-200 m depth for the period 1977-2011. Data for 2012 are still not available. ”Fugløya-Bjørnøya” had the highest observed temperatures in 2007-2009 and a little colder temperatures in 2010 and 2011. “Vardø-Nord” shows the same trend, but we do not have an observation for March 2011.



Figur 4.1. Mean temperatures in 50-200 m depth in 1977-2011. A) "Fugløya-Bjørnøya" in March, B) "Vardø-Nord" in March.

5 Total echo abundance of cod and haddock

Table 5.1 presents the time series of total echo abundance (echo density multiplied by area) of cod and haddock in the investigated areas. Since 1993 the acoustic values have been split between the two species. The values for cod showed an increasing trend from the mid 2000s, with peaks in 2008 and 2010. The values for haddock increased gradually from the end of the 1990s to 2009, and have decreased somewhat over the two last years. The fraction of the total echo abundance recorded in the bottom layer has been somewhat lower in later years for cod compared to the mid 2000s. For haddock this fraction is lower than for cod and more stable over the time series. Figures 5.1 and 5.2 present the distribution of total echo abundance by estimation rectangles in 2007-2012 for cod and haddock, respectively.

Table 5.1. Cod and haddock. Total echo abundance and echo abundance in the 10 m layer above the bottom in the Barents Sea winter 1981-2012 (m^2 reflecting surface $\cdot 10^{-3}$). 1981 - 1992 includes only 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
2005	1299	2873	4172	457	940	1397	0.35	0.33	0.33
2006	1195	2755	3950	462	697	1159	0.39	0.25	0.29
2007[1,2]	681	2515							
2008	3636	5981	9617	958	1306	2264	0.26	0.22	0.24
2009	2513	6326	8839	806	1280	2086	0.32	0.20	0.24
2010	3712	5905	9617	1014	1186	2200	0.27	0.20	0.23
2011	3044	3790	6834	823	864	1687	0.27	0.22	0.25
2012	3762	4157	7919	1028	810	1838	0.27	0.19	0.23

[1] not scaled for uncovered areas

[2] not possible to split on bottom and total due to LSSS settings

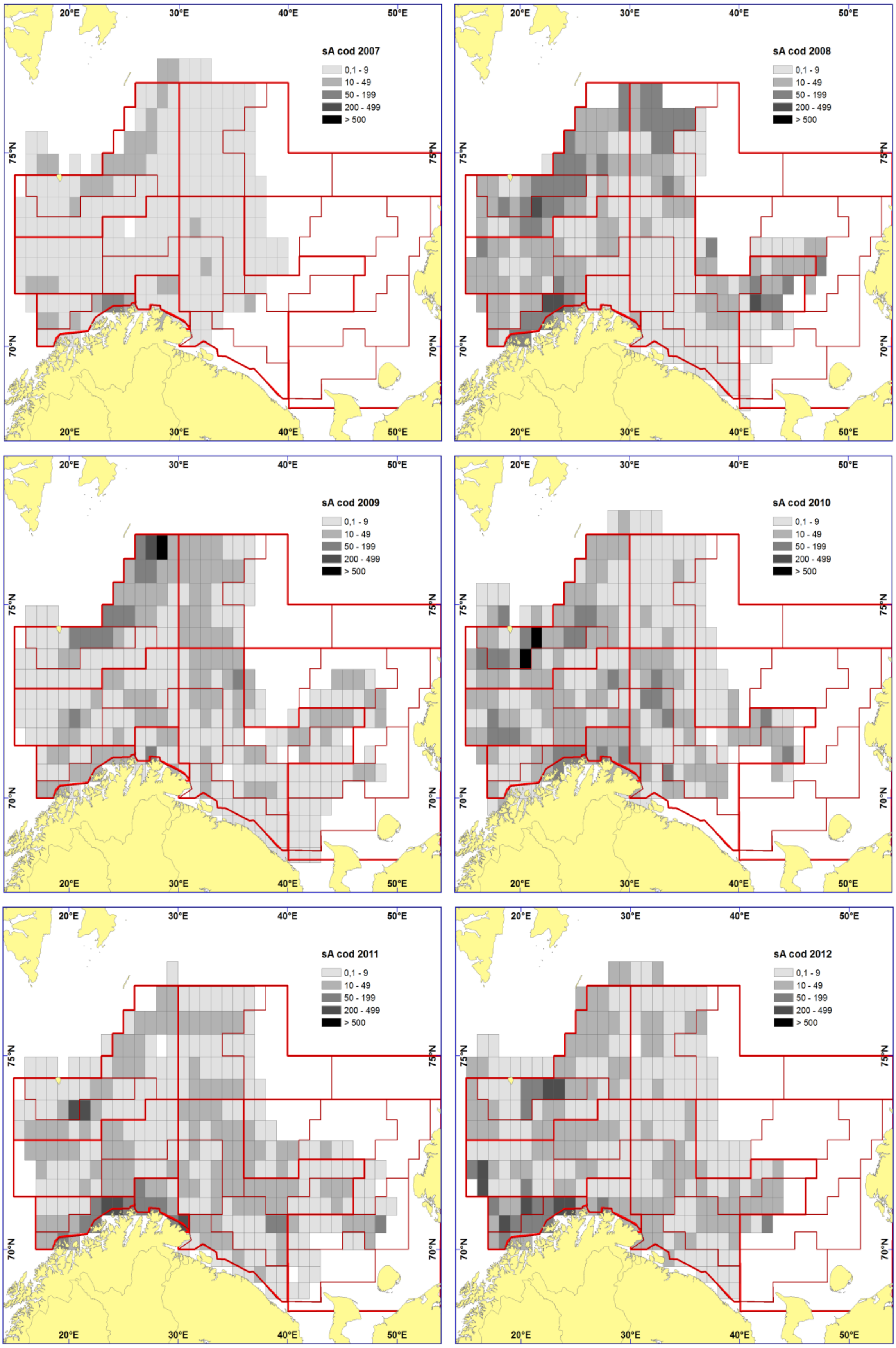


Figure 5.1. COD. Distribution of total echo abundance winter 2007-2012. Unit is s_A per square nautical mile (m^2/n.mile^2). Swept area strata and main areas (thick line) in red.

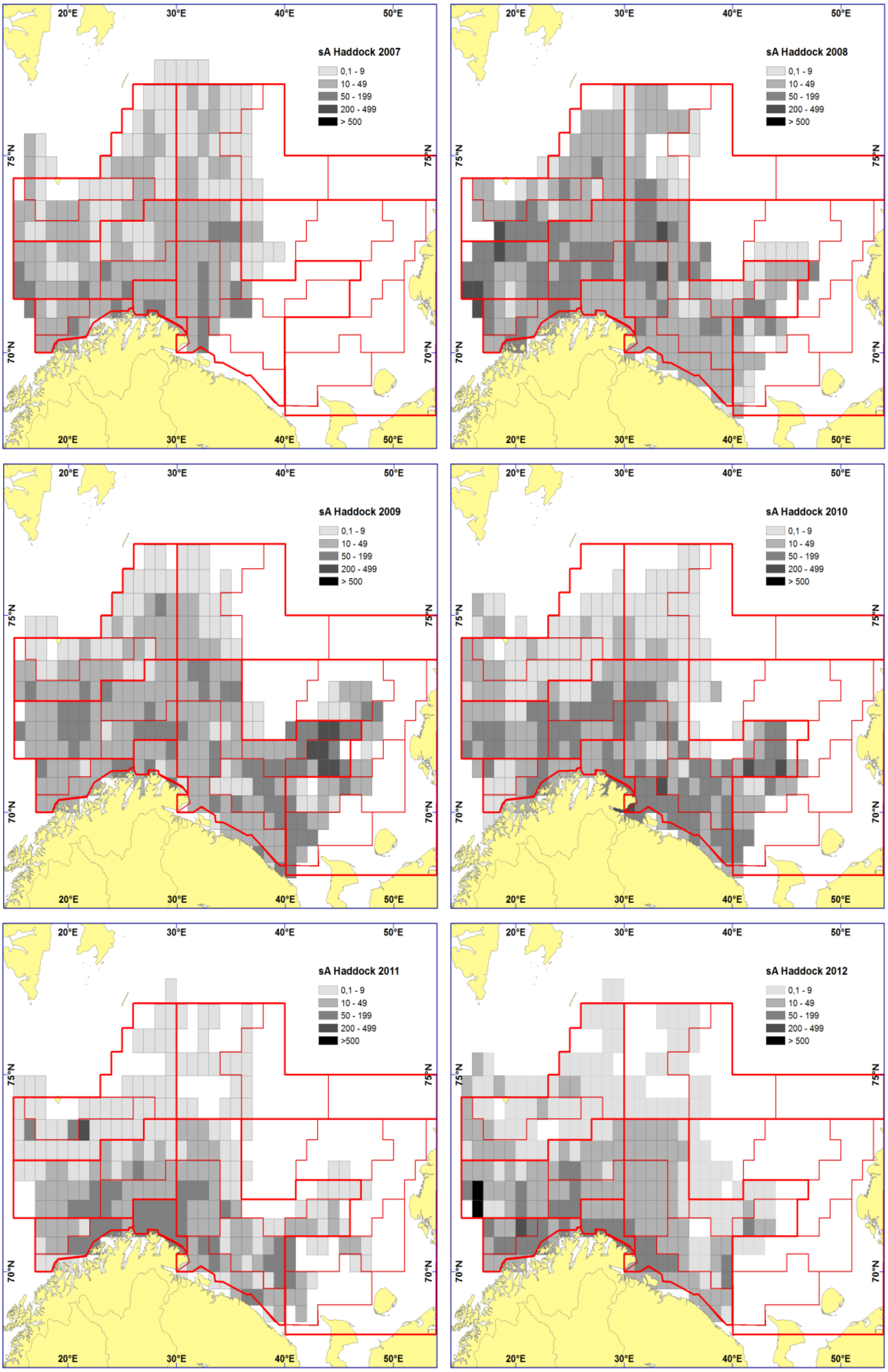


Figure 5.2. HADDOCK. Distribution of total echo abundance winter 2007-2012. Unit is s_A per square nautical mile (m^2/n.mile^2). Swept area strata and main areas (thick line) in red.

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 their spawning migration southwards out of the investigated area, and are therefore to a lesser extent covered. There are indications that a higher proportion than normal spawned along Finnmark in some of the recent years, e.g. 2004-2006. Thereby a higher proportion of the spawners might have been covered by the survey these years.

Table 6.1 shows the acoustic indices for each age group by main areas in 2007-2012. In 2007 no Russian vessels participated and Norwegian vessels were not allowed to cover the Russian EEZ. It was decided to estimate the amount in the Russian zone by using the 2004-2006 average ratio between the index in REZ and neighbouring areas (western part of main areas D and D’ in Figure 2.1) (ICES 2007). In 2012 Norwegian vessels did not enter REZ due to technical problems, the Russian vessel did only cover a part of REZ and main area D’ was largely uncovered. The estimates within the covered area were raised by the “index ratio by age” observed for the same area in 2008-2011 (ICES 2012) (the scaling factor for estimating adjusted total from <Total –D’> is the average ratio by age for Total/(Total-D’) in the years 2008-2011, Aglen et al. 2012). The time series (1981-2012) is presented in Table 6.2.

The estimates have fluctuated in recent years, and this may partly be explained by variable and not complete coverage of the distribution area towards north and east in several years. As cod grow older it get a more south-westerly distribution during winter, it so to say “grows” into the incomplete survey. This is especially evident for the strong 2004 and 2005 year-classes, which as 6-8 year olds stand out as the strongest in the time series. Of more recent year-classes the 2011 year-class seems to be strong, and more than half of the index at age 1 was estimated in main area S.

Table 6.1. COD. Acoustic abundance for the main areas of the Barents Sea winter 2007-2012 (numbers in millions).

Area	Year	Age group										Total	Biomass ('000 t)
		1	2	3	4	5	6	7	8	9	10+		
A	2007	4.5	0.6	1.9	2.0	4.0	1.4	3.0	0.9	0.3	0.1	18.8	26.2
	2008	1.6	1.1	10.2	30.0	13.8	16.4	3.7	2.5	0.5	0.3	80.1	120.7
	2009	7.1	0.6	2.1	10.6	15.8	6.1	2.6	0.9	0.6	0.1	46.5	69.8
	2010	42.4	3.6	2.2	7.3	25.7	28.0	8.6	3.0	0.5	0.8	121.9	161.6
	2011	14.2	4.5	2.4	1.7	6.2	14.5	7.5	2.5	0.6	0.3	54.4	77.4
	2012	27.2	1.9	8.8	6.7	5.4	11.2	33.9	21.1	0.8	0.2	117.2	213.1
B	2007	1.4	0.1	1.3	2.6	3.3	2.4	5.7	2.8	1.4	0.5	21.4	58.0
	2008	2.8	0.6	5.6	24.9	22.6	20.2	9.0	4.2	1.2	0.3	91.4	182.1
	2009	1.2	0.4	0.8	3.3	5.6	2.3	2.7	1.1	1.2	0.4	19.0	47.4
	2010	2.9	1.0	1.1	3.6	4.4	9.9	4.5	2.4	0.5	1.0	31.4	72.6
	2011	1.1	1.1	1.1	1.3	4.5	13.3	27.5	5.2	2.0	0.9	58.0	165.0
	2012	6.2	0.3	7.6	5.4	12.1	15.4	40.1	34.1	6.8	3.9	131.9	409.1
C	2007	3.2	0.5	1.9	1.4	1.7	0.7	0.3	0.3	0.1	+	10.1	9.4
	2008	1.6	0.3	0.5	1.5	0.2	0.5	0.1	0.3	-	-	5.0	5.8
	2009	4.1	0.4	1.4	4.7	2.9	0.7	1.7	0.6	0.2	0.1	16.8	31.0
	2010	18.7	0.6	0.9	2.6	3.3	9.3	5.0	1.9	0.7	0.6	43.6	70.9
	2011	28.3	2.2	1.7	1.8	3.8	8.0	21.2	3.7	0.8	0.8	72.3	123.6
	2012	9.6	0.3	0.6	3.2	0.8	1.6	4.9	4.2	0.2	0.2	25.6	44.3
D	2007	12.3	2.9	9.2	6.9	5.6	1.3	1.4	0.3	0.1	+	39.9	24.7
	2008	20.0	14.3	29.1	66.0	37.6	10.5	3.9	2.3	0.4	0.1	184.2	177.3
	2009	144.7	11.4	30.5	36.6	28.8	15.4	3.4	1.8	0.8	0.3	273.7	139.0
	2010	265.7	31.3	16.4	33.5	53.3	54.6	20.8	4.2	1.3	0.6	481.7	311.8
	2011	162.4	21.4	15.7	10.3	13.4	28.0	21.7	4.1	0.9	0.9	278.8	176.7
	2012	170.1	18.3	11.3	9.7	5.8	9.0	17.7	10.9	1.9	1.4	256.1	152.2
D'	2007	1.4	2.4	2.0	0.7	0.6	0.1	0.1	+	-	-	7.3	2.3
	2008	6.0	16.9	26.0	19.1	4.8	1.2	0.3	0.1	-	-	74.4	33.0
	2009	16.2	3.1	5.6	10.2	7.3	1.3	0.2	-	-	-	43.9	21.0
	2010	29.4	3.7	1.1	1.5	2.4	3.2	0.6	+	+	-	41.9	13.0
	2011	58.1	48.9	7.6	2.1	6.2	10.5	5.5	0.6	0.1	-	139.6	50.6
	2012[1]	38.0	5.3	4.1	2.3	0.9	2.9	3.5	1.4	0.1	0.1	58.6	24.9
E	2007	8.7	9.6	7.7	1.9	0.9	0.1	0.1	+	+	+	29.1	6.2
	2008	18.8	31.6	71.9	50.1	10.1	5.6	0.4	1.0	0.1	-	189.6	93.0
	2009	70.7	5.7	20.6	18.3	11.5	3.5	0.9	0.2	0.2	-	131.6	45.4
	2010	29.8	5.9	1.2	3.5	2.2	1.9	0.3	0.2	+	-	45.0	11.9
	2011	64.5	23.2	7.4	3.3	3.3	2.8	2.3	0.2	-	-	107.0	25.1
	2012	88.1	11.9	11.1	4.8	1.6	1.2	1.4	0.7	0.3	-	121.1	20.9
S	2007	63.4	23.0	30.0	11.4	5.2	0.8	1.3	0.2	0.9	+	135.3	30.4
	2008	18.0	32.8	66.9	114.6	51.2	15.0	4.2	1.9	0.8	0.1	305.5	233.9
	2009	77.4	9.0	121.5	94.6	65.3	5.6	1.0	0.5	0.7	+	375.6	187.7
	2010	96.5	13.4	11.9	69.8	83.3	55.4	4.8	2.0	0.5	0.5	338.1	290.6
	2011	60.8	23.6	11.2	8.6	43.0	30.7	19.8	1.0	0.1	-	198.8	159.0
	2012	565.2	25.0	82.3	20.1	10.1	28.0	20.9	5.0	0.4	0.1	757.1	155.8
ABCD	2007	21.4	4.1	14.3	12.9	14.6	5.8	10.4	4.3	1.9	0.6	90.2	118.3
	2008	26.0	16.3	45.4	122.4	74.2	47.6	16.7	9.3	2.2	0.7	360.7	485.9
	2009	157.1	12.8	34.8	55.2	53.1	24.5	10.4	4.4	2.8	0.9	356.0	287.2
	2010	329.7	36.5	20.6	47.0	86.7	101.8	38.9	11.5	3.0	3.0	678.6	616.9
	2011	206.0	29.2	20.9	15.1	27.9	63.8	77.9	15.5	4.3	2.9	463.5	542.7
	2012	213.2	20.9	28.5	25.0	24.3	37.2	96.6	70.4	9.8	5.8	531.7	818.7
Total	2007	94.8	39.0	54.0	26.9	21.3	6.8	11.8	4.5	2.0	0.6	261.9	157.0
	2008	68.8	97.6	210.2	306.1	140.6	69.4	21.6	12.2	3.1	0.8	930.4	845.8
	2009	321.5	30.5	182.6	178.3	137.1	35.0	12.5	5.2	3.7	0.9	907.3	541.3
	2010	485.4	59.4	34.7	121.9	174.7	162.3	4.4	13.8	3.5	3.5	1103.6	932.4
	2011	389.4	124.8	47.1	29.1	80.4	107.7	105.4	17.1	4.5	3.0	908.6	777.4
	2012[1]	904.5	63.0	125.8	52.3	37.0	69.3	122.3	77.6	10.5	6.1	1468.3	1020.3

[1] not scaled for uncovered areas

Table 6.2. COD. Abundance indices from acoustic surveys in the Barents Sea winter 1981-2012 (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	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[1]	1623.5	430.5	188.3	51.7	49.3	37.2	22.3	4.0	0.7	0.1	2407.5	322
1998[1]	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
2005	465.3	119.6	123.9	33.7	62.8	16.9	14.5	4.2	1.0	0.4	842.4	249
2006	544.6	216.6	79.8	59.1	15.5	25.6	8.8	4.5	1.4	0.5	956.5	222
2007[1]	125.0	61.7	80.3	37.1	30.4	9.1	14.1	5.0	2.1	0.7	365.6	198
2008	68.8	97.6	210.2	306.1	140.6	69.4	21.6	12.2	3.1	0.8	930.4	846
2009	321.5	30.6	182.6	178.3	137.1	35.0	12.5	5.2	3.7	0.9	907.3	541
2010	485.4	59.4	34.7	121.9	174.7	162.3	44.4	13.8	3.5	3.5	1103.6	932
2011	389.4	124.8	47.1	29.1	80.4	107.7	105.4	17.1	4.5	3.0	908.6	777
2012[2]	950.6	72.7	133.9	52.7	37.7	69.4	126.1	77.0	10.4	6.0	1536.4	1030

[1] Indices raised to also represent the Russian EEZ

[2] Indices raised to also represent uncovered parts of Main Area D'

6.2 Swept area estimation

Figures 6.1 - 6.4 show the geographic distribution of bottom trawl catch rates (number of fish per 3 NM, corresponding to 1 hours towing) for cod size groups ≤ 19 cm, 20-34 cm, 35-49 cm and ≥ 50 cm. As in previous years, the greatest concentrations of the smallest cod (less than 35 cm) were found in the eastern part of the survey area within the Russian EEZ and near the northern borders of the area covered, indicating that these size groups might have been underestimated. Since 2009 more of the largest cod has been found in the north-western part of the survey area (main area S).

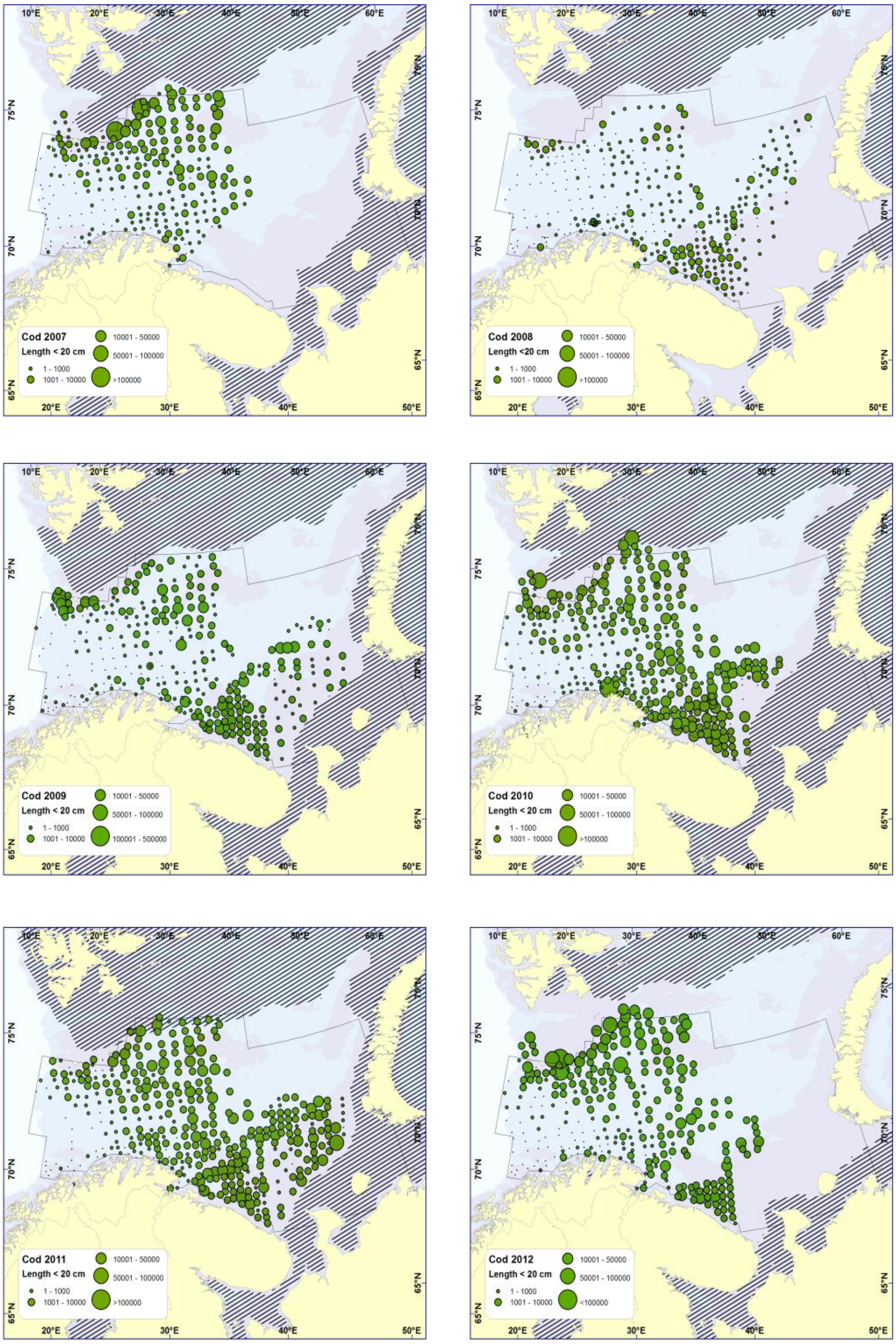


Figure 6.1. COD ≤ 19 cm. Distribution in valid bottom trawl catches winter 2007-2012 (number per nm^2).

Zero catches are indicated by black points.

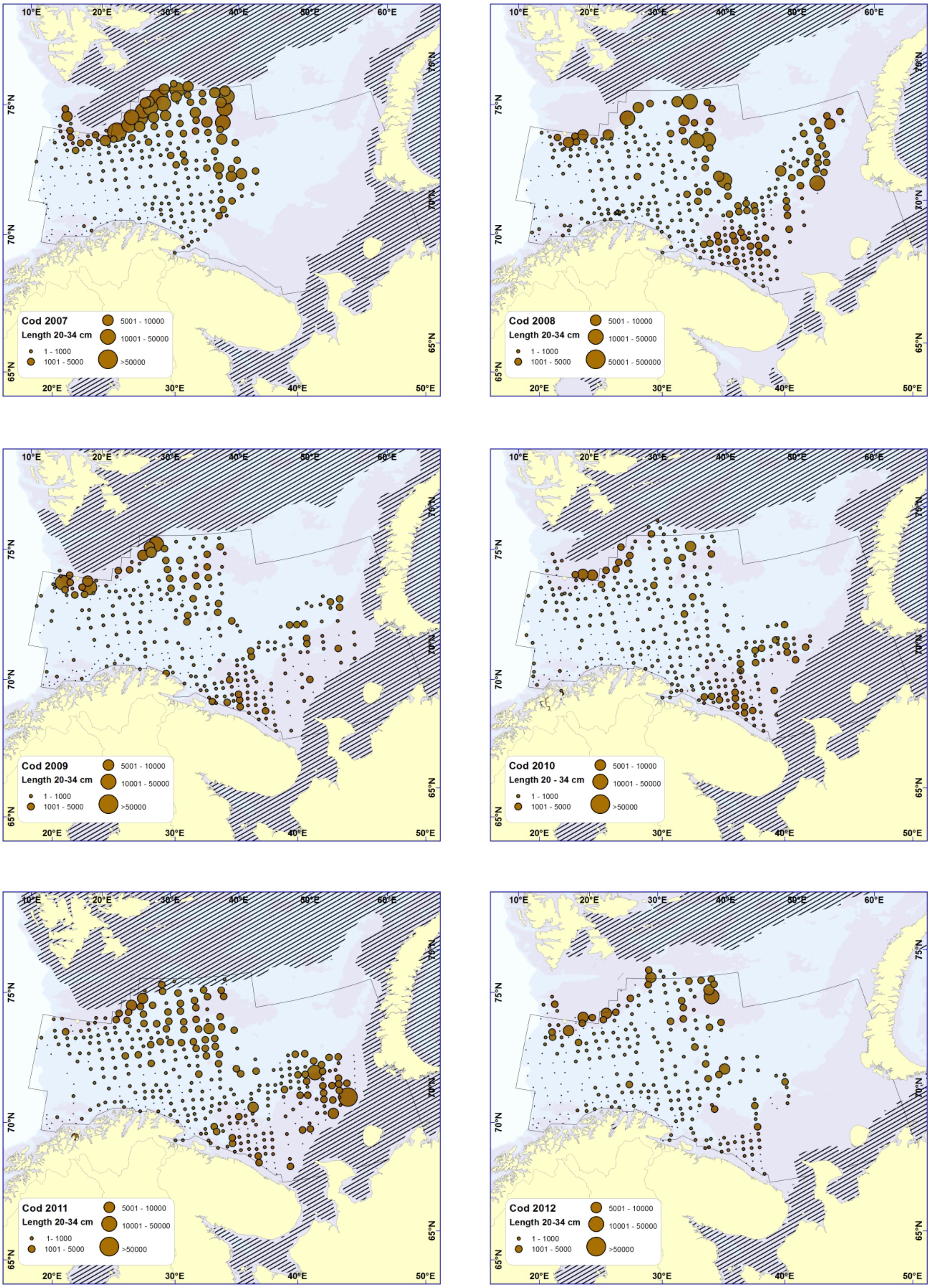


Figure 6.2. COD 20-34 cm. Distribution in valid bottom trawl catches winter 2007-2012 (number per nm^2). Zero catches are indicated by black points.

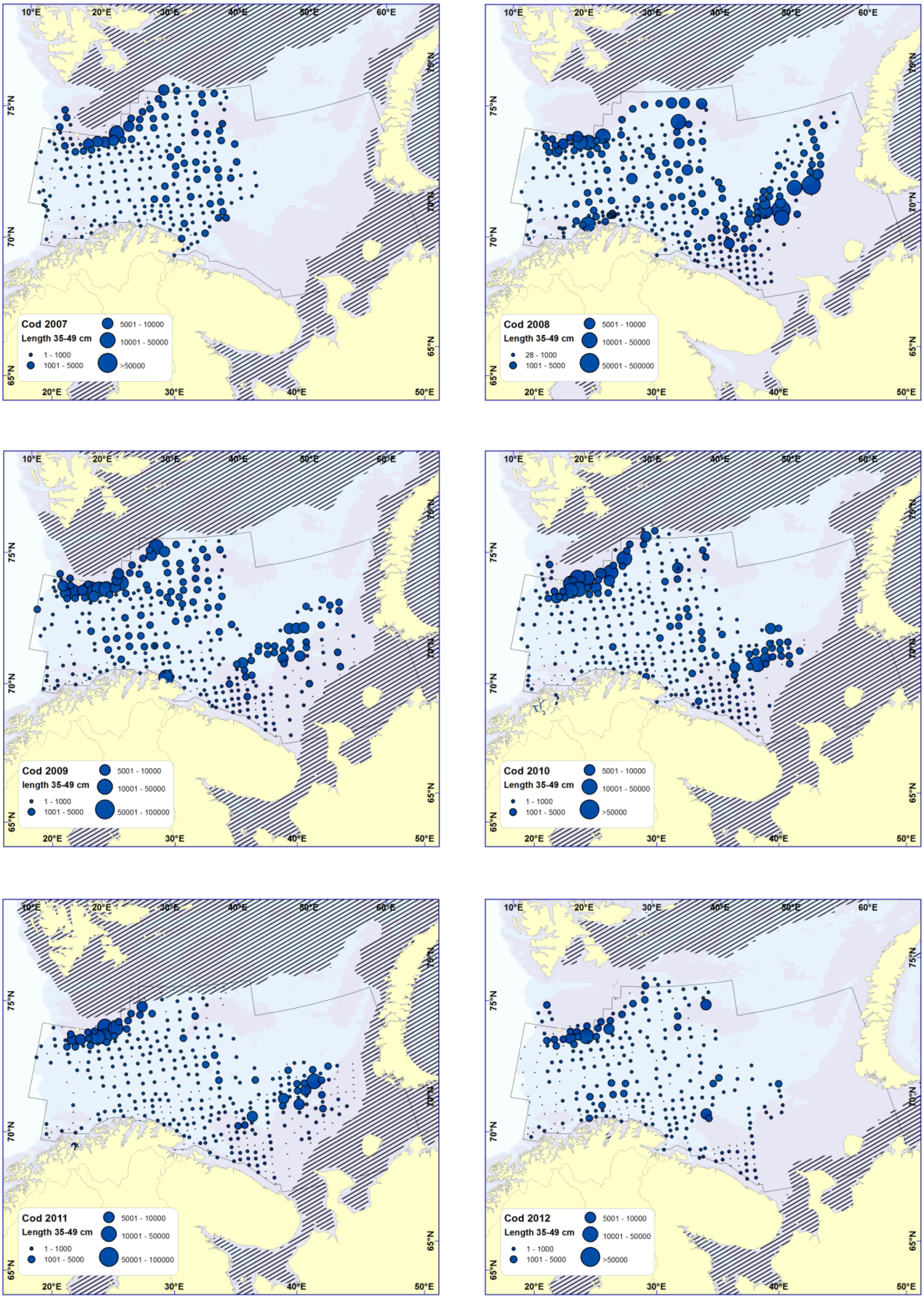


Figure 6.3. COD 35-49 cm. Distribution in valid bottom trawl catches winter 2007-2012 (number per nm^2). Zero catches are indicated by black points.

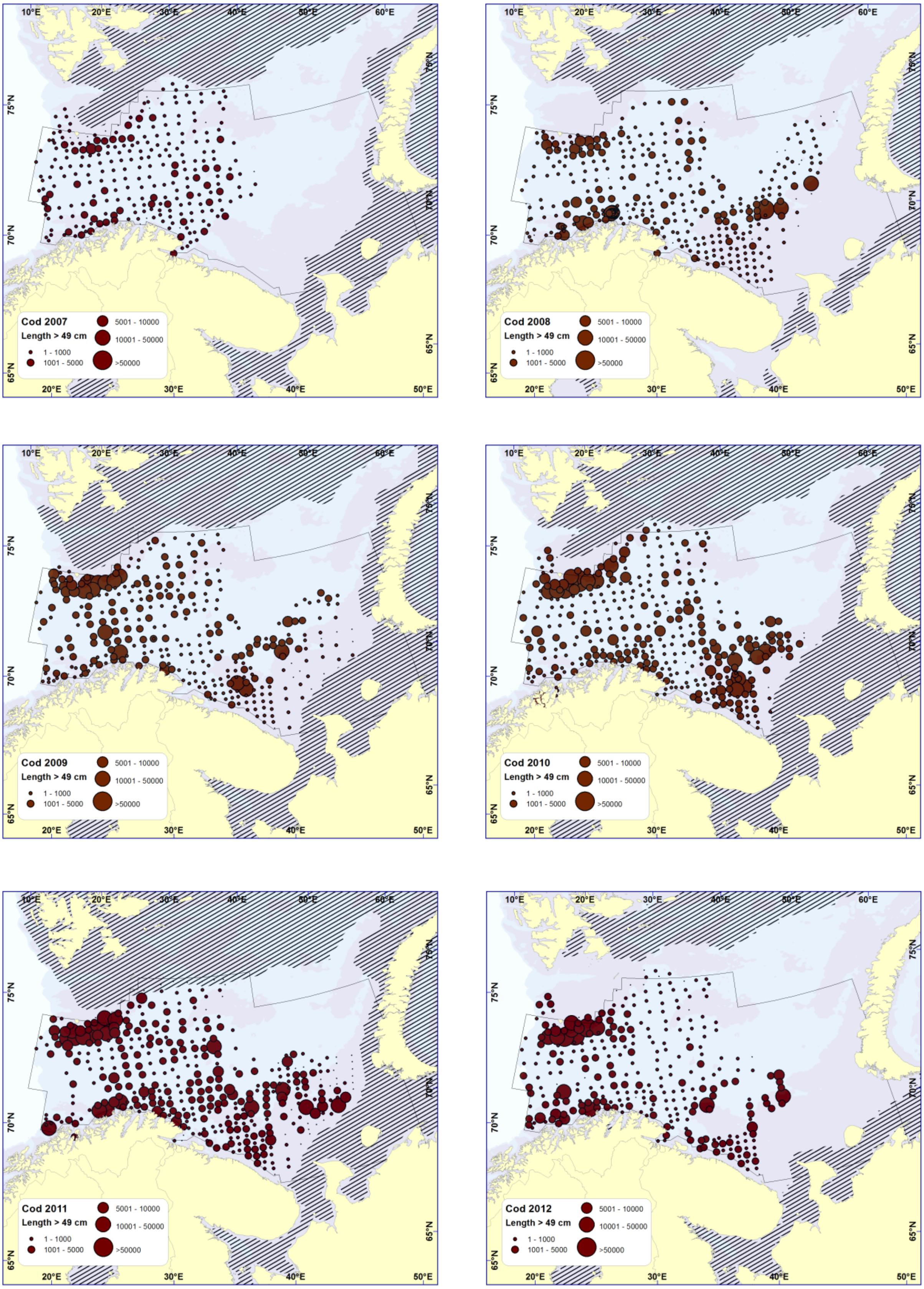


Figure 6.4. COD ≥ 50 cm. Distribution in valid bottom trawl catches winter 2007-2012 (number per nm^2). Zero catches are indicated by black points.

Table 6.3 presents the distribution of the indices by main area and age and the whole time series (1981-2012) is shown in Table 6.4. In 2007 and 2012 the indices were adjusted the same way as the acoustic indices (see Section 6.1). Also the bottom trawl indices have fluctuated somewhat due to the same reasons as for the acoustic indices, and the 2004 and 2005 year-classes at the moment stand out as the strongest in the time series. Both the 2009 and 2011 year-classes seemed to be strong as 1-year olds, but the 2009 year-class was reduced to below average level at age 3.

Table 6.3. COD. Abundance indices from bottom trawl hauls for main areas of the Barents Sea winter 2007-2012 (numbers in millions.).

		Age group											Biomasse
Area	**Year**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10+**	**Total**	**('000 t)**
A													
	2007	10.0	1.9	6.3	4.6	7.4	2.3	4.6	1.1	0.3	0.1	38.6	42.6
	2008	1.4	0.9	7.3	19.6	10.2	9.7	2.1	1.5	0.2	0.2	53.1	73.0
	2009	12.0	1.0	5.2	22.9	36.7	17.0	7.3	2.4	1.7	0.1	106.0	168.4
	2010	28.3	2.5	1.3	4.1	13.7	15.7	4.4	1.8	0.4	0.4	72.6	89.5
	2011	28.1	7.9	5.6	2.6	8.6	16.8	10.5	3.4	0.9	0.3	84.7	100.4
	2012	15.5	1.1	8.8	8.0	2.7	6.3	14.5	6.4	0.9	0.2	64.4	96.7
B													
	2007	0.6	0.1	0.6	1.2	2.4	1.5	4.0	1.7	1.0	0.3	13.3	37.2
	2008	0.9	0.2	1.2	6.7	5.2	5.5	2.4	1.4	0.3	0.1	23.9	48.9
	2009	0.6	0.3	0.3	1.3	2.4	1.8	1.6	0.6	0.7	0.1	9.7	26.2
	2010	1.2	0.2	0.2	0.9	1.6	4.7	1.8	1.2	0.2	0.5	12.4	32.1
	2011	0.5	0.7	0.5	0.7	3.4	6.7	11.5	3.0	0.9	0.6	28.5	84.0
	2012	1.8	0.1	0.7	1.8	1.4	3.6	11.7	8.4	1.4	1.0	31.8	100.5
C													
	2007	2.5	0.3	1.4	1.0	1.2	0.5	0.3	0.3	0.1	+	7.5	7.2
	2008	2.3	0.3	0.7	1.5	0.2	0.6	0.1	0.3	0.1	-	6.1	6.9
	2009	2.4	0.2	2.1	9.3	3.6	0.7	0.8	0.3	0.1	0.1	19.5	22.9
	2010	355.8	0.2	0.3	0.9	1.2	3.1	1.7	0.8	0.3	0.1	364.3	28.7
	2011	8.2	0.6	0.6	0.4	1.4	2.6	5.2	0.9	0.2	0.2	20.3	33.1
	2012	2.8	0.1	0.5	0.6	0.3	0.5	1.0	1.2	0.1	0.1	7.2	11.8
D													
	2007[1]	25.9	8.3	21.3	14.1	11.7	2.9	2.5	0.4	0.1	0.1	87.3	49.9
	2008	31.9	21.0	39.8	127.3	41.1	19.5	5.8	3.6	1.1	0.1	291.2	283.3
	2009	182.5	15.9	25.4	46.1	44.8	21.8	6.1	2.5	1.4	0.4	346.7	200.0
	2010	377.1	54.1	16.0	30.9	58.1	60.9	23.9	6.4	1.9	0.8	629.9	357.8
	2011	256.7	34.3	28.3	22.7	24.8	40.5	26.8	5.8	1.3	1.1	442.3	259.4
	2012	216.0	58.9	15.5	16.4	12.9	17.4	37.0	21.7	4.1	3.1	403.0	297.8
D													
	2007[1]	9.8	13.4	13.1	3.9	4.3	0.9	0.4	0.1	-	-	45.8	14.5
	2008	9.3	19.2	51.6	97.0	10.9	2.7	0.5	0.6	-	-	191.8	112.0
	2009	28.6	8.0	12.9	19.9	14.9	2.6	0.3	0.1	-	-	87.4	41.4
	2010	77.8	12.2	3.6	6.4	5.1	7.6	2.6	0.2	0.3	-	115.8	41.3
	2011	116.9	103.0	18.2	4.0	12.4	22.2	13.9	1.8	0.2	-	292.6	115.8
	2012[1]	84.9	11.7	7.2	6.2	1.6	8.2	12.0	5.3	0.1	0.1	137.2	72.3
E													
	2007[1]	82.8	95.5	79.7	14.4	6.7	1.0	0.5	0.2	0.1	0.1	281.0	50.3
	2008	16.6	35.1	58.8	39.8	8.5	4.0	0.4	0.6	0.1	-	163.9	73.2
	2009	52.0	6.9	14.2	11.6	6.9	2.4	0.5	0.2	0.1	-	94.7	29.4
	2010	72.1	21.4	6.3	8.7	6.6	4.9	0.9	0.4	0.1	-	121.3	32.6
	2011	101.1	39.4	13.7	4.5	4.4	4.4	3.0	0.1	0.1	-	170.7	37.5
	2012	162.8	28.6	23.0	8.6	2.1	1.4	1.9	1.5	0.4	0.2	230.4	35.0

Table 6.3. Cont.

Area	Year	Age group										Total	Biomasse
		1	2	3	4	5	6	7	8	9	10+		('000 t)
S	2007	236.9	129.5	125.0	22.4	10.4	2.1	2.7	0.4	0.2	0.1	529.6	91.7
	2008	8.0	15.4	30.6	41.7	15.0	5.4	1.7	0.9	0.2	-	118.9	87.1
	2009	104.7	6.9	58.2	108.5	84.6	12.3	3.1	0.7	0.9	-	380.2	250.2
	2010	107.9	13.9	8.3	55.1	74.6	43.8	4.8	1.1	0.3	0.3	310.2	232.0
	2011	107.1	37.2	21.3	19.3	67.2	46.8	24.8	1.8	0.2	0.1	325.8	244.1
	2012	800.7	150.7	32.1	23.4	21.7	51.1	49.6	11.2	0.6	0.3	1141.3	302.6
ABCD	2007[1]	39.1	10.6	29.6	20.8	22.7	7.1	11.5	3.5	1.5	0.5	146.8	136.9
	2008	36.5	22.4	49.1	155.1	56.7	35.2	10.4	6.9	1.6	0.4	374.3	412.2
	2009	197.4	17.3	32.9	79.5	87.4	41.3	15.7	5.8	3.9	0.6	481.9	417.4
	2010	762.4	56.9	17.9	36.8	74.5	84.4	31.7	10.2	2.7	1.8	1079.3	508.1
	2011	293.5	43.5	35.0	26.3	38.2	66.6	54.0	13.1	3.3	2.3	575.8	476.9
	2012	236.1	60.2	25.5	26.8	17.2	27.7	64.1	37.7	6.6	4.4	506.3	506.8
Total	2007[1]	368.5	249.0	247.4	61.6	44.1	11.1	15.0	4.2	1.7	0.6	1003.1	293.4
	2008	70.4	92.1	190.2	333.6	91.0	47.2	13.0	8.8	2.0	0.4	848.9	684.4
	2009	382.7	39.1	118.3	219.6	193.9	58.6	19.6	6.8	4.9	0.9	1044.2	738.4
	2010	1020.2	104.4	36.0	106.9	160.8	140.7	40.0	11.9	3.5	2.2	1626.5	814.0
	2011	618.6	223.0	88.1	54.1	122.1	139.9	95.6	16.8	3.9	2.4	1364.9	874.3
	2012[1]	1284.4	251.2	87.8	65.0	42.6	88.4	127.5	55.6	7.7	4.9	2015.2	916.6

[1] not scaled for uncovered areas

Table 6.4 and Figure 6.5 presents estimated coefficients of variation (CV) for cod age groups 1-15 in 1989-2012 (also indices will be presented for older groups in future reports). Estimates are based on a stratified bootstrap approach with 500 replicates (with trawl stations being primary sampling unit). The red horizontal line (Figure 6.5) corresponds to a CV of 30 %. Values above this indicate a highly uncertain index with little information regarding year class strength. A CV of 20 % or less could be viewed as acceptable in a traditional stock assessment approach if the indices are unbiased (conditional on a catchability model). Identification and possible correction of bias is limited by a high CV and much longer time series of consistent data will be needed.

Table 6.4. COD. Abundance indices from bottom trawl surveys in the Barents Sea winter 1981-2012 (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	203
1982	0.8	2.9	28.3	27.7	23.6	15.5	16.0	1.4	0.2	0	116	174
1983	152.9	13.4	25.0	52.3	43.3	17.0	5.8	3.2	1.0	0.1	314	220
1984	2755.0	379.1	97.5	28.3	21.4	11.7	4.1	0.4	0.1	0.1	3298	310
1985	49.5	660.0	166.8	126.0	19.9	7.7	3.3	0.2	0.1	0.1	1034	421
1986	665.8	399.6	805.0	143.9	64.1	8.3	1.9	0.3	0	0	2089	639
1987	30.7	445.0	240.4	391.1	54.3	15.7	2.0	0.5	0	0	1180	398
1988	3.2	72.8	148.0	80.5	173.3	20.5	3.6	0.5	0	0	502	285
1989	8.2	15.6	46.4	75.9	37.8	90.2	9.8	0.9	0.1	0.1	285	271
1990	207.2	56.7	28.4	34.9	34.6	20.6	27.2	1.6	0.4	0	412	246
1991	460.5	220.1	45.9	33.7	25.7	21.5	12.2	12.7	0.6	0	833	352
1992	126.6	570.9	158.3	57.7	17.8	12.8	7.7	4.3	2.7	0.2	959	383
1993	534.5	420.4	273.9	140.1	72.5	15.8	6.2	3.9	2.2	2.4	1472	565
1994	1035.9	535.8	296.5	310.2	147.4	50.6	9.3	2.4	1.6	1.3	2391	761
1995	5253.1	541.5	274.6	241.4	255.9	76.7	18.5	2.4	0.8	1.1	6666	943
1996	5768.5	707.6	170.0	115.4	137.2	106.1	24.0	2.9	0.4	0.5	7033	701
1997[1]	4815.5	1045.1	238.0	64.0	70.4	52.7	28.3	5.7	0.9	0.5	6321	495
1998[1]	2418.5	643.7	396.0	181.3	36.5	25.9	17.8	8.6	1.0	0.5	3730	429
1999	484.6	340.1	211.8	173.2	58.1	13.4	6.5	5.1	1.2	0.4	1294	318
2000	128.8	248.3	235.2	132.1	108.3	26.9	4.3	2.0	1.2	0.4	888	356
2001	657.9	76.6	191.1	182.8	83.4	38.2	8.9	1.1	0.4	0.2	1241	428
2002	35.3	443.9	88.3	135.0	109.6	42.5	15.1	2.4	0.3	0.2	873	441
2003	2991.7	79.1	377.0	129.7	91.1	67.3	18.3	4.9	1.0	0.2	3760	546
2004	328.5	235.4	76.6	172.5	56.9	44.7	27.3	7.6	1.7	0.4	952	413
2005	824.3	224.6	246.9	62.1	98.1	24.7	15.5	4.5	1.1	0.4	1502	355
2006	862.7	288.4	118.1	111.5	28.7	43.7	10.2	4.9	1.4	0.6	1470	335
2007[1]	485.9	393.9	367.7	85.0	62.9	14.8	17.9	4.8	1.8	0.7	1435	397
2008	70.4	92.1	190.2	333.6	91.0	47.2	13.0	8.8	2.0	0.4	849	684
2009	382.7	39.1	118.3	219.6	193.9	58.6	19.6	6.8	4.9	0.9	1044	738
2010	1020.2	104.4	36.0	106.9	160.8	140.7	40.0	11.9	3.5	2.2	1627	814
2011	618.6	223.0	88.1	54.1	122.1	139.9	95.6	16.8	3.9	2.4	1365	874
2012[2]	1364.0	329.9	98.0	68.4	44.8	87.3	124.1	53.1	7.9	4.8	2182	910

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

[2] Indices raised to also represent uncovered parts of Main Area D'

Table 6.5. COD. Estimates of coefficients of variation (%) from bottom trawl hauls in the Barents Sea winter 1989-2012. 1989 -1992 includes only main areas A, B, C and D.

	Age														
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1989	23	19	27	27	19	10	13	18	40	52					
1990	16	15	17	22	17	14	14	24	44	50	53				
1991	18	14	13	12	21	12	9	10	25	45					
1992	19	31	17	11	13	11	11	12	16	49	59	54			
1993	37	27	12	11	11	10	12	15	20	16	53	53			
1994	10	18	17	10	10	11	12	19	26	28	22	67	48		
1995	10	17	12	13	11	11	12	23	35	27	48	49			
1996	10	14	17	12	12	10	14	14	25	52	49	45	52	49	
1997	28	14	16	16	14	12	11	17	22	72	52				
1998	10	15	13	12	12	11	11	12	22	51	54		50		64
1999	19	24	19	12	10	12	17	31	25	66	52	52	52		
2000	11	22	19	10	12	10	14	18	23	36	57	51	48		
2001	10	13	13	11	9	11	15	26	32	32	57				51
2002	15	13	11	8	9	11	9	14	32	48	62				52
2003	14	17	27	17	9	9	10	15	19	51	56		53	45	
2004	16	21	24	15	12	11	13	14	14	48	51	43	51		
2005	9	16	37	19	19	17	12	14	25	25	50	54	51	51	
2006	12	18	12	21	15	12	14	13	17	28	54	92			
2007	27	24	19	15	9	10	10	15	19	24	33	45			
2008	12	16	17	24	28	13	25	15	32	39	53	39	47		
2009	11	12	16	14	16	15	17	26	21	38	44	58	42		
2010	35	12	12	17	11	10	17	17	22	21	27	68	57	44	
2011	8	26	12	16	14	10	10	12	22	21	53	37	65	50	48
2012	50	51	36	13	17	21	17	11	20	22	28	37	61	42	

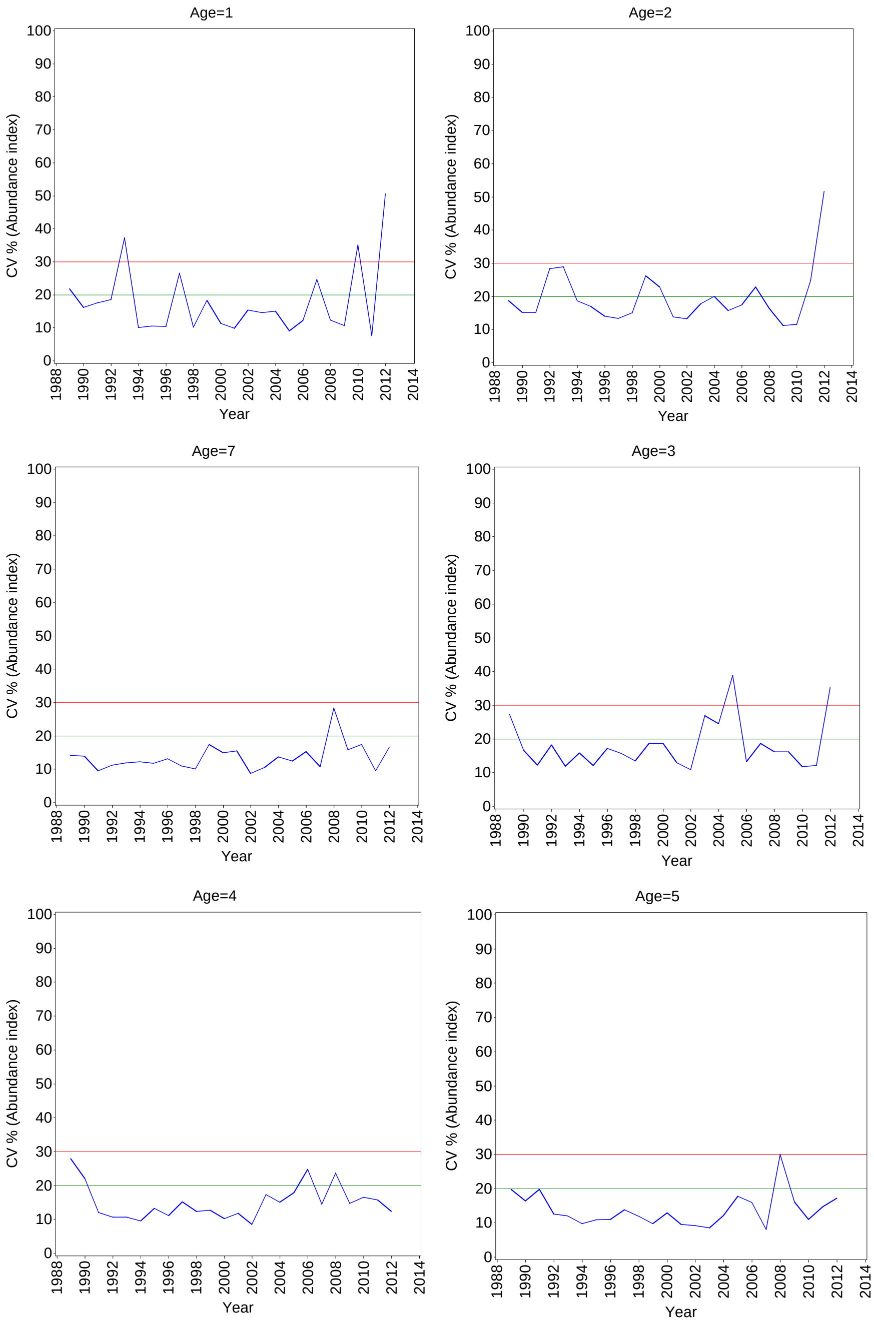


Figure 6.5. COD. Coefficients of variation (%) for age groups 1-14 from bottom trawl hauls in the Barents Sea winter 1989-2012. 1989 -1992 includes only main areas A, B, C and D.

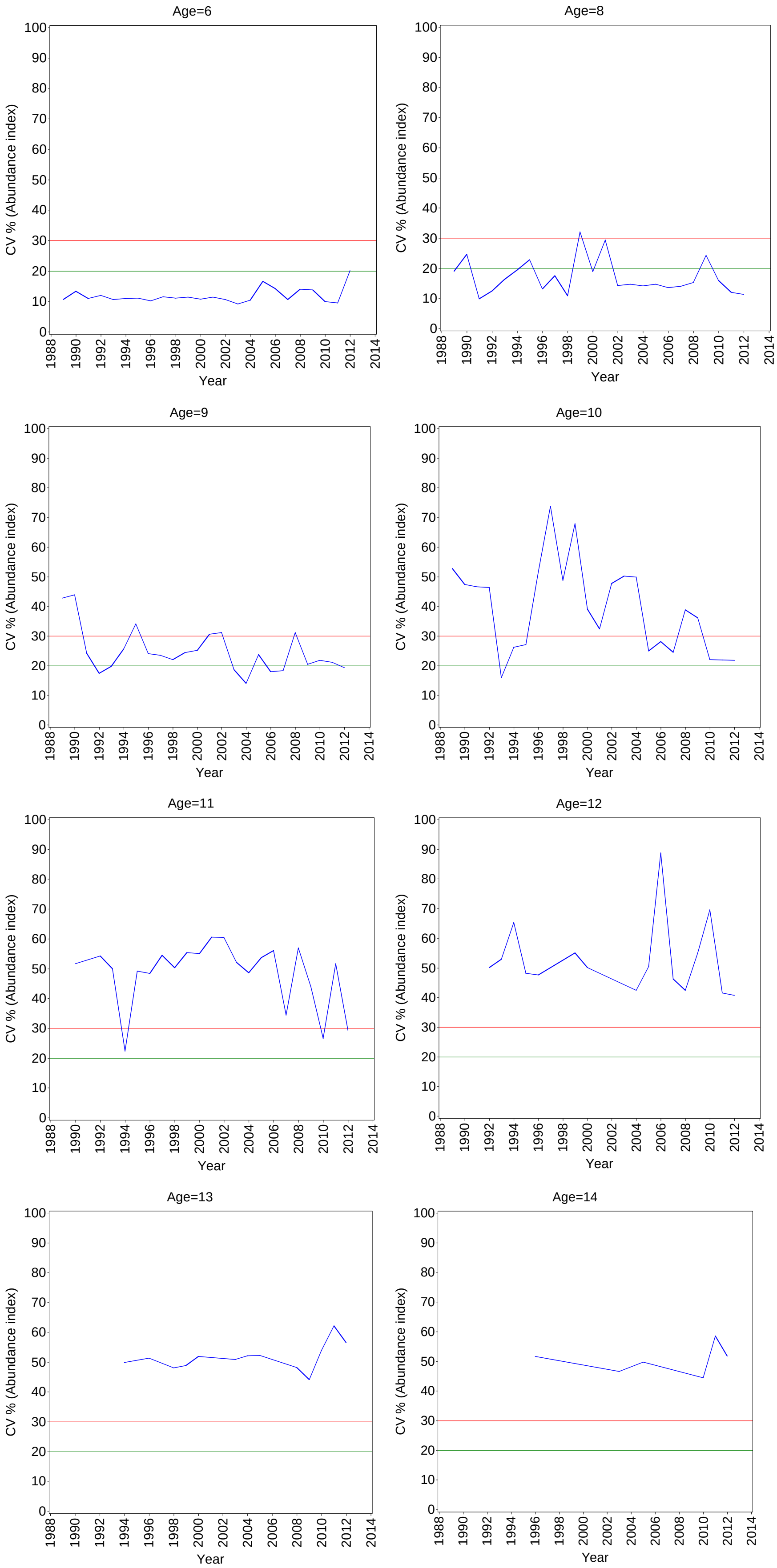


Figure 6.5 cont.

6.3 Growth and survey mortalities

Tables 6.6 and 6.7 present the time series for mean length (1981-2012) and mean weight (1983-2012) 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, but with a slight decreasing trend in the last years. The same pattern is reflected in the annual weight increments (Table 6.8).

Table 6.6. COD. Length (cm) at age in the Barents Sea from the investigations winter 1981 - 2012.

	Age							
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
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
2005	11.5	18.6	29.3	43.0	51.1	60.3	71.1	78.4
2006	12.2	19.9	31.3	42.1	53.5	60.8	68.9	77.7
2007	13.4	21.3	30.7	42.2	52.8	62.3	70.5	77.9
2008	12.5	22.3	32.5	43.7	52.4	63.6	71.6	80.8
2009	11.7	21.4	32.2	43.2	53.6	63.3	76.0	84.4
2010	11.4	19.1	31.2	42.3	52.0	61.3	70.5	80.6
2011	12.5	19.9	30.3	42.3	51.4	60.8	68.6	78.3
2012[1]	11.8	18.6	28.2	41.3	51.3	59.0	67.1	75.2

[1)]Adjusted lengths

Table 6.7. COD. Weight (g) at age in the Barents Sea from the investigations winter 1983-2012.

	Age							
Year	**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
2005	13	57	230	705	1135	1817	2948	4081
2006	15	71	288	682	1366	1991	2959	4354
2007	19	78	253	691	1302	2128	3032	4327
2008	16	94	319	798	1393	2412	3413	5067
2009	13	83	291	724	1337	2180	3775	5267
2010	12	63	300	683	1246	2041	3076	4765
2011	15	64	255	683	1179	1933	2740	4048
2012[2]	13	53	214	635	1168	1706	2560	3667

1) Estimated weights

2) Adjusted weights

Table 6.8. COD. Yearly weight increment (g) from the investigations in the Barents Sea winter 1983 - 2012.

	Age						
Year	**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
2004-05	46	172	411	535	650	1014	1424
2005-06	58	231	452	661	856	1142	1406
2006-07	63	182	403	620	762	1041	1368
2007-08	75	241	545	702	1110	1285	2035
2008-09	67	197	405	539	797	1363	1854
2009-10	50	217	392	522	704	896	990
2010-11	52	192	383	496	687	699	972
2011-12	38	132	365	477	506	574	877

Table 6.9 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 by natural and fishing mortality, age reading errors, and the catchability and availability (coverage) 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. Most later surveys show lower mortalities, but there are some fluctuations for the same reasons as mentioned for the acoustic and swept area indices. 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 low survey mortalities in the most recent years could partly be caused by fish gradually “growing into” the covered area at increasing age. The observed mortality rates in the acoustic investigations have been more variable. This might be caused by changes in fish behaviour and how available the fish is for acoustic registration.

Table 6.9. Survey mortality observed for cod during the winter survey in the Barents Sea in 1993-2012.

	Age							
Year	**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
2004-05	0.28	-0.16	0.00	0.39	0.60	0.64	1.40	1.77
2005-06	0.76	0.40	0.74	0.78	0.90	0.65	1.17	1.10
2006-07	2.18	0.99	0.76	0.67	0.53	0.60	0.57	0.76
2007-08	0.25	-1.23	-1.34	-1.33	-0.83	-0.86	0.14	0.48
2008-09	0.81	-0.63	0.16	0.80	1.39	1.71	1.42	1.19
2009-10	1.69	-0.13	0.40	0.02	-0.17	-0.24	-0.10	0.40
2010-11	1.36	0.23	0.18	0.42	0.48	0.43	0.95	1.12
2011-12	1.68	-0.07	-0.11	-0.26	0.15	-0.16	0.31	0.50
	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	1.06
2004-05	0.38	-0.05	0.21	0.56	0.83	1.06	1.80	1.93
2005-06	1.05	0.64	0.79	0.77	0.81	0.89	1.15	1.17
2006-07	0.78	-0.24	0.33	0.57	0.66	0.89	0.75	1.00
2007-08	1.66	0.73	0.10	-0.07	0.29	0.13	0.71	0.88
2008-09	0.59	-0.25	-0.14	0.54	0.44	0.88	0.65	0.59
2009-10	1.30	0.08	0.10	0.31	0.32	0.38	0.50	0.66
2010-11	1.52	0.17	-0.41	-0.13	0.14	0.39	0.87	1.12
2011-12	0.63	0.82	0.25	0.19	0.34	0.12	0.59	0.75

6.4 Stomach sampling

Since 1984, cod stomachs have been sampled regularly during the winter survey. The sampling strategy has generally been the same as that for sampling otoliths. Stomach have been frozen onboard and analysed in the laboratory, except for the period 1994-2000, when some of the stomachs were analysed onboard and only the main prey categories were identified. For details about the sampling methodology and the Norwegian-Russian cooperation on diet investigations in the Barents Sea, see Mehl and Yaragina (1992) and Dolgov *et al*. (2007).

The number of stations and stomachs sampled as well as the proportion of empty stomachs and the mean stomach fullness index (SFI, see below) for each of 4 size groups (≤ 19 cm, 20-34 cm, 35-49 cm, ≥ 50 cm) is given in Table 6.10. Table 6.11 - 6.14 show the mean diet composition by prey species/groups by year for each size group. Note that in the years 1994-2000, blue whiting, long rough dab and Norway pout were included in the category 'other fish' when stomachs were analysed onboard. Also, some of the Russian data for 2012 have not yet been analysed.

The stomach fullness index is calculated as $SFI_i=100*\Sigma WS_i/W_i$, where WS_i is the weight (g) of the stomach of fish *i*, and W_i is the weight (g) of fish *i*. For 1987 SFI has not been calculated, because very few fish were weighed that year due to technical problems. The distribution on prey groups has been adjusted by distributing the unidentified component of the diet proportionally among the various components, taking into account the level of identification.

The geographical distribution of stomach fullness and prey composition divided into three prey categories (capelin, other fish, other food) by length group and year is shown in Figures 6.6-6.9.

The proportion of empty stomachs is largest for the smallest fish (Table 6.10), a pattern seen for all years. Capelin is the dominating prey for cod ≥ 20cm (Tables 6.12-6.14), while krill dominates for the smallest cod (Table 6.11). However, in many years capelin is also an important prey for the smallest cod. For the period 2007-2012, the stomach fullness index as well as the proportion of capelin was lowest in 2007, which is reasonable since the capelin stock was lower in 2007 than in 2008-2012. However, much lower values of SFI and % capelin than in 2007 were observed during previous capelin collapses in the 1980s and 1990s. Considering other prey, the most noticeable feature is the high abundance of haddock in stomachs of large cod during the 2000s, especially from 2005 onwards. This corresponds well with the appearance of strong haddock year classes in 2004-2006.

Capelin is found in cod stomachs over a wide area in all the years 2008-2012. In 2007 the capelin stock was lower and also the spatial coverage was more limited than in later years. The highest stomach fullness is found in the south-eastern part of the survey area and along the coast of Norway and Russia. However, there are also in most years some stations with high stomach fullness close to the northern limit of the survey area. In between these two areas with high SFI and large proportion of capelin in the diet there is for most years and size groups an area with lower SFI and proportion of capelin. One possible explanation for this ‘discontinuity’ is that cod prey on pre-spawning capelin in the southeast and along the coast, while the predation in the north is on immature capelin. This could be investigated further by looking at the length distribution of capelin in cod stomachs in different areas.

Table 6.10. Number of stations and stomach sampled, % empty stomachs, and mean stomach fullness by length group.

		Stomachs				% empty				Stomach fullness			
Year	**Stations**	**<20cm**	**20-34cm**	**35-49cm**	**>=50cm**	**<20cm**	**20-34cm**	**35-49cm**	**>=50cm**	**<20cm**	**20-34cm**	**35-49cm**	**>=50cm**
1984	31	176	288	242	381	18.8	14.9	5.0	4.5	1.59	2.05	1.80	1.46
1985	49	106	494	582	612	44.3	34.0	19.8	20.6	1.55	3.58	4.46	3.43
1986	73	231	309	398	427	43.3	32.4	26.9	19.0	0.73	2.48	2.90	2.94
1987	52	133	415	501	409	32.3	48.9	45.3	48.9				
1988	79	29	418	844	704	34.5	40.2	31.6	29.7	1.01	1.29	0.91	0.84
1989	82	82	378	890	1132	40.2	21.2	16.3	20.6	1.45	2.28	2.12	1.47
1990	60	177	300	450	870	39.0	22.7	18.4	16.4	1.84	2.18	2.01	1.60
1991	70	271	463	450	1107	40.6	25.5	11.3	9.5	0.95	2.28	3.73	4.27
1992	100	229	382	471	922	65.9	45.8	31.4	38.2	1.79	3.15	3.05	1.92
1993	117	139	393	570	1073	76.3	38.4	21.2	26.7	1.86	3.34	2.99	3.05
1994	138	296	370	580	1163	64.9	34.9	25.0	24.3	0.76	2.04	2.00	1.63
1995	161	452	517	638	1482	52.2	36.4	32.0	30.8	1.16	1.39	0.93	0.80
1996	254	483	507	540	1338	55.7	39.1	28.0	27.4	0.92	1.32	1.38	1.02
1997	149	305	337	358	1105	57.0	34.1	20.7	29.5	0.98	1.60	1.81	1.48
1998	197	496	492	564	1042	64.7	48.2	29.3	28.6	2.20	1.93	1.67	1.22
1999	211	310	471	554	849	61.3	38.6	27.4	25.9	2.11	1.90	2.06	1.76
2000	243	413	645	669	1069	53.8	28.7	21.2	21.1	1.36	1.98	2.41	1.74
2001	361	644	728	884	1485	72.4	42.3	29.3	32.2	2.32	2.98	3.33	2.79
2002	345	393	704	799	1423	69.2	42.8	30.9	30.9	1.57	2.78	2.36	1.88
2003	285	325	499	637	1468	61.5	39.5	22.6	24.4	5.55	2.78	2.55	2.28
2004	329	508	525	663	1522	51.8	37.9	24.1	27.6	1.94	2.02	1.76	1.55
2005	335	509	651	648	1423	43.6	34.7	26.5	25.4	2.29	2.22	1.79	1.65
2006	259	402	464	534	1059	59.2	42.5	21.9	24.5	1.80	1.88	2.56	1.80
2007	273	386	483	592	1341	60.6	45.3	30.7	30.1	1.68	1.87	1.83	1.50
2008	326	260	733	933	1655	61.9	38.5	26.0	23.0	1.94	2.42	2.93	2.19
2009	319	385	547	798	1657	56.1	35.1	22.3	23.9	1.57	1.89	2.02	1.58
2010	360	594	552	748	2079	51.5	38.6	23.0	25.5	1.83	2.19	2.72	2.49
2011	359	515	628	506	1821	56.7	37.7	17.2	23.9	2.08	2.06	2.47	2.49
2012	292	371	406	422	1583	42.9	27.6	13.7	20.8	1.78	2.46	2.30	1.69

Table 6.11. Stomach content composition (% of total SFI) of cod ≤ 19 cm from the winter survey.

Year	Amphi-pods	Krill	Shrimp	Other Invert	Capelin	Herring	Polar Cod	Blue Whiting	Cod	Haddock	Redfish	Long rough dab	Norway pout	Other fish
1984	1.2	7.7	37.5	4.5	13.3						35.8			
1985	15.5	7.9	27.9	44.4										4.3
1986	14.3	3.8	34.0	14.4	15.2									18.3
1987	24.8	17.7	10.9	0.2	25.4		21.0							
1988	3.5	19.2		64.3							13.0			
1989	41.1	27.9		31.0										
1990	5.5	14.2	38.4	3.7	3.8						3.2			31.2
1991	12.2	18.7	6.9	8.4	53.8									
1992	3.7	3.8	6.9	54.3	17.7									13.6
1993	35.3	59.0		5.7										
1994	19.1	40.8	10.9	11.6										17.6
1995	12.9	6.7	33.9	3.5	7.4		27.8		6.2					1.6
1996	16.3	25.4	15.0	27.4	9.4									6.5
1997	23.3	35.9	26.5	0.3										14.0
1998	20.9	30.3	17.2	12.4	16.9							2.3		
1999	9.9	18.4	34.0	6.5		18.0	13.2							
2000	3.3	57.1	17.8	0.0	17.3									4.5
2001	7.0	31.2	10.1	10.7	26.8	8.6								5.6
2002	15.0	32.1	21.1	13.9	17.9									
2003	1.6	80.0	10.4	1.4	6.6									
2004	11.0	44.7	5.9	9.1	14.3	4.2	10.8							
2005	17.2	22.8	16.2	0.3	35.8									7.7
2006	9.7	49.9	7.8	20.5	12.1									
2007	6.0	74.6	6.1	0.5	11.6							1.2		
2008	7.3	47.6	31.3	8.7	0.7							0.3		4.1
2009	4.7	61.4	1.9	8.8	18.1									5.1
2010	3.5	41.7	1.4	1.6	48.2						0.7			2.9
2011	1.5	24.8	14.6	4.0	29.6						8.2			17.3
2012	4.8	20.6	8.7	4.2	54.2									7.5

Table 6.12. Mean stomach content composition (% of total SFI) of cod 20-34 cm from the winter survey.

Year	Amphipods	Krill	Shrimp	Other Invert	Capelin	Herring	Polar cod	Blue whiting	Cod	Haddock	Redfish	Long rough dab	Norway pout	Other Fish
1984	0.1	0.1	21.0	2.7	40.2		8.1				26.3	0.2		1.3
1985	0.2	0.1	17.0	2.0	69.2	9.3				1.1	0.2			0.9
1986	2.0	1.1	5.9	2.8	56.2	7.0				0.8	23.3			0.9
1987	0.5	1.9	25.2	0.3	53.7				6.6		11.4			0.4
1988	0.9	0.2	20.7	7.0	52.9						18.3			
1989	11.9	7.1	9.0	5.6	33.2		5.4		1.6		25.4	0.5		0.3
1990	0.6	0.5	18.5	0.7	66.7						8.4			4.6
1991	0.1	0.2	4.3	0.2	92.5						2.0			0.7
1992	0.4	0.8	6.4	1.2	88.1				0.4		2.5			0.2
1993	0.1	0.6	8.1	0.3	78.4	5.9	3.8		0.9	1.1	0.1			0.7
1994	1.2	10.2	8.3	1.7	54.9	14.2	4.8		1.7		1.2			1.8
1995	1.4	1.5	9.4	1.8	45.8		10.8	0.6	13.3	3.4	9.3			2.7
1996	1.9	0.5	13.6	1.3	48.9		5.3		24.9		1.8	0.3	0.8	0.7
1997	1.1	3.4	17.6	1.6	42.6		1.2	5.4	10.0					17.1
1998	2.2	2.6	23.5	1.6	47.8	3.4			10.3			5.6		3.0
1999	2.3	4.0	24.5	3.4	45.6	13.5	0.8		3.2	2.7				
2000	0.7	8.0	14.2	0.3	59.4	4.2	5.3		3.6	2.1		0.1		2.1
2001	0.9	2.8	8.5	2.8	69.4	4.7	5.6		4.0					1.3
2002	0.5	1.6	12.2	2.9	71.2	0.7	7.0			1.9				2.0
2003	0.5	2.4	7.3	0.7	71.9	14.4			2.1			0.1	0.5	0.1
2004	2.1	5.2	9.7	1.9	60.6	5.9	6.4		1.9	4.2				2.1
2005	0.6	2.3	12.0	0.9	61.2	3.6	7.7		5.7				4.9	1.1
2006	1.4	1.5	11.8	3.2	66.6	1.6	2.8	2.1		3.4			4.9	0.7
2007	2.3	4.8	15.0	7.3	58.8	0.1				7.7	3.7			0.3
2008	0.5	3.8	11.1	4.7	63.3		3.5			2.4	4.2	1.0		5.5
2009	0.5	6.6	8.8	5.6	71.2		2.4		1.5		0.2			3.2
2010	0.7	5.2	7.4	1.8	74.2	1.0			6.4		2.2			1.1
2011	0.9	3.3	8.3	3.7	74.3				1.1		6.0	0.1	1.1	1.2
2012	0.4	2.7	7.2	2.1	77.2	0.4			7.7					2.3

Table 6.13. Mean stomach content composition (% of total SFI) of cod 35-49 cm from the winter survey.

Year	Amphipods	Krill	Shrimp	Other invert	Capelin	Herring	Polar cod	Blue whiting	Cod	Haddock	Redfish	Long rough dab	Norway pout	Other fish
1984	0.5		18.2	1.3	41.5				0.7	2.6	34.5	0.1	0.6	
1985	0.5		4.7	0.2	88.7	4.2			0.5	0.2	0.9			0.1
1986	0.8	2.5	6.8	3.6	58.4	12.4					15.3			0.2
1987	0.5	0.2	22.9	1.7	47.9	9.2	1.8		4.4	2.0	5.5		3.8	0.1
1988	1.0	1.9	29.1	6.3	51.2			1.5			8.8			0.2
1989	4.1	1.8	11.3	3.3	50.2		7.9		0.2		18.6	0.8	0.2	1.6
1990	0.1	0.1	7.4	1.6	84.8	2.0				1.3	2.5		0.2	
1991	0.1	0.1	1.8	0.6	94.0					1.5	1.2	0.1		0.6
1992		0.1	3.3	3.7	79.7	9.1			0.3	0.3	1.2		1.7	0.6
1993	0.1	0.2	6.0	0.6	85.4	5.6	0.5		0.2	0.4		0.2	0.8	
1994	0.9	14.2	6.9	1.2	48.9	13.5	9.1		2.2	0.4	0.3			2.4
1995	0.9	0.6	12.8	2.2	44.7	6.2	1.2		17.9	8.6	4.7			0.2
1996	1.8	0.7	10.0	2.2	21.6	1.5	2.1	5.5	37.4	6.7	2.5		6.9	1.1
1997	0.9	0.3	14.8	4.3	40.3		5.2	3.6	17.1	3.7	0.5	0.1	1.2	8.0
1998	1.1	0.4	23.2	6.8	50.3	8.5	1.2	1.8	4.1	1.5	0.8			0.3
1999	0.3	0.4	28.0	1.8	44.9	12.0	2.4		1.9	5.7	0.5	0.1	0.4	1.6
2000	0.9	0.3	8.2	0.6	83.5	4.1	0.4		0.7	0.3				1.0
2001	0.4	0.2	6.3	3.3	73.6	5.2	7.3	1.4	1.1	0.5		0.3		0.4
2002	0.2	0.6	10.4	4.2	68.3	2.3	4.8	0.8	3.2	3.9		0.5	0.4	0.4
2003	0.3	1.1	8.2	1.6	68.4	11.1	1.2	0.2	2.7	4.9				0.3
2004	0.9	1.6	14.5	4.5	61.7	6.5	2.3	1.0	4.1	1.5			1.0	0.4
2005	0.7	0.7	13.7	2.1	58.3	3.1	3.6	1.9	0.2	13.2		0.3	1.4	0.8
2006	0.1	0.2	13.1	1.5	64.8	2.0	1.3	1.6	1.1	12.7		0.2	0.3	1.1
2007	3.5	0.8	18.7	2.4	47.6	7.8		0.2	1.1	13.1	0.4	0.4	3.3	0.7
2008	0.3	0.9	11.7	1.3	71.9	2.7	7.4			0.9	1.1	0.3	0.4	1.1
2009	0.8	1.7	6.9	6.9	75.9	1.8	2.4		1.7	0.4	0.6	0.1	0.8	
2010	1.0	1.2	6.3	1.3	81.2	0.4	0.3		2.2	3.6	1.4	0.1	0.6	0.4
2011	0.1	0.7	7.5	3.2	76.0	1.5		1.4	4.2	0.9	2.3	0.1	1.4	0.7
2012	0.5	0.9	9.7	2.2	71.7	0.5	0.6	0.2	3.4	3.5	1.2	0.3	2.1	3.2

Table 6.14. Mean stomach content composition (% of total SFI) of cod ≥ 50 cm from the winter survey.

Year	Amphi-pods	Krill	Shrimp	Other invert	Capelin	Herring	Polar cod	Blue whiting	Cod	Haddock	Redfish	Long rough dab	Norway pout	Other fish
1984	0.4	0.0	16.3	1.3	48.1	0.0	0.6	0.0	3.5	2.4	26.4	0.3	0.0	0.7
1985	0.2	0.0	5.2	0.4	85.8	3.0	0.0	0.3	2.1	0.6	1.2	1.1	0.1	0.0
1986	0.6	0.2	4.4	3.9	53.9	3.2	0.0	2.5	9.5	7.9	7.7	0.1	4.1	2.0
1987	1.9	0.1	7.4	6.5	2.2	3.6	3.1	3.3	15.6	0.0	35.3	0.3	18.9	1.8
1988	0.9	0.7	11.7	7.0	11.9	0.0	0.0	4.8	0.0	0.0	16.3	4.7	0.0	42.0
1989	0.8	1.0	10.1	7.2	50.9	0.0	1.1	0.0	0.0	0.5	25.1	1.2	0.8	1.3
1990	0.1	0.3	5.2	1.8	74.4	1.1	0.0	5.2	0.1	4.8	4.0	0.9	1.8	0.3
1991	0.0	0.0	1.2	0.5	94.1	0.4	0.0	0.0	0.6	0.9	1.0	0.1	0.4	0.8
1992	0.2	0.1	5.6	3.8	56.7	17.6	0.1	0.0	2.3	4.1	3.7	2.3	2.6	0.9
1993	0.0	0.3	2.2	11.4	54.9	16.0	0.3	0.6	5.2	4.3	0.9	0.0	3.8	0.1
1994	0.5	12.9	5.9	2.8	35.4	7.1	4.4	0.2	12.0	4.3	5.8	1.1	0.0	7.6
1995	0.5	0.3	5.0	2.2	8.4	8.0	0.7	0.0	18.3	20.4	18.8	2.2	0.2	15.0
1996	0.5	0.2	4.1	2.7	9.3	14.6	2.5	0.4	27.2	27.8	6.2	1.8	2.6	0.1
1997	0.2	0.2	10.1	0.8	45.8	5.0	1.1	3.4	5.3	8.2	4.3	0.8	0.6	14.2
1998	1.2	0.2	22.7	3.8	34.5	7.3	1.0	1.2	6.2	6.6	4.1	3.7	2.6	4.9
1999	0.2	0.1	25.8	6.3	26.5	9.8	2.5	0.7	10.3	5.0	0.4	1.4	0.5	10.5
2000	0.9	0.4	7.9	1.6	68.9	6.5	0.8	2.3	2.8	3.4	0.7	1.5	0.0	2.3
2001	0.7	0.2	4.4	4.6	71.7	4.4	1.6	2.5	3.3	2.6	0.3	1.9	0.4	1.4
2002	0.2	0.7	5.9	6.5	50.9	3.0	4.2	2.0	9.0	13.0	1.0	1.7	0.7	1.2
2003	0.1	0.2	5.5	4.9	59.1	10.6	1.5	1.1	4.3	9.1	0.5	1.4	0.4	1.3
2004	0.2	0.2	6.5	3.2	48.2	4.9	0.5	2.6	7.6	17.0	1.6	2.7	1.6	3.2
2005	0.3	0.3	5.8	4.2	33.2	2.9	0.8	5.6	7.9	31.2		1.5	2.5	3.8
2006	0.1	0.1	4.6	4.8	45.8	1.8	0.6	6.1	1.8	28.3	1.6	1.8	1.5	1.1
2007	0.5	0.2	8.3	5.0	29.2	18.4		1.9	7.8	20.8	2.0	2.3	2.7	0.9
2008	0.1	0.4	4.9	2.7	60.7	7.5	0.3	0.4	0.9	17.4	0.8	1.8	0.9	1.2
2009	0.2	0.3	5.5	4.2	53.0	8.6	0.8	0.4	4.1	12.9	1.5	2.9	3.9	1.7
2010	0.6	0.3	2.5	2.3	72.7	1.7	0.2	0.1	3.5	10.6	0.9	2.0	2.5	0.1
2011	0.1	0.3	3.1	2.9	82.0	0.4	0.6		2.6	5.2	0.9	0.5	1.1	0.3
2012	0.1	0.2	4.0	6.7	61.8		0.1	0.1	2.4	16.4	0.5	1.4	3.9	2.4

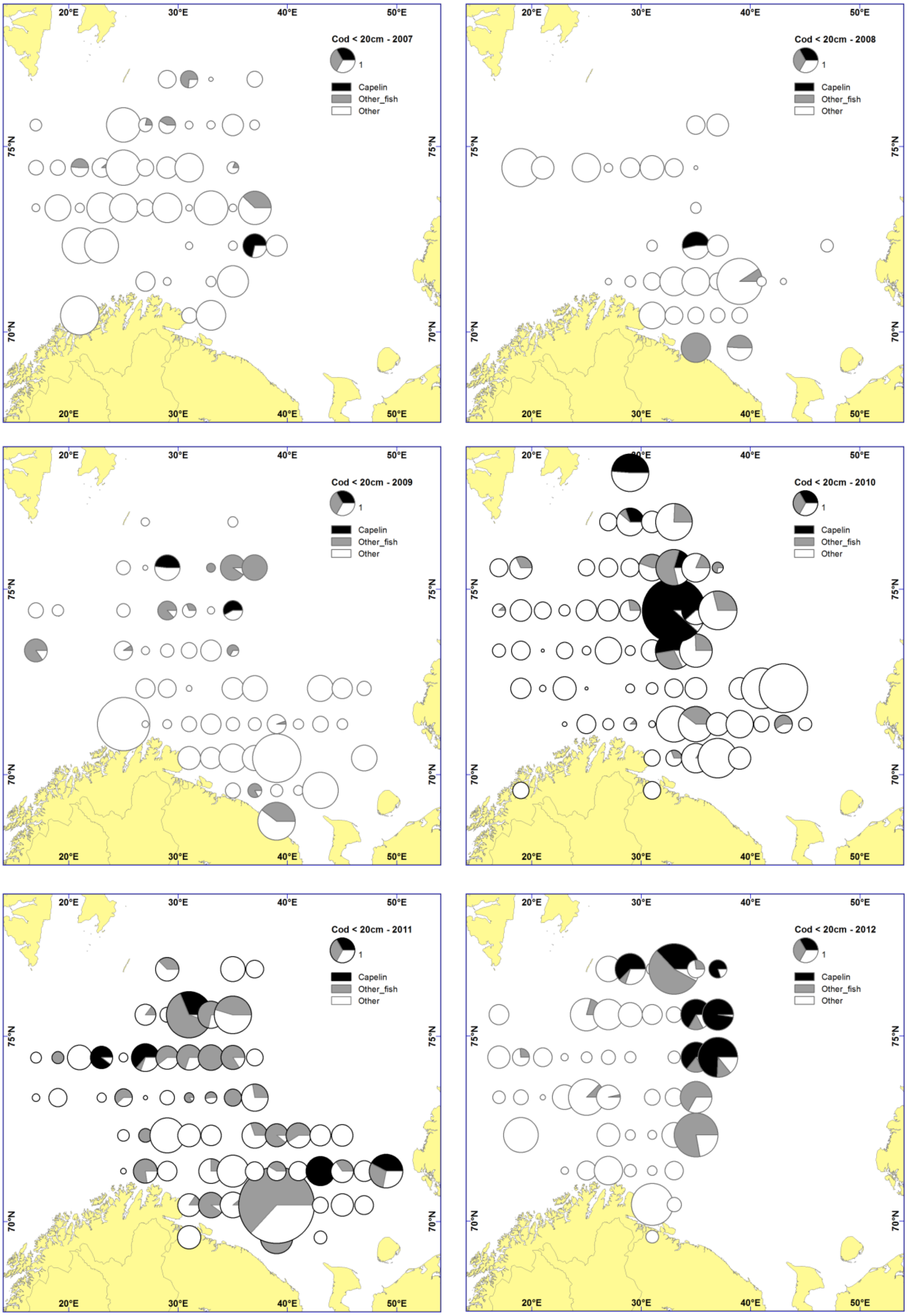


Figure 6.6. Stomach fullness and diet composition for cod ≤ 19 cm in 2007-2012, by 1° x 2° areas . Prey are grouped into the categories capelin, other fish and other prey. The size of the circles indicate the stomach fullness.

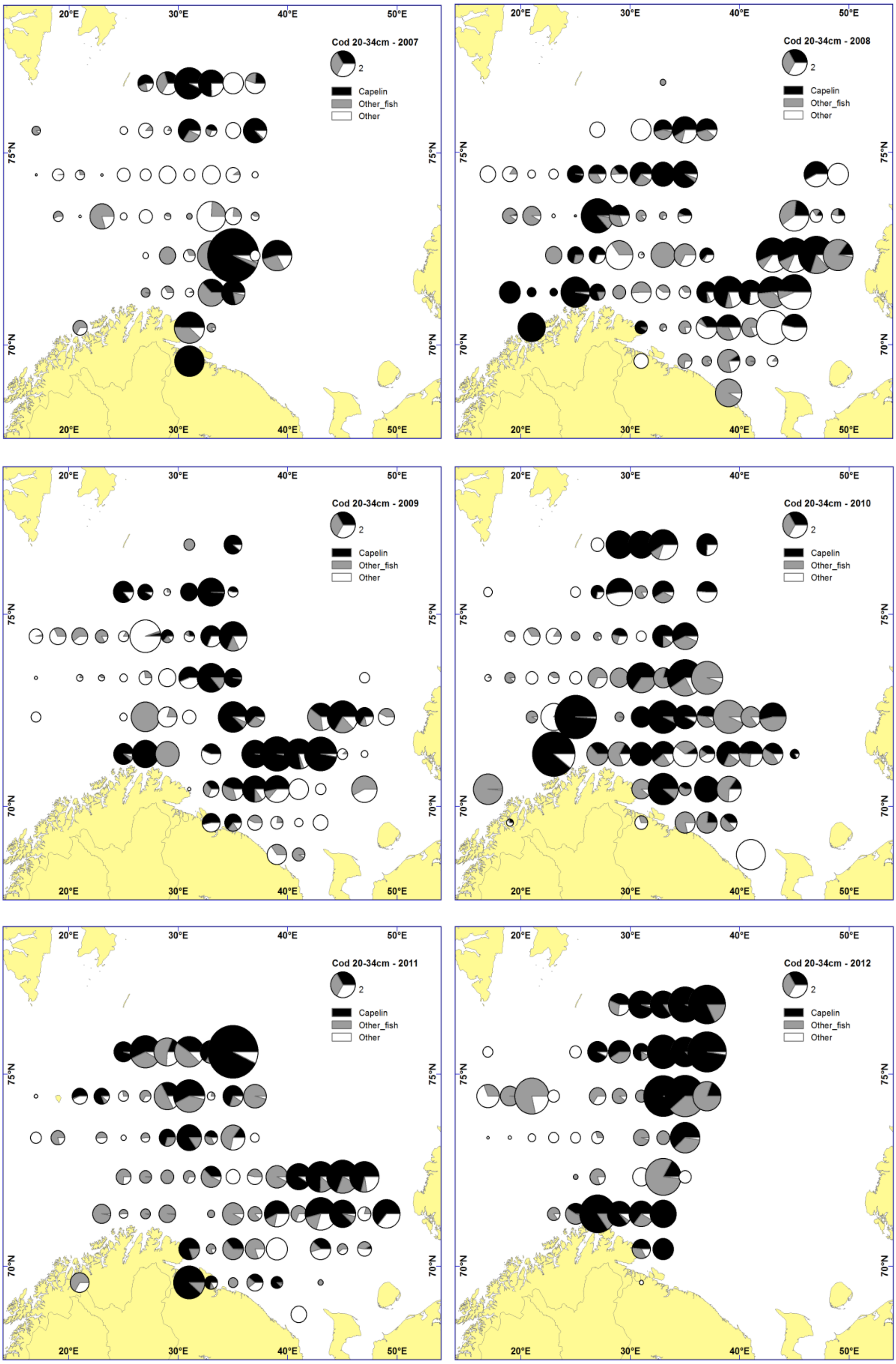


Figure 6.7. Stomach fullness and diet composition for cod 20-34 cm in 2007-2012, by 1° x 2° areas . Prey are grouped into the categories capelin, other fish and other prey. The size of the circles indicate the stomach fullness.

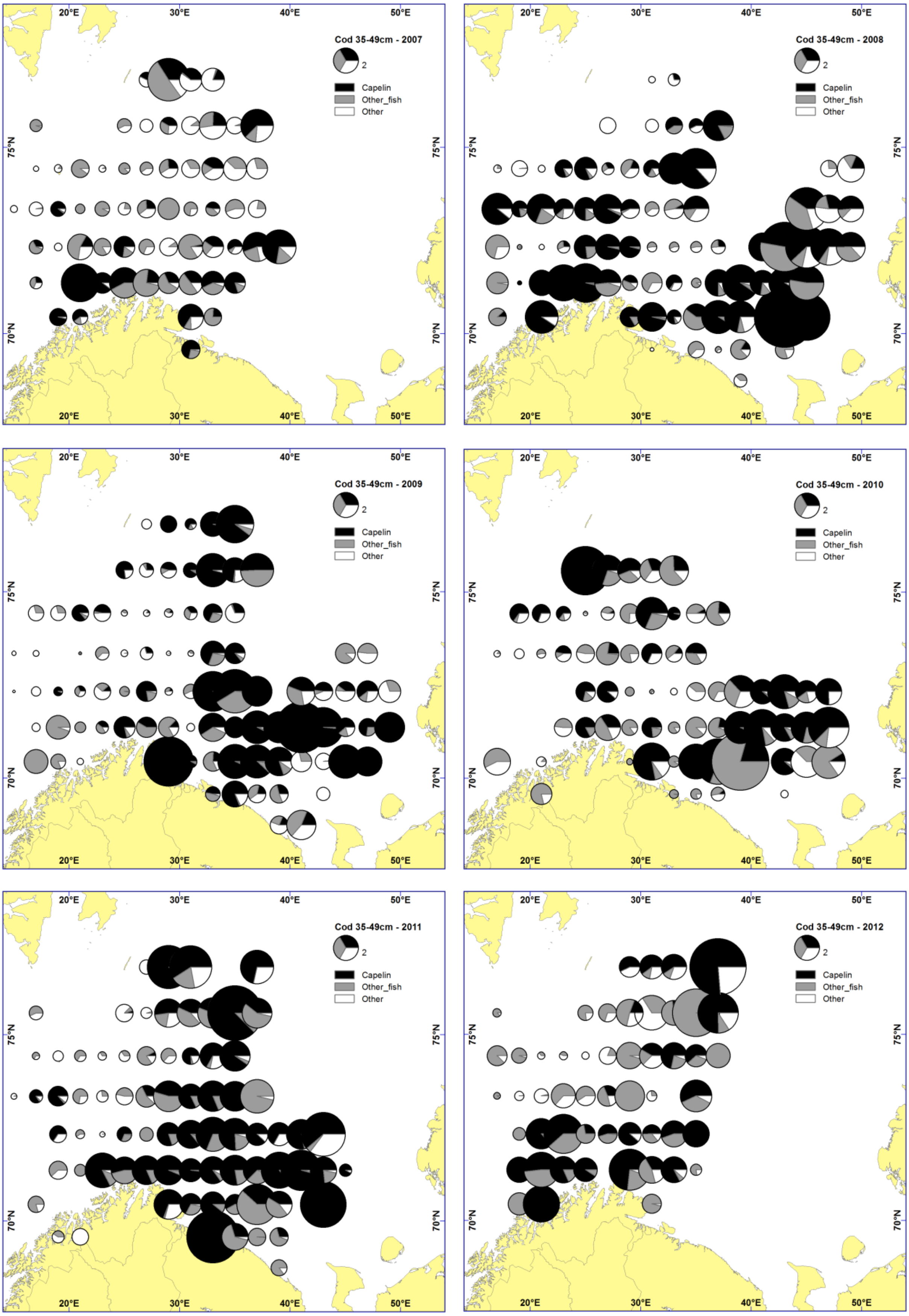


Figure 6.8 Stomach fullness and diet composition for cod 35-49 cm in 2007-2012, by 1° x 2° areas . Prey are grouped into the categories capelin, other fish and other prey. The size of the circles indicate the stomach fullness.

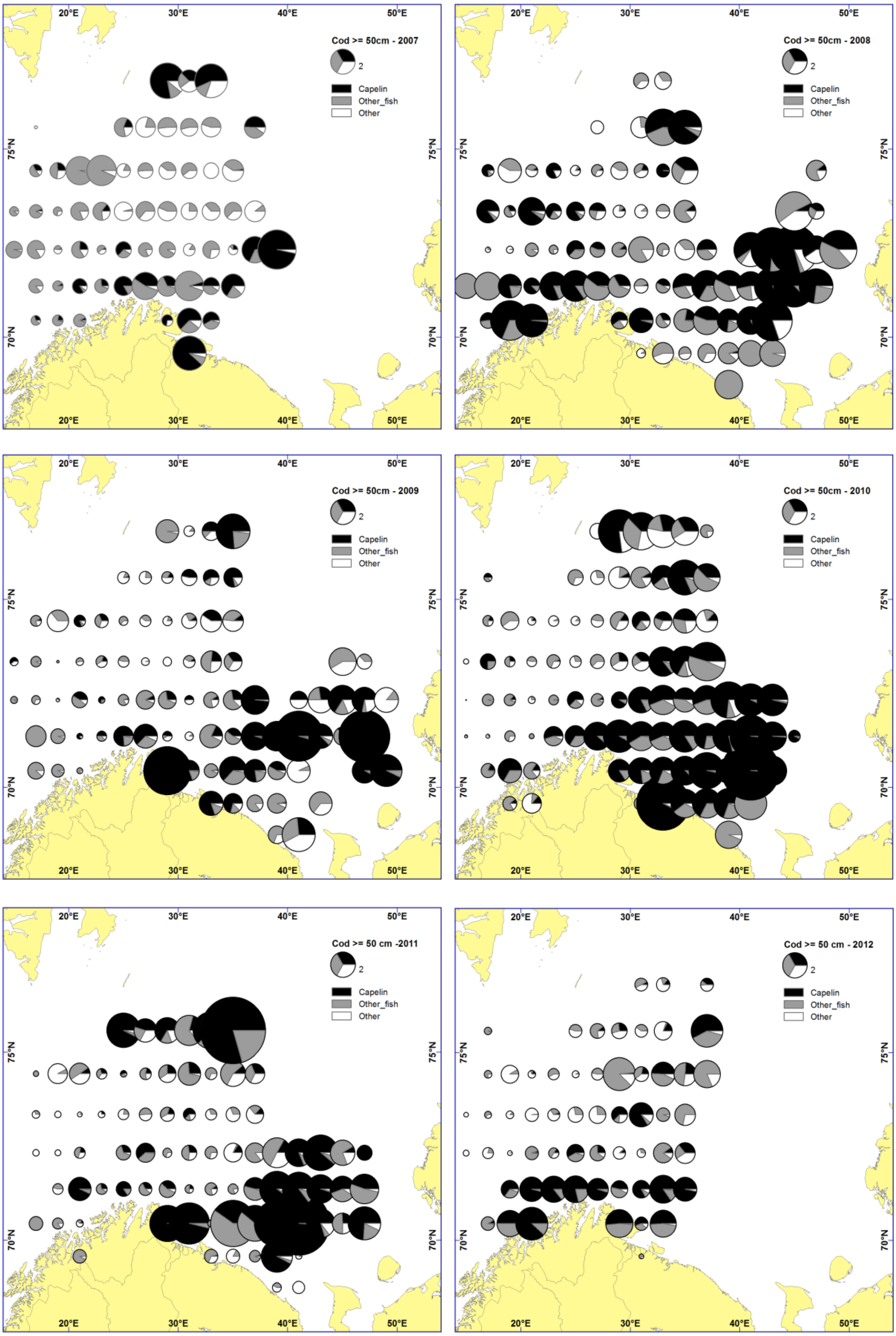


Figure 6.9. Stomach fullness and diet composition for cod ≥ 50 cm in 2007-2012, by 1° x 2° areas . Prey are grouped into the categories capelin, other fish and other prey. The size of the circles indicate the stomach fullness.

7 Distribution and abundance of haddock

7.1 Acoustic estimation

Like 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. In some earlier years, e.g. 2004 and 2005, concentrations of mature haddock have been observed pelagic rather far above bottom along the shelf edge. These concentrations are poorly covered by the bottom trawl sampling.

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. This occurred in the late 1990s and will have strongest effect on poor year-classes. In the later surveys small haddock has been widely distributed, and the strong year-classes have been found unusually far to the north. This might be caused by favourably hydrographic conditions and/or density-dependent mechanisms. However, it is difficult to separate the two factors. Favourable hydrographic conditions may lead to better distribution of larvae and thus better survival. On the other hand, high densities of juveniles may cause delayed settlement and more active movement in search of prey.

Table 7.1 shows the acoustic abundance indices by age within the main areas. As in most of the previous years the highest abundance was observed in main area D. In 2007 the indices were adjusted by calculating the time series of ratios between the bottom trawl index in the 1993-2006 coverage and the reduced area (2007 coverage). The age-based scaling factors were then estimated as the 1-step predictions given by fitting the ratios to AR models (ICES 2007). In 2012, the scaling factors for estimating adjusted total from (Tot –D') are the average ratio by age for Total/(Total-D') in the years 2008-2011 (Aglen et al. 2012). The time series (1981-2012) are presented in Table 7.2. The strong 2004-2006 year-classes can be followed through the time series and still have a strong contribution to the total abundance. In later years, the 2009 and 2011 year-classes seem to be fairly strong.

Table 7.1. HADDOCK. Acoustic abundance indices for the main areas of the Barents Sea winter 2007-2012 (numbers in millions).

Area	Year	Age group										Total	Biomass ('000 t)
		1	2	3	4	5	6	7	8	9	10+		
A	2007	656.8	141.5	18.5	5.1	19.2	8.5	2.3	3.8	1.6	0.2	857.6	94.1
	2008	605.7	631.4	97.5	44.0	25.4	48.9	2.4	3.2	0.3	1.0	1459.8	297.0
	2009	258.7	64.0	213.3	83.6	30.5	4.9	7.3	0.6	-	0.3	663.2	176.9
	2010	530.4	29.6	32.1	111.6	107.5	81.7	3.2	2.0	0.5	0.5	899.2	271.8
	2011	131.2	135.7	10.9	9.4	83.2	66.8	10.2	0.5	-	0.5	448.6	176.3
	2012	590.4	33.0	56.0	6.1	21.6	143.5	55.7	15.7	-	-	922.0	300.8
B	2007	257.6	25.6	16.1	2.3	6.4	2.8	0.4	0.5	0.1	0.1	311.9	30.2
	2008	203.0	85.0	27.5	20.7	9.6	8.1	5.6	1.2	-	-	360.7	76.1
	2009	137.2	36.1	44.8	13.5	9.2	1.3	1.9	0.1	-	0.1	244.3	43.4
	2010	123.4	12.6	7.0	7.2	11.8	14.9	1.7	0.1	+	-	178.6	35.9
	2011	77.2	31.1	17.2	4.5	22.6	27.8	7.7	0.3	0.1	-	188.6	71.9
	2012	587.7	104.1	31.9	7.6	3.7	17.4	16.0	3.8	-	0.1	772.3	88.5
C	2007	242.4	47.3	3.7	0.3	2.1	0.8	0.3	0.2	+	-	297.1	18.1
	2008	92.8	50.0	7.1	2.0	0.5	0.5	0.1	-	-	-	153.0	12.6
	2009	87.0	19.7	22.2	8.8	26.3	1.3	0.8	0.1	-	-	166.2	34.8
	2010	116.8	2.7	9.2	22.7	16.9	8.9	0.5	0.1	+	-	177.8	40.3
	2011	151.5	97.0	1.0	9.2	28.4	40.4	8.2	0.1	0.1	-	336.0	93.9
	2012	175.4	4.3	20.9	2.1	11.0	37.3	16.2	0.4	-	+	267.6	80.9
D	2007[1]	644.8	320.9	50.4	10.7	18.4	3.1	0.9	0.1	0.1	+	1049.4	93.2
	2008	231.3	568.9	333.4	137.4	16.4	14.0	1.9	0.7	0.1	-	1304.1	267.3
	2009	220.4	91.4	456.7	448.8	271.5	22.9	4.6	0.8	-	-	1517.1	532.0
	2010	1094.7	29.8	83.3	386.0	332.7	69.1	3.6	0.4	0.1	-	1999.8	256.8
	2011	349.6	138.1	15.9	39.6	119.2	75.2	21.4	0.6	0.3	-	759.9	232.5
	2012	687.2	27.4	91.5	10.1	13.8	76.0	35.7	8.9	0.8	0.2	951.7	199.8
D'	2007[1]	15.8	14.6	0.5	+	+	-	-	-	-	-	30.9	2.4
	2008	8.8	71.2	79.1	30.9	2.1	1.2	0.2	0.3	-	-	193.8	48.8
	2009	3.7	7.2	162.4	153.0	53.8	+	-	-	-	-	380.2	123.4
	2010	18.2	3.1	1.8	34.4	72.5	11.8	0.3	+	+	+	142.3	67.3
	2011	1.2	0.9	0.7	1.9	35.6	16.3	2.4	0.1	-	-	59.1	40.2
	2012[1]	22.3	0.8	0.2	0.2	-	1.0	0.5	-	-	-	25.0	2.9
E	2007[1]	84.4	53.0	9.2	0.3	-	0.6	+	-	-	-	147.4	12.3
	2008	42.5	89.6	43.7	2.3	0.6	0.2	-	-	-	-	178.9	30.3
	2009	32.9	9.3	26.0	8.3	2.0	+	0.2	-	-	-	78.8	15.9
	2010	79.3	1.2	0.7	4.8	1.1	-	-	-	-	-	87.0	5.3
	2011	11.3	0.2	-	0.1	+	+	-	-	-	-	11.6	0.3
	2012	27.8	0.1	1.4	0.1	0.2	-	0.3	-	-	-	29.9	1.8
S	2007	231.5	63.8	29.7	3.5	1.4	0.4	0.4	0.1	-	-	330.8	25.0
	2008	82.5	338.9	135.0	14.6	2.6	1.2	-	0.3	-	-	575.1	109.3
	2009	109.1	18.6	96.3	56.9	8.7	0.8	0.2	-	0.1	0.2	290.8	79.5
	2010	73.1	2.8	4.0	26.3	14.8	4.9	1.1	0.3	-	+	127.3	40.5
	2011	64.4	5.1	1.8	3.3	23.9	36.1	2.4	-	-	-	137.0	67.4
	2012	141.6	2.2	5.0	0.8	1.9	9.6	8.0	1.9	-	0.1	171.1	31.7
ABCD	2007[1]	1801.6	535.3	88.7	18.4	46.1	15.2	3.9	4.6	1.8	0.3	2516.0	235.6
	2008	1132.8	1335.5	465.5	204.0	52.0	71.7	10.0	5.2	0.4	1.0	3277.6	653.0
	2009	703.3	211.2	737.0	554.7	337.5	30.4	14.6	1.6	-	0.4	2590.8	787.1
	2010	1865.3	74.7	131.6	527.5	468.9	174.6	9.0	2.6	0.6	0.5	3255.4	861.6
	2011	709.5	401.9	45.0	62.7	253.4	210.2	47.5	1.5	0.5	0.5	1733.1	574.6
	2012	2040.8	168.8	200.3	26.0	50.2	274.1	123.4	28.7	0.8	0.4	2913.5	670.0
Total	2007[1]	2133.4	666.6	128.0	22.2	47.6	16.3	4.4	4.7	1.8	0.3	3025.2	275.3
	2008	1266.6	1835.2	723.4	251.7	57.3	74.2	10.2	5.8	0.4	1.0	4225.7	841.4
	2009	849.0	246.3	1021.7	773.0	402.1	31.3	14.9	1.6	0.1	0.5	3340.6	1005.9
	2010	2035.8	81.8	138.0	593.0	557.4	191.4	10.3	2.9	0.7	0.7	3612.0	974.6
	2011	786.5	408.0	47.6	68.1	313.0	262.6	52.4	1.6	0.5	0.6	1941.0	682.7
	2012[1]	2232.4	172.0	206.8	27.0	52.3	284.8	132.2	30.6	0.8	0.4	3139.4	706.4

[1] not scaled for uncovered areas

Table 7.2. HADDOCK. Abundance indices from acoustic surveys in the Barents Sea winter 1981-2012 (numbers in millions). 1981-1992 includes mainly areas A, B, C and D.

Year	Age										Total	Biomass
	1	2	3	4	5	6	7	8	9	10+		('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[1]	693	24	51	17	12	43	43	2	+	+	885	155
1998[1]	220	122	20	28	12	5	13	16	1	+	437	92
1999	855.8	45.5	57.3	13.1	13.9	3.6	1.4	1.9	1.6	0.03	994	81
2000	1024.4	508.9	32.2	64.9	18.5	10.5	1.6	0.5	1.8	0.4	1664	185
2001	976.5	315.6	209.6	23.1	21.6	1.3	0.9	0.1	0.04	0.5	1549	175
2002	2062.1	282.0	215.7	149.5	13.5	11.7	1.0	0.2	0.03	0.7	2736	264
2003	2394.5	278.6	145.2	197.6	168.8	17.2	5.0	0.2	0.1	1.1	3208	455
2004	751.8	474.3	126.7	75.9	76.0	65.9	6.6	2.0	0.1	0.3	1580	287
2005	3363.6	209.2	218.9	101.9	36.5	40.1	9.0	0.1	0.1	0.0	3979	302
2006	2767.1	803.6	54.2	86.2	30.2	11.6	9.0	2.2	0.09	0.21	3764	282
2007[1]	3197.0	868.0	379.0	54.0	88.0	22.0	6.0	5.0	2.00	0.00	4621	462
2008	1266.6	1835.2	723.4	251.7	57.3	74.2	10.2	5.8	0.35	1.03	4226	841
2009	849.0	246.3	1021.7	773.0	402.1	31.3	14.9	1.6	0.13	0.53	3341	1006
2010	2035.8	81.8	138.0	593.0	557.4	191.4	10.3	2.9	0.68	0.72	3612	975
2011	786.5	408.0	47.6	68.1	313.0	262.6	52.4	1.6	0.45	0.63	1941	683
2012	2222.2	176.0	224.3	30.0	58.4	294.3	134.9	31.6	0.83	0.42	3173	739

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

[2] Indices raised to also represent uncovered parts of Main Area D'

7.2 Swept area estimation

Figures 7.1 - 7.4 show the geographic distribution of bottom trawl catch rates (number of per nm^2, corresponding to 1 hours towing) for haddock size groups $\leq$ 19 cm, 20-34 cm, 35-49 cm and $\geq$ 50 cm. The distribution extends further to the north and to the east than what was usual in the 1990s. To a certain degree, one can follow the high densities through the size groups, especially the northern and eastern distributions. This indicates that the distribution is more cohort-dependent than age-dependent, and it may be more appropriate to use cohort as scaling covariate rather than age, when indices are adjusted for poor coverage.

Table 7.3 presents the indices for each age group by main areas In 2007 the indices were adjusted by calculating the time series of ratios between the bottom trawl index in the 1993-2006 coverage and the reduced area (2007 coverage). The age-based scaling factors were then estimated as the 1-step predictions given by fitting the ratios to AR models (ICES 2007). In 2012, the scaling factors for estimating adjusted total from (Tot –D’) are the average ratio by age for Total/(Total-D’) in the years 2008-2011 (Aglen et al. 2012). The time series (1981-2012) are shown in Table 7.4. As with the acoustic indices, the strong 2004-2006 year-classes dominates bottom trawl indices. Overall, this survey tracks both strong and poor year-classes fairly well. In later years, the 2009 and 2011 year-classes are stronger than the 2007, 2008, and 2010 year-classes.

Table 7.5 and Figure 7.5 presents estimated coefficients of variation (CV) for haddock age groups 1-16 in 1989-2012 (also indices will be presented for older groups in future reports). Estimates are based on a stratified bootstrap approach with 500 replicates (with trawl stations being primary sampling unit). The red horizontal line corresponds to a CV of 30%. Values above this indicate a highly uncertain index with little information regarding year class strength. A CV of 20% or less could be viewed as acceptable in a traditional stock assessment approach if the indices are unbiased (conditional on a catchability model). Identification and possible correction of bias is limited by a high CV and much longer time series of consistent data will be needed. In Table 7.5, there are some cohort trends in estimated CVs, e.g. the relatively poor 1997 year-class have high CVs throughout the time series. There are also some co-variability within years, e.g. 2010, all ages above age 4 have high CV. It is also evident that indices above age 7 are not reliable.

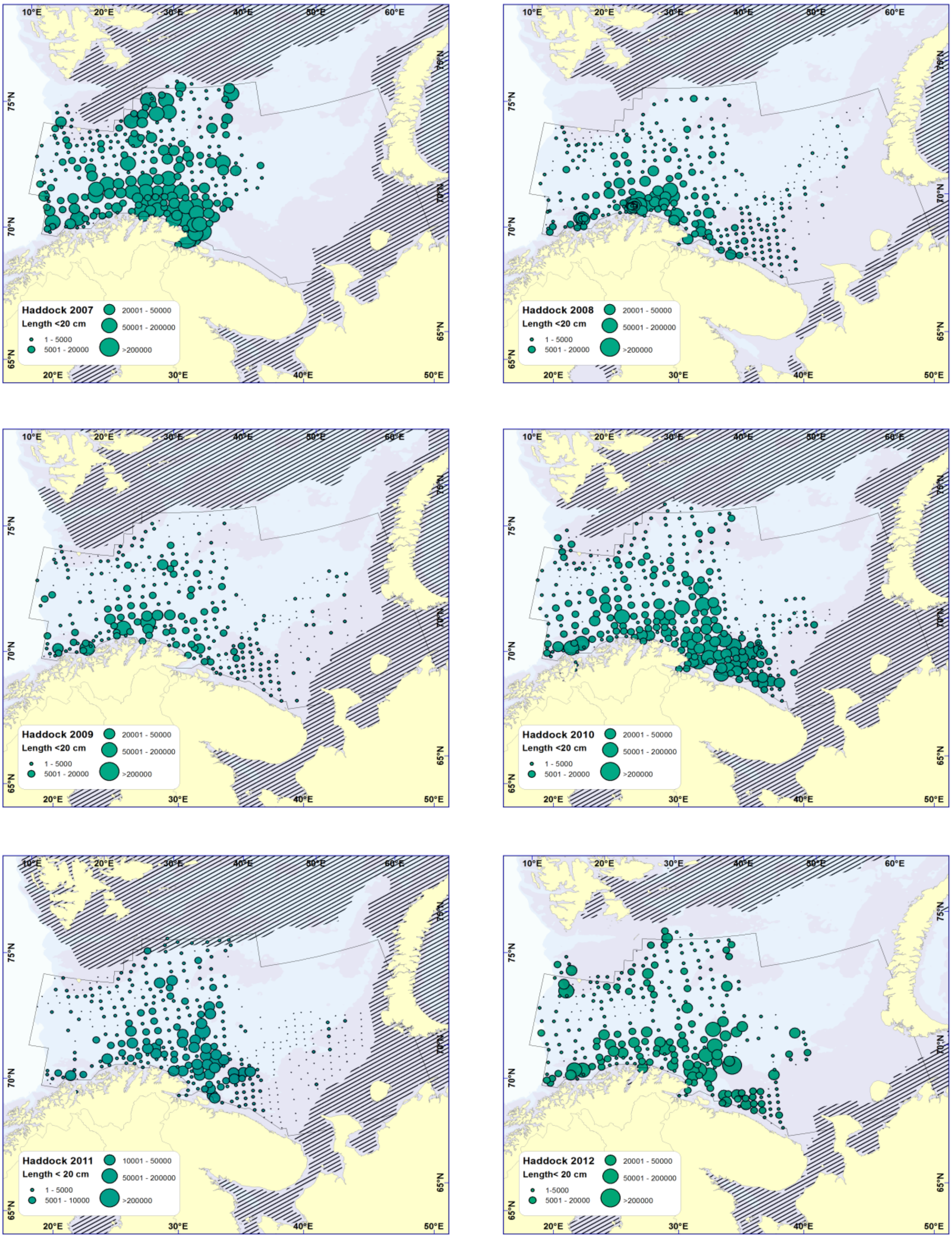


Figure 7.1. HADDOCK ≤ 19 cm. Distribution in valid bottom trawl catches winter 2007-2012 (number per nm^2). Zero catches are indicated by black points.

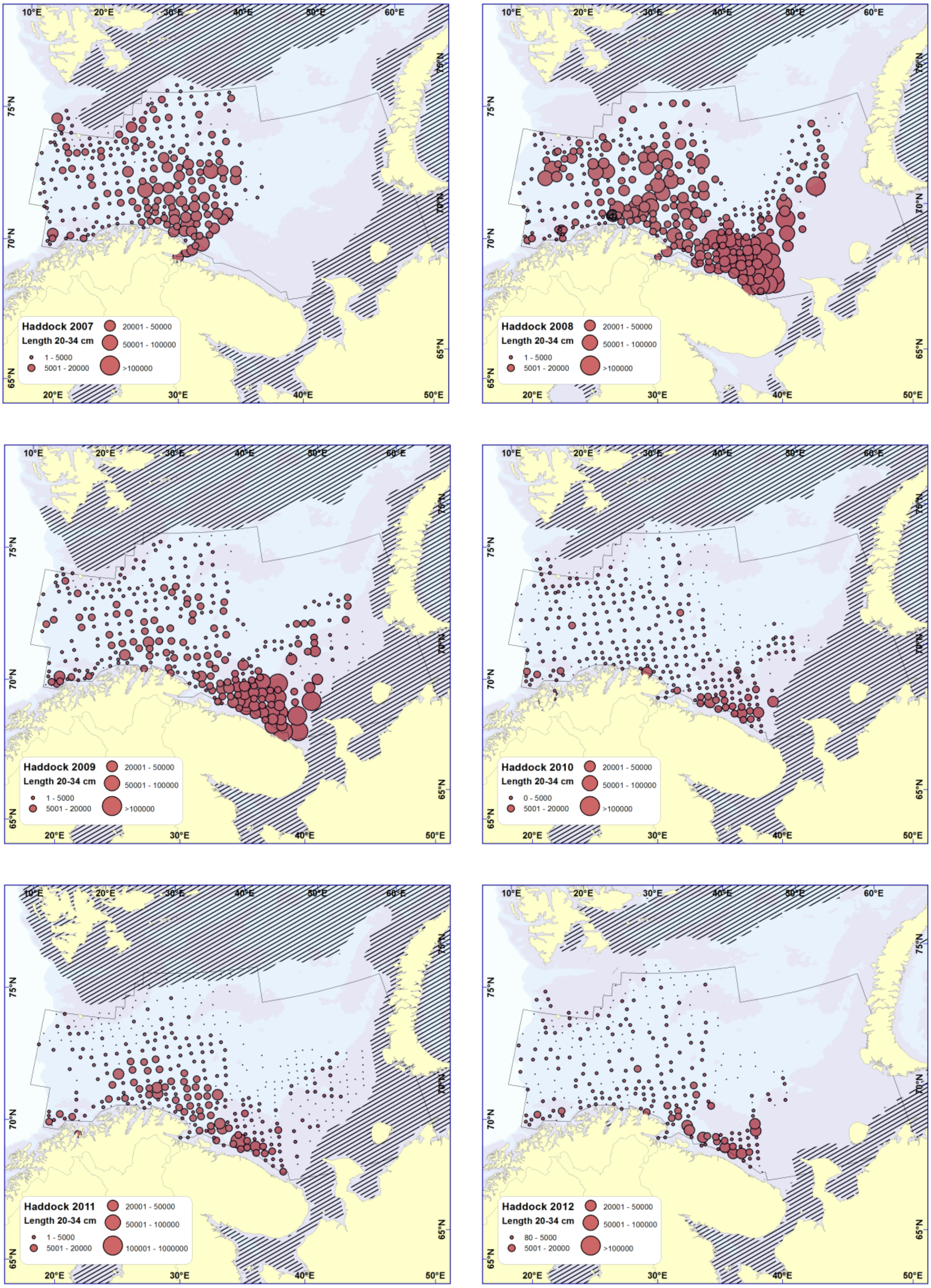


Figure 7.2. HADDOCK 20-34 cm. Distribution in valid bottom trawl catches winter 2007-2012 (number per nm^2). Zero catches are indicated by black points.

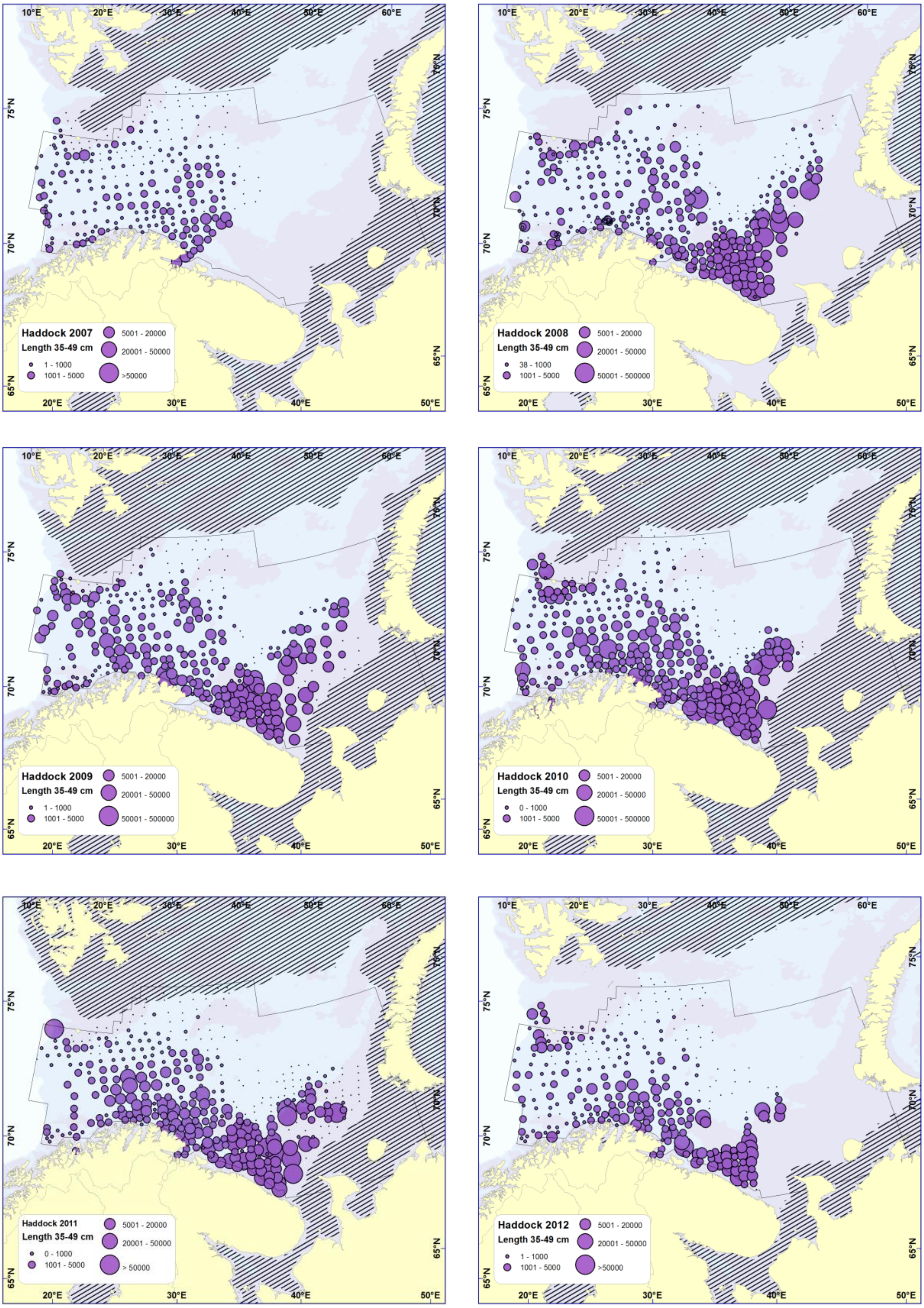


Figure 7.3. HADDOCK 35-49 cm. Distribution in valid bottom trawl catches winter 2007-2012 (number per nm^2). Zero catches are indicated by black points.

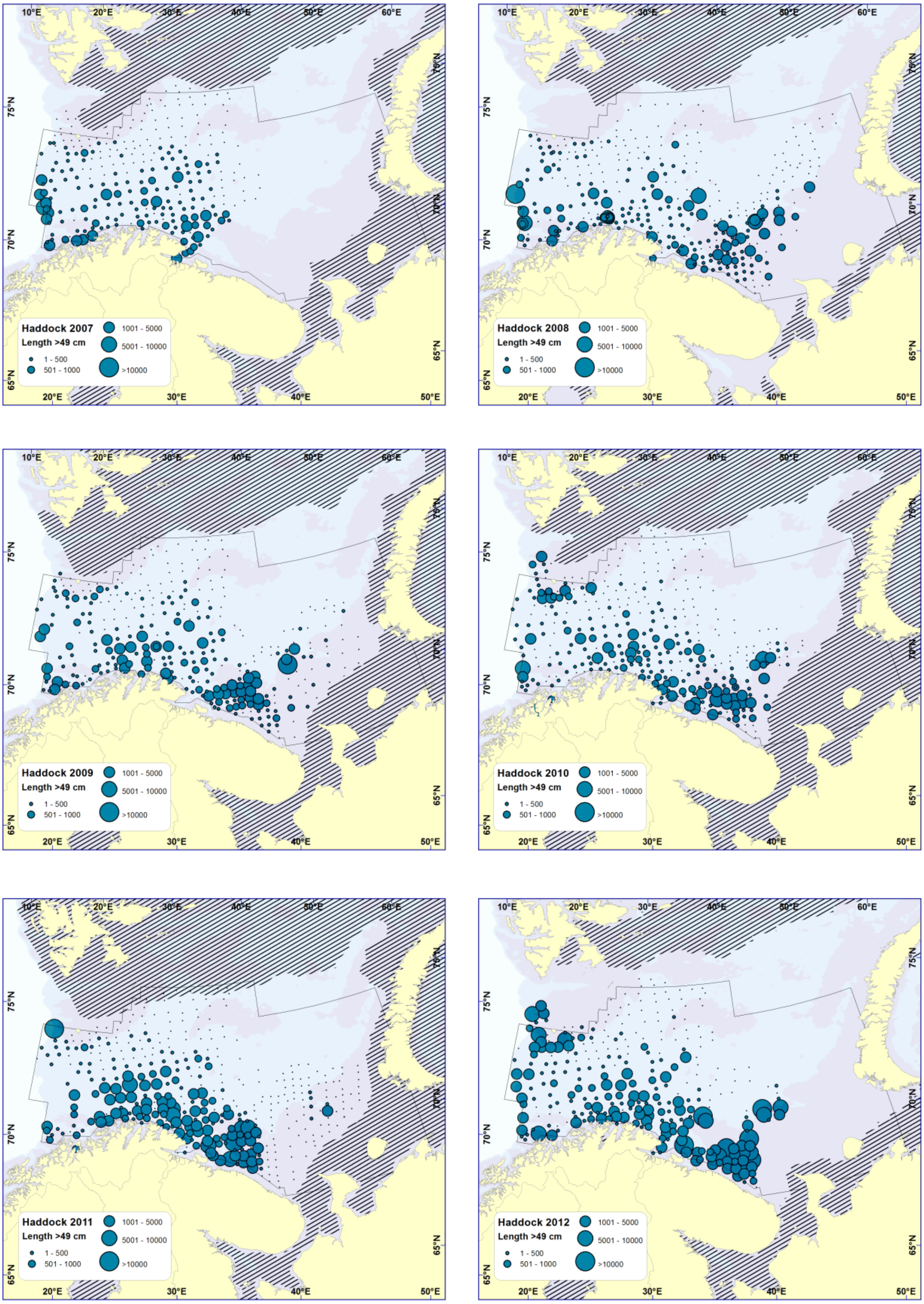


Figure 7.4. HADDOCK ≥ 50 cm. Distribution in valid bottom trawl catches winter 2007-2012 (number per nm^2). Zero catches are indicated by black points.

Table 7.3. HADDOCK. Abundance indices from bottom trawl hauls for main areas of the Barents Sea winter 2007-2012 (numbers in millions).

Area	Year	Age group										Total	Biomass
		1	2	3	4	5	6	7	8	9	10+		('000 t)
A	2007	782.0	198.8	32.5	4.6	16.1	7.7	2.8	2.4	1.2	0.2	1048.1	99.3
	2008	333.1	440.3	72.4	13.7	10.7	10.9	0.8	1.0	0.6	0.1	883.6	135.1
	2009	247.1	76.5	187.1	83.3	32.6	7.8	3.0	0.6	-	0.2	638.1	161.8
	2010	352.4	23.6	17.6	62.6	55.8	20.4	1.1	0.3	0.1	0.3	534.2	122.3
	2011	110.6	105.8	16.7	10.8	62.3	56.1	6.5	0.3	-	0.1	369.1	136.2
	2012	228.8	18.4	20.0	5.0	11.1	28.3	14.8	2.8	-	-	329.2	78.9
B	2007	154.2	29.1	19.8	1.9	5.2	2.6	0.7	0.3	0.1	+	213.8	25.8
	2008	55.2	24.8	8.1	8.2	3.2	2.0	1.6	0.3	-	-	103.4	23.4
	2009	53.3	19.3	16.0	7.1	3.9	0.6	1.2	0.1	+	+	101.4	17.7
	2010	130.7	25.3	7.9	7.4	10.0	5.6	0.8	-	+	+	187.7	29.5
	2011	33.8	23.7	9.9	2.9	6.9	8.5	3.5	0.3	0.1	-	89.6	27.0
	2012	160.3	10.4	7.8	2.3	1.1	5.1	4.9	1.2	-	-	193.1	25.0
C	2007	195.7	59.6	10.1	0.7	3.3	1.3	0.4	0.3	-	-	271.5	21.5
	2008	190.3	84.0	15.5	4.2	1.2	1.4	0.1	0.1	-	-	296.8	24.4
	2009	61.2	17.7	28.2	20.1	26.9	4.3	1.7	0.2	-	-	160.3	47.9
	2010	69.9	1.7	8.2	30.6	12.4	6.4	0.3	0.1	+	+	129.5	36.2
	2011	52.0	35.8	1.4	4.4	10.3	18.1	3.1	0.1	0.1	+	125.4	39.1
	2012	62.3	1.3	8.0	1.5	5.1	12.9	6.8	0.1	-	-	98.0	31.5
D	2007[1]	894.6	366.9	71.6	16.6	21.0	5.0	1.4	0.4	0.1	+	1377.6	120.2
	2008	204.1	762.5	461.1	254.1	35.9	23.5	3.3	0.9	0.2	-	1745.6	405.4
	2009	146.9	133.4	517.6	389.3	226.7	25.2	4.7	0.5	-	-	1444.2	504.7
	2010	936.1	56.2	65.4	279.1	253.4	62.3	4.0	0.5	0.4	0.2	1657.6	405.4
	2011	408.2	171.5	31.7	61.1	244.8	182.6	35.9	0.8	0.3	+	1136.8	463.5
	2012	1239.2	59.0	169.4	21.2	40.1	186.8	99.4	15.8	2.4	0.2	1833.4	481.1
D'	2007[1]	33.2	48.4	6.3	-	-	-	-	-	-	-	87.8	7.9
	2008	4.8	615.6	864.5	311.7	33.2	10.2	0.3	0.2	-	-	1840.5	449.9
	2009	2.5	66.1	478.6	247.9	70.9	-	-	-	-	-	866.0	230.2
	2010	11.9	-	-	109.5	137.7	33.1	0.4	-	-	-	292.6	148.8
	2011	3.1	1.7	4.6	14.8	125.8	59.1	11.2	0.1	-	-	220.3	147.5
	2012[1]	59.6	-	0.4	-	4.6	22.3	15.8	2.4	0.2	-	103.4	49.5
E	2007[1]	179.9	52.4	10.5	0.3	-	0.5	-	-	-	-	243.5	14.6
	2008	40.4	58.8	37.5	2.4	1.7	0.3	-	-	-	-	141.1	26.8
	2009	5.8	3.0	7.1	2.4	0.8	+	0.1	-	-	-	19.2	4.6
	2010	39.0	0.8	0.3	1.0	0.2	-	-	-	-	-	41.4	1.6
	2011	28.4	0.3	-	0.2	+	+	-	-	-	-	28.9	0.7
	2012	82.3	0.4	0.8	0.1	0.1	-	-	-	-	-	83.7	2.1
S	2007	346.0	99.4	33.8	3.4	1.1	0.3	0.1	0.1	-	-	484.1	32.4
	2008	32.4	143.6	63.3	6.6	1.0	0.6	0.2	0.1	-	-	247.8	48.7
	2009	48.0	12.1	35.8	23.3	3.6	0.5	0.1	-	0.1	0.1	123.4	32.5
	2010	79.5	3.6	3.4	18.3	10.0	3.4	0.5	0.2	-	0.1	118.9	27.7
	2011	49.4	4.7	0.6	1.0	18.1	13.7	1.9	-	-	-	89.4	35.9
	2012	138.2	3.4	4.5	0.6	1.7	7.5	8.7	1.1	-	0.1	165.8	29.0
ABCD	2007[1]	2026.6	654.4	133.9	23.7	45.5	16.6	5.3	3.3	1.4	0.2	2911.0	266.8
	2008	782.6	1311.4	557.1	280.3	51.0	37.8	5.8	2.3	0.8	0.1	3029.2	588.3
	2009	508.5	246.8	748.9	499.7	290.1	37.9	10.5	1.4	-	0.2	2344.0	732.1
	2010	1489.1	106.8	99.0	379.7	331.7	94.6	6.2	0.9	0.6	0.5	2509.1	593.5
	2011	604.6	336.8	59.7	79.2	324.4	265.2	49.0	1.5	0.4	0.2	1720.9	665.8
	2012	1690.5	89.1	205.1	30.0	57.3	233.1	125.9	19.9	2.4	0.3	2453.7	616.5
Total	2007[1]	2585.6	854.6	184.5	27.3	46.6	17.4	5.4	3.4	1.4	0.2	3726.4	321.7
	2008	860.2	2129.4	1522.4	600.9	86.8	48.9	6.3	2.5	0.8	0.1	5258.4	1115.0
	2009	564.7	328.0	1270.4	773.2	365.4	38.5	10.6	1.4	0.1	0.3	3352.6	999.3
	2010	1619.5	111.2	102.8	508.6	479.6	131.2	7.0	1.0	0.6	0.6	2962.0	771.6
	2011	685.4	343.5	64.9	95.1	468.3	338.1	62.1	1.6	0.4	0.2	2059.6	849.9
	2012[1]	1970.6	93.0	210.8	30.7	63.6	262.9	150.4	21.7	2.4	0.4	2806.5	697.0

[1] not scaled for uncovered areas

Table 7.4. HADDOCK. Abundance indices from bottom trawl surveys in the Barents Sea winter 1981-2012 (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	26
1982	3.9	1.5	1.7	1.8	1.9	4.8	2.4	0.2	0.0	0.0	18	23
1983	2919.3	4.8	3.1	2.4	0.9	1.9	2.5	0.7	0.0	0.0	2936	170
1984	3832.6	514.6	18.9	1.5	0.8	0.2	0.1	0.4	0.1	0.0	4369	249
1985	1901.1	1593.8	475.9	14.7	0.5	0.5	0.1	0.1	0.4	0.3	3987	507
1986	665.0	370.3	384.6	110.8	0.6	0.2	0.1	0.1	0.1	0.1	1532	271
1987	163.8	79.9	154.4	290.2	52.9	0.0	0.0	0.0	0.0	0.3	742	261
1988	35.4	15.3	25.3	68.9	116.4	13.8	0.1	0.0	0.0	0.0	275	142
1989	81.2	9.5	14.1	21.6	34.0	32.7	3.4	0.1	0.0	0.0	197	82
1990	644.1	54.6	4.5	3.4	5.0	9.2	11.8	1.8	0.0	0.0	734	72
1991	2006.0	300.3	33.4	5.1	4.2	2.7	1.7	4.2	0.0	0.0	2358	165
1992	1659.4	1375.5	150.5	24.4	2.1	0.6	0.7	1.6	2.3	0.0	3217	337
1993	727.9	599.0	507.7	105.6	10.5	0.6	0.4	0.3	0.4	1.1	1954	336
1994	603.2	228.0	339.5	436.6	49.7	3.4	0.2	0.1	0.2	0.6	1662	417
1995	1463.6	179.3	53.6	171.1	339.5	34.5	2.8	0.0	0.1	0.0	2245	444
1996	309.5	263.6	52.5	48.1	148.6	252.8	11.6	0.9	0.0	0.1	1088	461
1997[1]	1268.0	67.9	86.1	28.0	19.4	46.7	62.2	3.5	0.1	0.0	1582	226
1998[1]	212.9	137.9	22.7	33.2	13.2	3.4	8.0	8.1	0.7	0.1	440	78
1999	1244.9	57.6	59.8	12.2	10.2	2.8	1.0	1.7	1.1	0.0	1391	86
2000	847.2	452.2	27.2	35.4	8.4	4.0	0.8	0.3	0.7	0.2	1376	126
2001	1220.5	460.3	296.0	29.3	25.1	1.7	0.9	0.1	0.1	0.3	2034	232
2002	1680.3	534.7	314.7	185.3	17.6	8.2	0.8	0.3	+	0.3	2742	316
2003	3332.1	513.1	317.4	182.0	73.6	5.5	2.3	0.2	0.1	0.2	4427	429
2004	715.9	711.2	188.1	102.7	80.4	46.2	5.9	1.1	0.2	0.1	1852	311
2005	4630.2	420.4	346.5	133.3	66.8	52.2	12.3	0.6	0.2	0.0	5663	440
2006	5141.3	1313.1	77.4	140.5	48.2	19.6	15.2	3.1	0.1	0.3	6759	462
2007[1]	3874.0	1594.0	508.0	66.0	86.0	23.0	7.5	3.7	1.4	0.2	6164	591
2008	860.2	2129.4	1522.4	600.9	86.8	48.9	6.3	2.5	0.8	0.1	5258	1115
2009	564.7	328.0	1270.4	773.2	365.4	38.5	10.6	1.4	0.1	0.3	3353	999
2010	1619.5	111.2	102.8	508.6	479.6	131.2	7.0	1.0	0.6	0.6	2962	772
2011	685.4	343.5	64.9	95.1	468.3	338.1	62.1	1.6	0.4	0.2	2060	850
2012[2]	1921.5	108.4	315.3	46.1	83.2	289.6	145.7	21.9	2.4	0.4	2934	761

[1] Indices raised to also represent the Russian EEZ

[2] Indices raised to also represent uncovered parts of Main Area D'

Table 7.5. HADDOCK. Estimates of coefficients of variation (%) from bottom trawl hauls in the Barents Sea winter 1989-2012. 1989 -1992 includes only main areas A, B, C and D.

	Age															
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1989	18	27	29	21	21	16	23	61								
1990	24	17	20	18	20	15	14	23	55	88						
1991	14	16	16	30	25	23	21	22	56							
1992	14	19	11	16	22	30	26	22	20	50						
1993	11	18	15	16	19	43	37	49	34	31	47					
1994	12	16	18	16	17	23	53	40	38	53	40	51				
1995	13	18	28	32	16	19	42	55	53	47		60	47			
1996	13	14	14	31	24	35	44	63		47		48	49			
1997	16	39	15	18	19	20	19	38	52				56	54		
1998	16	13	17	15	22	25	24	19	44	41	51				53	49
1999	17	32	14	22	25	24	38	31	25	45		51				
2000	10	17	26	12	18	18	54	38	27	42	56	60	50			
2001	11	15	17	21	14	32	34	68	53	52	48	66	49			54
2002	9	32	16	13	33	19	31	52	37	54	63	49	55			
2003	16	24	29	14	10	21	28	56	72	70	71	61	45			
2004	10	32	25	24	14	15	36	31	40	53	57	54	50	59		
2005	20	30	20	15	17	18	20	98	85	53						
2006	16	16	19	14	15	19	19	26	58	65		56			43	43
2007	11	8	9	15	12	15	25	33	47	44	64				67	
2008	12	17	16	16	32	20	28	73	99		63	53				
2009	11	25	20	20	21	29	22	33	77	64		45				
2010	9	19	12	33	38	33	27	27	46	55	62	60				
2011	10	10	15	28	20	16	20	34	76			62	54			
2012	15	22	14	23	17	12	14	28	94	45	61	63				

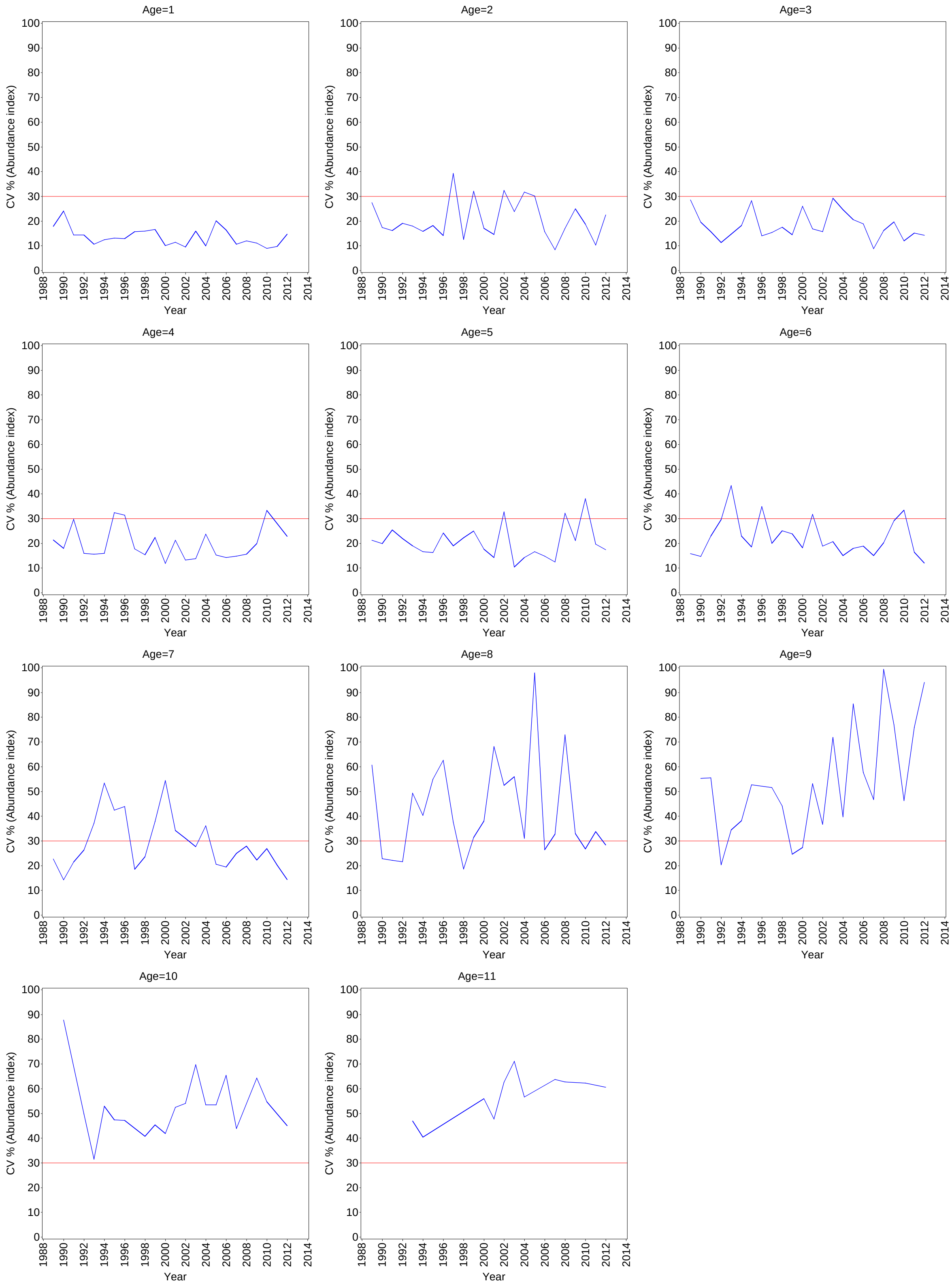


Figure 7.5. HADDOCK. Coefficients of variation (%) for age groups 1-11 from bottom trawl hauls in the Barents Sea winter 1989-2012. 1989 -1992 includes only main areas A, B, C and D.

7.3 Growth and survey mortalities

Tables 7.6 and 7.7 present the time series for mean length (1983-2012) and mean weight (1983-2012) at age for the entire investigated area. Length estimates have been variable with no specific trends in the latest years. However, the variation is less than what it has been in earlier periods. Weight estimates also show less variation in later years, however there is a slight trend of decreasing weights of 4 years and older haddock for the last decade. Annual weight increments are shown in Table 7.8, these are highly variable and show no trends.

Table 7.6. HADDOCK. Length (cm) at age in the Barents Sea from the investigations winter 1983 – 2012.

	Age							
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1983	16.8	25.2	34.9	44.7	52.5	58.0	62.4	65.1
1984	16.6	27.5	32.7	-	56.6	62.4	61.8	66.2
1985	15.7	23.9	35.6	41.9	58.5	61.9	63.9	67.6
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	57.6
1990	15.7	24.7	32.7	43.4	46.1	50.1	52.4	55.7
1991	16.8	24.0	35.7	44.4	52.4	54.8	55.6	55.9
1992	15.1	23.9	33.9	45.5	53.1	59.2	60.6	60.5
1993	14.5	21.4	31.8	42.4	50.6	56.1	59.4	64.2
1994	14.7	21.0	29.7	38.5	47.8	54.2	56.9	63.6
1995	15.4	20.1	28.7	34.2	42.8	51.2	55.8	60.0
1996	15.4	21.6	28.6	37.8	42.0	46.7	55.3	60.2
1997[1]	16.1	21.2	27.7	35.4	39.7	47.5	50.1	55.3
1998[1]	14.4	22.9	29.2	35.8	41.3	48.4	50.9	55.3
1999	14.7	20.8	32.3	39.4	45.5	52.3	54.6	52.6
2000	15.8	22.5	30.3	41.6	47.7	50.8	51.1	56.5
2001	14.6	22.2	32.2	37.8	47.2	51.2	58.7	53.9
2002	15.5	21.1	29.6	40.2	44.2	50.9	58.4	59.4
2003	16.5	24.1	28.0	37.2	46.5	49.6	54.7	59.4
2004	14.2	22.3	30.6	36.3	43.4	49.8	51.4	58.0
2005	15.1	20.8	30.0	36.6	41.5	47.9	51.9	56.9
2006	14.7	22.6	31.3	37.8	43.2	48.0	50.8	57.0
2007	15.7	23.2	28.7	37.4	45.5	48.5	53.5	55.5
2008	15.9	23.8	30.1	38.1	39.7	48.6	53.4	54.3
2009	14.5	22.5	29.6	36.0	41.9	46.9	51.7	55.5
2010	14.7	20.2	30.4	37.1	41.2	45.9	50.0	58.4
2011	13.9	23.4	27.7	37.2	42.8	46.1	48.6	61.4
2012[1]	15.8	21.1	31.3	34.2	43.7	47.5	50.4	52.1

[1]Adjusted lengths

Table 7.7. HADDOCK. Weight (g) at age in the Barents Sea from the investigations winter 1983 – 2012.

	Age							
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1983	52	133	480	1043	1641	2081	2592	2847
1984	36	196	289	964	1810	2506	2240	2905
1985	35	138	432	731	1970	2517	-	3600
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	1833
1990	34	148	346	854	986	1295	1526	1782
1991	41	138	457	880	1539	1726	1808	1869
1992	32	136	392	949	1467	2060	2274	2341
1993	26	93	317	766	1318	1805	2166	2734
1994	25	86	250	545	1041	1569	1784	2633
1995	30	71	224	386	765	1286	1644	2070
1996	30	93	220	551	741	1016	1782	1998
1997[2]	35	88	200	429	625	1063	1286	1670
1998[2]	25	112	241	470	746	1169	1341	1700
1999	27	85	333	614	947	1494	1616	1509
2000	32	108	269	720	1068	1341	1430	1910
2001	28	106	337	556	1100	1429	2085	1746
2002	30	84	244	623	848	1341	1938	2032
2003	38	127	202	493	981	1189	1613	1925
2004	23	98	266	459	780	1167	1328	1894
2005	29	84	253	469	699	1054	1378	1919
2006	26	107	303	540	821	1111	1332	1846
2007	32	112	237	539	970	1195	1608	1759
2008	33	115	250	538	692	1259	1609	1649
2009	25	98	230	440	718	1029	1402	1627
2010	28	76	273	473	656	945	1249	1799
2011	21	114	198	491	737	932	1152	2211
2012[2]	34	86	283	384	809	1036	1270	1379

[1]Estimated weights

[2]Adjusted weights

Table 7.8. HADDOCK. Yearly weight increment (g) from the investigations in the Barents Sea winter 1983-2012.

	Age						
Year	**1-2**	**2-3**	**3-4**	**4-5**	**5-6**	**6-7**	**7-8**
1983-84	144	156	484	767	865	159	313
1984-85	102	236	442	1006	707	-	1360
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	264
1989-90	105	221	545	502	564	514	383
1990-91	104	309	534	685	740	513	343
1991-92	95	254	492	587	521	548	533
1992-93	61	181	374	369	338	106	460
1993-94	60	157	228	275	251	-21	467
1994-95	46	138	136	220	245	75	286
1995-96	63	149	327	355	251	496	354
1996-97	58	107	209	74	322	270	-112
1997-98	77	153	270	317	544	278	414
1998-99	60	221	373	477	748	447	168
1999-00	81	184	387	454	394	-64	294
2000-01	74	229	287	380	361	744	316
2001-02	56	38	286	292	241	603	-53
2002-03	97	118	349	358	341	272	-13
2003-04	60	139	257	287	186	139	281
2004-05	61	155	203	240	274	211	591
2005-06	78	219	287	352	412	278	468
2006-07	86	130	236	430	374	497	427
2007-08	83	138	301	153	289	414	41
2008-09	65	115	190	180	338	143	18
2009-10	51	175	243	216	227	220	397
2010-11	86	122	218	264	276	207	962
2011-12	65	169	186	318	299	338	227

Survey mortalities based on the acoustic indices (Table 7.9) have varied between years, and for most age groups there is no obvious trends. However, there are signs of co-variability within years.

Table 7.9. Survey mortality observed for haddock during the winter survey in the Barents Sea for the period 1993-2012.

	Age						
Year	**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
2004-05	1.28	0.77	0.22	0.73	0.64	1.99	4.19
2005-06	1.43	1.35	0.93	1.22	1.15	1.49	1.41
2006-07	1.16	0.75	0.00	-0.02	0.32	0.66	0.59
2007-08	0.56	0.18	0.41	-0.06	0.17	0.77	0.03
2008-09	1.64	0.59	-0.07	-0.47	0.60	1.61	1.85
2009-10	2.34	0.58	0.54	0.33	0.74	1.11	1.64
2010-11	1.61	0.54	0.71	0.64	0.75	1.30	1.86
2011-12	1.50	0.60	0.46	0.15	0.06	0.67	0.51
				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
2004-05	0.53	0.72	0.34	0.43	0.43	1.32	2.29
2005-06	1.26	1.69	0.90	1.02	1.23	1.23	1.38
2006-07	1.17	0.95	0.16	0.49	0.74	0.96	1.41
2007-08	0.60	0.05	-0.17	-0.27	0.56	1.29	1.10
2008-09	0.96	0.52	0.68	0.50	0.81	1.53	1.50
2009-10	1.62	1.16	0.92	0.48	1.02	1.70	2.36
2010-11	1.55	0.54	0.08	0.08	0.35	0.75	1.48
2011-12	1.84	0.09	0.34	0.13	0.48	0.84	1.04

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 has been the case since 2003 survey, 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 8.1 - 8.3) 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.

Figure 8.1 shows the geographical distribution of *Sebastes marinus* (Golden redfish) based on the catch rates in bottom trawl. It is mainly distributed south of the Bear Island, with weak signs of a more south-eastern distribution in the period 2007-2012. In all years the distribution is completely covered except towards west. Table 8.1 presents the time series (1986-2012) of swept area indices by 5 cm length groups. The indices have remained low since 1999 for all length groups. This indicates that at least the last fifteen year classes are very weak.

The mapping of the distribution of *S. mentella* (Beaked redfish) (Figure 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 The distribution has been quite similar from year to year in the period 2008-2012. Table 8.2 presents the time series (1986-2012) of swept area indices for *S. mentella* by 5 cm length groups. A few good year classes were born in 1988-1990 before the recruitment collapse in 1991 and the stock decreased to low levels for about fifteen years. However, these few year classes got enough protection to survive to maturity and since 2007-2008 both recruitment and the number of larger *S. mentella* has been at a fairly high level.

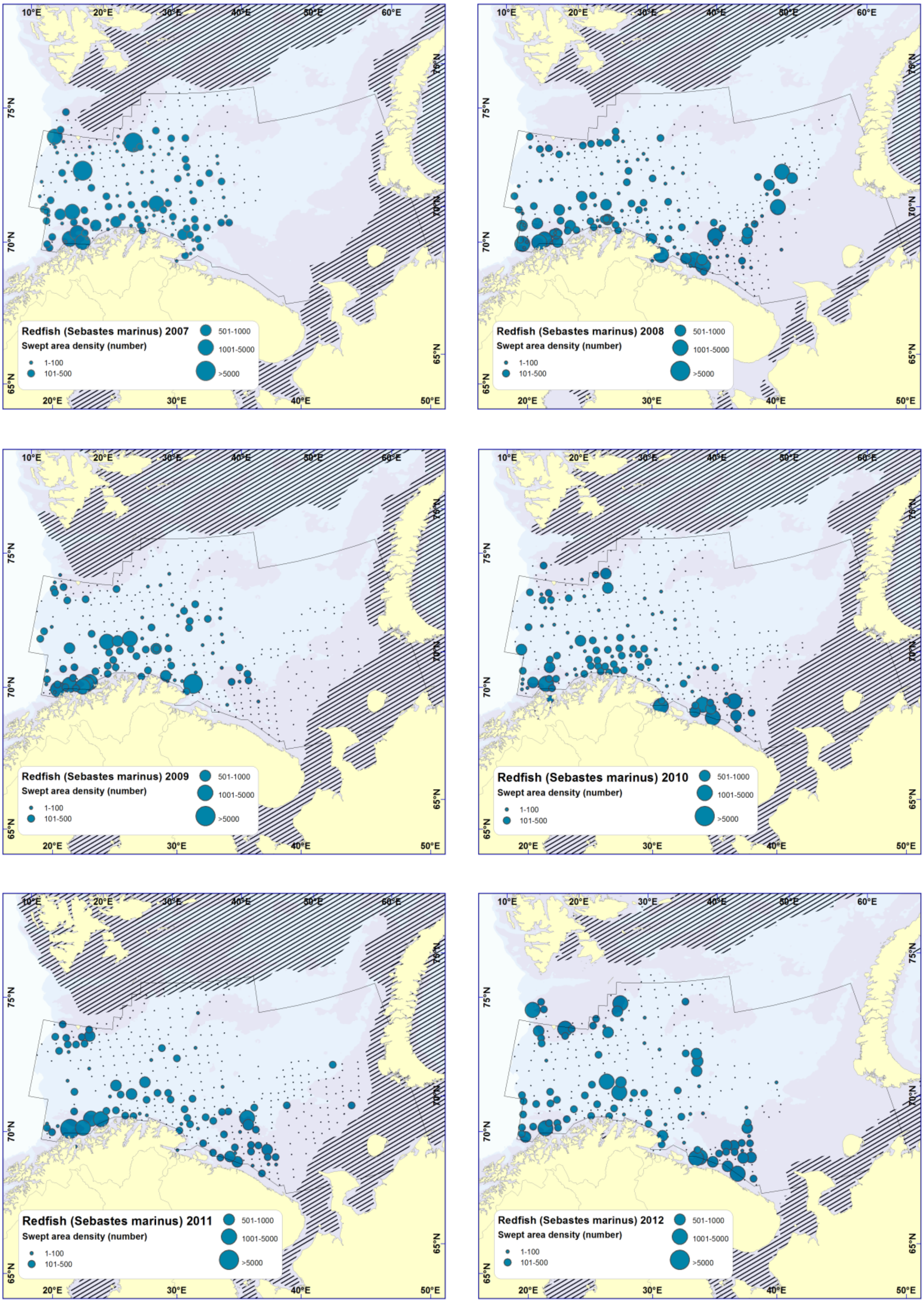


Figure 8.1. *SEBASTES MARINUS*. Distribution in the trawl catches winter 2007-2012 (number per nm^2). Zero catches are indicated by black points.

Table 8.1. *SEBASTES MARINUS*. Abundance indices from bottom trawl surveys in the Barents Sea winter 1986-2012 (numbers in millions). 1986-1992 includes only main areas A, B, C and D. Species identification uncertain for fish < 10cm.

Year	Length group (cm)									Total	Biomass
	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	≥ 45		(tons)
1986	3.0	11.7	26.4	34.3	17.7	21.0	12.8	4.4	2.6	134	42811
1987	7.7	12.7	32.8	7.7	6.4	3.4	3.8	3.8	4.2	83	21627
1988	1.0	5.6	5.5	14.2	12.6	7.3	5.2	4.1	3.7	59	24793
1989	48.7	4.9	4.3	11.8	15.9	12.2	6.6	4.8	3.0	114	28792
1990	9.2	5.3	6.5	9.4	15.5	14.0	8.0	4.0	3.4	75	29920
1991	4.2	13.6	8.4	19.4	18.0	16.1	14.8	6.0	4.0	105	42146
1992	1.8	3.9	7.7	20.6	19.7	13.7	10.5	6.6	5.8	92	41492
1993	0.1	1.2	3.5	6.9	10.3	14.5	12.5	8.6	6.3	64	40909
1994	0.7	6.5	9.3	11.7	11.5	19.4	9.1	4.4	2.8	75	32348
1995	0.6	5.0	13.1	11.5	9.1	15.9	17.2	10.9	4.7	88	46558
1996	+	0.7	3.5	6.4	9.4	11.7	16.6	7.9	3.9	60	37756
1997[1]	-	0.5	1.5	3.2	6.6	21.4	28.0	8.4	3.3	73	49454
1998[1]	0.2	6.0	2.5	10.5	49.5	25.2	13.1	6.9	2.3	116	51114
1999	0.2	0.9	2.1	4.0	4.6	6.4	6.0	5.3	3.3	33	18281
2000	0.5	1.1	1.5	4.2	4.7	5.0	3.5	1.8	1.2	23.6	10316
2001	0.1	0.4	0.4	2.4	5.7	5.5	4.5	3.2	1.6	23.8	12970
2002	0.1	1.0	2.0	1.8	3.8	4.1	3.3	3.6	2.5	22.2	13280
2003	-	0.5	1.2	1.5	4.3	3.8	2.7	3.3	2.9	20.2	13997
2004	0.7	0.2	0.4	1.0	2.9	4.4	5.5	4.0	3.2	22.3	16366
2005	-	0.1	0.2	0.4	1.1	2.0	3.8	4.6	4.4	16.6	16593
2006	-	-	-	0.2	2.5	5.4	6.1	4.1	4.2	22.5	18323
2007[2]	-	0.1	0.5	0.1	0.6	3.6	4.8	4.7	4.1	18.5	17067
2008	1.8	2.6	0.2	0.2	0.4	0.7	1.9	2.5	4.4	14.7	12243
2009	-	-	0.1	-	0.1	0.4	1.7	3.7	6.6	12.7	17495
2010	0.4	2.0	1.2	0.6	0.1	0.1	0.8	1.1	3.9	10.3	9564
2011	0.3	3.1	2.1	0.3	0.4	0.1	0.3	2.3	5.2	14.1	13124
2012[2]	0.8	4.4	4.0	1.9	0.6	0.3	0.9	3.6	6.2	22.7	16011

[1] Indices raised to also represent the Russian EEZ

[2] not scaled for uncovered areas.

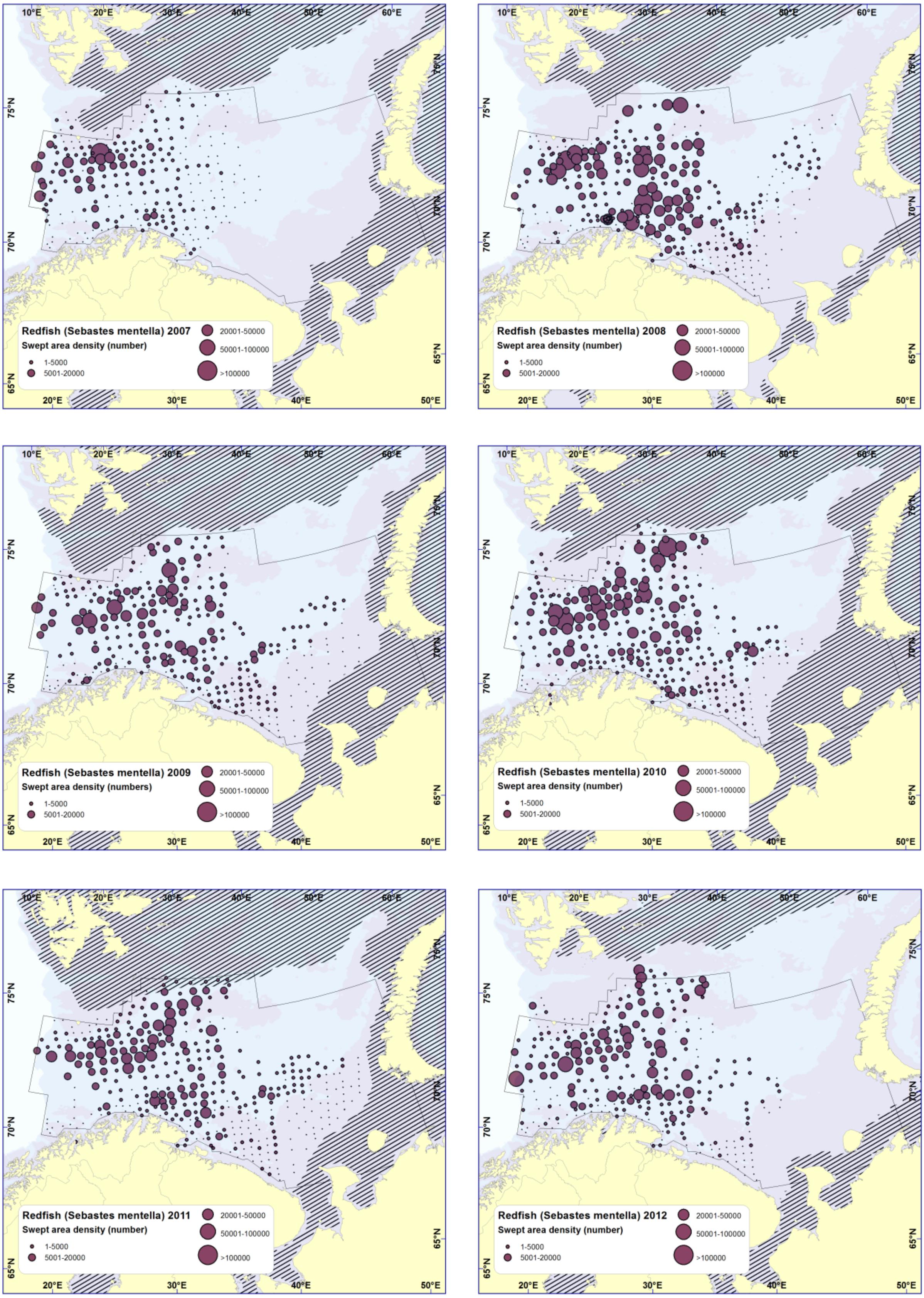


Figure 8.2. *SEBASTES MENTELLA*. Distribution in the trawl catches winter 2007-2012 (number per nm^2). Zero catches are indicated by black points.

Table 8.2. *SEBASTES MENTELLA*[1]. Abundance indices from bottom trawl surveys in the Barents Sea winter 1986-2012 (numbers in millions). 1986-1992 includes only main areas A. B. C and D.

	Length group (cm)										**Biomass**
Year	**5-9**	**10-14**	**15-19**	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**≥ 45**	**Total**	**(tons)**
1986	81.3	151.9	205.4	87.7	169.2	129.8	87.5	23.6	13.8	951	215946
1987	71.8	25.1	227.4	56.1	34.6	11.4	5.3	1.1	0.1	433	40365
1988	587.0	25.2	132.6	182.1	39.6	50.1	47.9	3.6	0.1	1070	99517
1989	622.9	55.0	28.4	177.1	58.0	9.4	8.0	1.9	0.3	962	55059
1990	323.6	304.5	36.4	55.9	80.2	12.9	12.5	1.5	0.2	830	52713
1991	395.2	448.8	86.2	38.9	95.6	34.8	24.3	2.5	0.2	1123	78144
1992	139.0	366.5	227.1	34.6	55.2	34.4	7.5	1.8	0.5	867	62528
1993	30.8	592.7	320.2	116.3	24.2	25.0	6.3	1.0	+	1117	70561
1994	6.9	258.6	289.4	284.3	51.4	69.8	19.9	1.4	0.1	979	117111
1995	263.7	71.4	637.8	505.8	90.8	68.8	31.3	3.9	0.5	1674	184972
1996	213.1	100.2	191.2	337.6	134.3	41.9	16.6	1.4	0.3	1037	122860
1997[2]	63.2	120.9	24.8	278.2	271.8	70.9	39.8	5.2	0.1	875	166996
1998[2]	1.3	88.2	62.5	101.0	203.2	40.4	12.9	1.1	0.2	511	95024
1999	2.2	6.8	68.2	36.8	167.4	71.3	21.0	3.1	0.1	374	96757
2000	9.0	12.7	39.4	76.8	141.9	97.1	26.6	6.9	1.5	412	113417
2001	9.3	22.5	7.0	54.9	77.4	73.2	9.4	0.6	0.1	254	63286
2002	16.1	7.2	19.1	41.7	103.9	113.7	22.9	1.4	0.03	326	91453
2003	3.9	3.9	10.0	12.4	70.8	199.8	46.9	6.0	0.3	354	137169
2004	2.2	3.0	6.9	18.5	32.9	86.7	31.8	2.0	0.1	184	70049
2005	-	6.2	7.3	10.7	28.4	153.4	86.6	3.9	0.2	297	129777
2006	98.8	1.9	9.8	14.6	22.7	102.8	81.9	2.7	0.7	336	103311
2007[2]	372.0	116.0	2.5	6.5	12.0	118.0	118.0	6.5	0.1	752	136545
2008	846.5	353.8	26.2	5.3	11.9	114.0	179.9	4.9	0.1	1543	160657
2009	94.2	321.7	134.2	5.4	8.7	66.1	160.1	5.7	0.4	797	149846
2010	646.8	273.1	213.2	63.8	7.1	73.4	190.4	5.9	0.4	1474	192570
2011	495.5	227.6	210.9	148.2	14.0	46.4	156.5	4.9	0.2	1304	168586
2012[2]	127.1	274.8	84.3	122.9	46.1	14.1	150.8	17.3	0.2	838	159784

[1] Includes unidentified *Sebastes* specimens, mostly less than 10 cm.
[2] Indices raised to also represent the Russian EEZ

Table 8.3 presents the time series (1986-2012) of swept area indices for ***S. viviparus*** (Norway redfish / lesser redfish) by 5 cm length groups. All *S. viviparus* is in most years registered in area ABCD, and mainly in sub-area B. The indices are often driven by a few large catches, and since the mid 1990s the indices has most in years been below the average level in the time series 1986-2012.

Table 8.3. *SEBASTES VIVIPARUS*. Abundance indices from bottom trawl surveys in the Barents Sea winter 1986-2012 (numbers in millions). 1986-1992 includes only the area covered in 1986. Species identification uncertain for fish < 10cm.

Year	Length group (cm)						Total	Biomass (tons)
	5-9	10-14	15-19	20-24	25-29	≥ 30		
1986	1.0	2.3	4.8	6.4	1.3	0.0	16	1989
1987	0.0	0.5	4.4	8.0	1.9	0.2	15	2469
1988	6.9	6.2	6.4	10.0	3.6	0.3	33	3785
1989	3.7	7.8	6.3	4.3	0.9	0.0	23	1802
1990	0.3	12.7	11.7	9.9	3.3	0.2	38	4204
1991	3.7	13.6	16.1	16.8	4.2	0.4	55	6199
1992	15.1	32.1	27.4	16.9	5.1	0.3	97	7996
1993	18.6	23.7	7.7	3.5	1.0	0.0	55	2378
1994	48.0	64.0	15.0	12.3	1.2	0.2	141	6057
1995	7.6	53.2	21.9	7.9	2.4	0.3	93	5709
1996	0.5	45.0	42.5	35.4	5.5	0.1	129	12751
1997[1]	0.9	23.8	28.5	18.5	4.3	0.0	76	7420
1998[1]	0.7	9.3	41.7	20.6	2.9	0.1	75	7894
1999	1.6	10.0	11.5	2.9	0.7	0.0	27	1990
2000	0.9	4.8	36.5	21.7	2.1	0.1	66	7887
2001	0.3	2.2	29.5	33.7	3.7	0.1	70	9190
2002	0.3	3.1	17.0	14.5	1.2	0.1	36	4660
2003	0.2	4.0	21.4	30.1	4.2	0.2	60	8527
2004	0.1	1.8	24.5	32.9	3.3	0.3	63	8967
2005	0.2	1.6	16.2	36.9	6.1	0.4	61	9691
2006	0.8	4.4	3.6	10.2	2.2	0.2	21	3002
2007[1]	0.7	5.2	15.6	36.5	3.4	0.1	62	8897
2008	0.0	1.8	5.8	20.8	4.5	0.0	33	5518
2009	0.5	0.5	3.1	10.9	3.4	0.4	19	3473
2010	1.7	0.5	10.0	52.5	7.5	0.0	72	12389
2011	0.5	1.2	2.1	7.5	2.1	0.1	14	2395
2012[1]	0.6	3.9	4.0	28.9	6.2	0.1	44	7126

[1] not scaled for uncovered areas, mainly found in NEZ

9 Distribution and abundance of Greenland halibut and long rough dab

9.1 Greenland halibut

Figure 9.1 shows the distribution of bottom trawl catch rates of Greenland halibut. The most important distribution areas for the adult fish (depths between 500 and 1000 m along the western slope), are not covered by the survey. The observed distribution pattern in 2007-2012 was similar to those observed in previous years' surveys, i.e., mainly in the Bear Island channel towards the Hopen Deep, with some registrations in deep and cold water further east.

The time series of swept area indices by 5 cm length groups for 1990-2012 is presented in Table 9.1. Abundance indices have been low in the whole period, with few signs of improved recruitment in the covered area. However, recruitment from more northern areas has lead to an increase in abundance indices of length groups above 30 cm since about 2005.

Figure 9.2 shows the geographical distribution of long rough dab based on catch rates in bottom trawl. Long rough dab was caught on almost every station in 2007-2012. It is more evenly spread over its area of distribution than most of the other reported species. This is also reflected in the low CVs of the abundance indices (Table 9.2).

There was an increase in abundance until about 2002, since then most abundance indices have been relatively stable (Figures 9.3a-b). The recruitment index has been more variable, with highest values between 2000 and 2006 (Figure 9.3b).

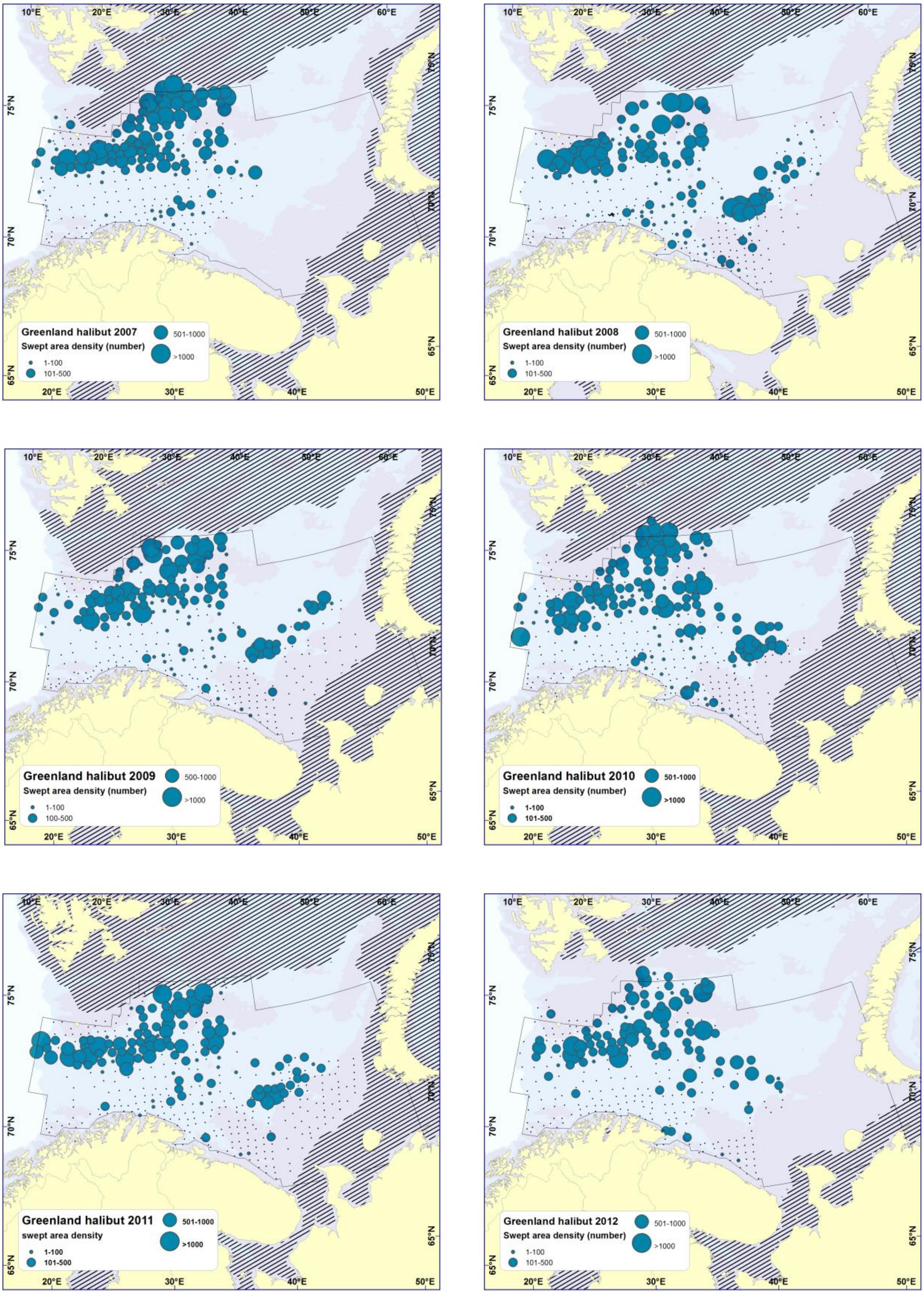


Figure 9.1 GREENLAND HALIBUT. Distribution in the trawl catches winter 2007-2012 (number per nm^2). Zero catches are indicated by black points.

Table 9.1. GREENLAND HALIBUT. Abundance indices from the bottom trawl surveys in the Barents Sea winter 1990-2012 (numbers in thousands). 1990-1992 includes only main areas A, B, C and D.

Year	Length group (cm)															Total	Biomass (tons)
	≤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		
1990	21	199	777	785	1205	1657	1829	2043	1349	479	159	160	40	40	0	10800	8443
1991	0	42	262	618	655	868	954	1320	1875	1577	847	165	34	34	0	9270	10584
1992	14	35	64	149	509	843	1096	1072	1029	827	633	108	31	31	26	6500	7319
1993	0	0	17	67	265	959	2310	4004	3374	1911	1247	482	139	139	34	14840	19299
1994	0	0	16	99	142	1191	2625	3866	2885	1796	753	440	25	25	0	13838	16337
1995	42	0	0	0	83	149	3228	9240	7438	2811	2336	909	468	468	0	26761	37576
1996	3149	0	0	0	61	124	1163	3969	4425	1824	1041	593	346	73	12	16781	19454
1997[1]	0	65	0	0	173	227	858	4344	5500	2725	1545	632	282	66	22	16439	23665
1998[1]	80	217	1006	444	532	403	1064	3888	6331	2977	1725	633	337	76	43	19765	26045
1999	41	82	261	427	576	264	757	1706	3069	1640	1077	483	109	74	28	10594	14649
2000	122	184	322	859	1753	3841	2190	1599	2143	1715	1163	564	242	75	0	16769	17024
2001	68	49	129	178	663	1470	3674	3258	2263	1990	1081	522	204	48	40	15636	18133
2002	268	0	71	33	408	996	1927	3702	3188	2210	1110	975	230	157	96	15371	21004
2003	50	0	71	17	295	674	1793	2916	4647	2186	708	609	231	125	0	14322	19490
2004	67	103	15	0	316	1238	1224	1714	2278	1227	791	298	146	95	26	9537	11795
2005	259	69	157	1125	2194	2695	4173	3687	3817	1992	935	583	330	116	0	22132	21922
2006	0	72	93	408	1949	5096	4565	5696	4250	2103	880	442	252	34	18	25859	25935
2007[2]	0	18	139	1715	1337	2885	4806	4890	3946	1945	678	547	351	78	89	23424	23957
2008	0	0	0	240	1689	6570	4762	6033	5163	3361	814	635	173	79	48	29567	29971
2009	55	0	0	25	1033	4256	8005	4476	4000	2221	978	613	430	249	149	26489	28663
2010	0	0	0	98	671	3607	5675	6498	4853	2449	1053	550	226	126	42	25850	29164
2011	50	0	0	0	214	4369	5812	5451	5189	3651	686	928	324	251	93	27020	31773
2012[2]	77	0	0	0	51	1124	4435	5275	4368	2744	1122	193	74	0	46	19507	22310

[1]Indices raised to also represent the Russian EEZ

[2]not scaled for uncovered areas.

9.2 Long rough dab

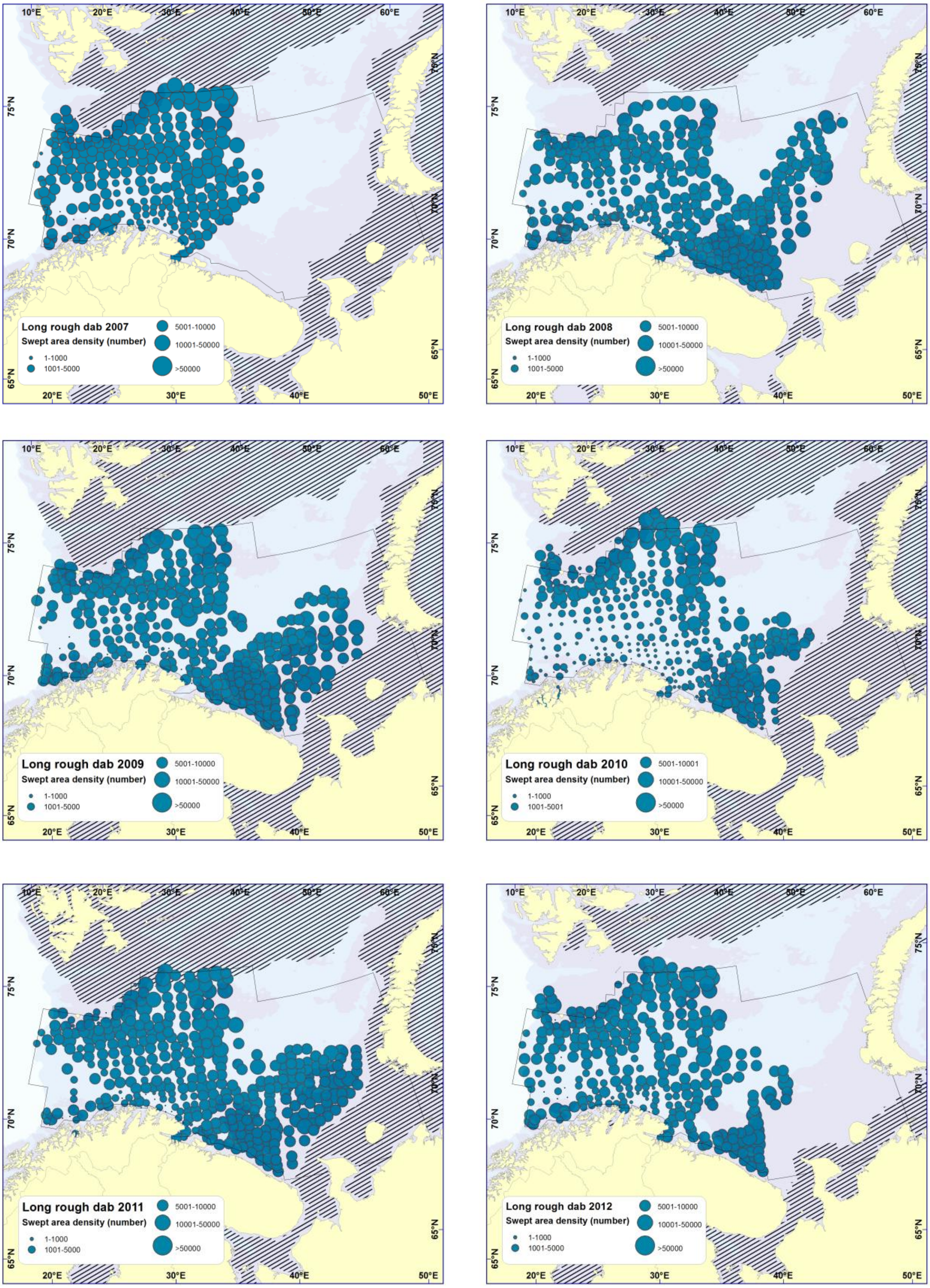


Figure 9.2. LONG ROUGH DAB. Distribution in the trawl catches winter 2007-2012 (number per nm^2). Zero catches are indicated by black points.

Table 9.2. LONG ROUGH DAB. Abundance, recruitment and biomass indices from bottom trawl surveys in the Barents Sea winter 1989-2012 (numbers in millions, biomass in 1000 t). 1989-1992 includes only main areas A, B, C and D.

Year	**N**	**CV% N**	**R**	**CV% R**	**B**	**CV% B**	**B(L≥25)**	**CV% B(L≥25)**	**SSB**	**CV% SSB**
1989	560	8	142	12	68	8	53	8	11	10
1990	565	7	242	11	54	7	42	7	9	8
1991	759	7	278	10	81	6	62	6	15	7
1992	768	8	199	10	80	7	55	7	14	7
1993	1360	11	451	16	138	8	98	8	25	8
1994	1057	12	400	26	108	7	80	7	20	7
1995	943	6	398	10	100	5	77	6	21	6
1996	926	7	366	14	111	6	91	7	24	7
1997	362	7	47	15	75	9	68	9	19	12
1998	401	15	121	44	71	9	65	9	18	10
1999	766	7	170	11	123	6	105	6	29	7
2000	1332	10	470	12	146	10	112	12	29	10
2001	1656	8	506	17	194	7	147	8	37	7
2002	1452	8	402	11	198	7	161	6	45	6
2003	1655	9	548	13	208	8	166	7	45	6
2004	1026	7	258	13	158	7	132	7	39	7
2005	1018	8	380	16	136	7	113	7	34	8
2006	1254	9	501	20	159	6	133	7	40	7
2007	836	8	245	14	131	6	112	7	34	8
2008	1026	7	226	12	170	5	144	6	45	6
2009	1210	6	290	10	191	6	160	7	48	7
2010	861	7	223	12	147	6	127	6	41	6
2011	1066	7	371	9	169	6	147	7	47	7
2012	911	7	326	11	154	6	136	7	46	8

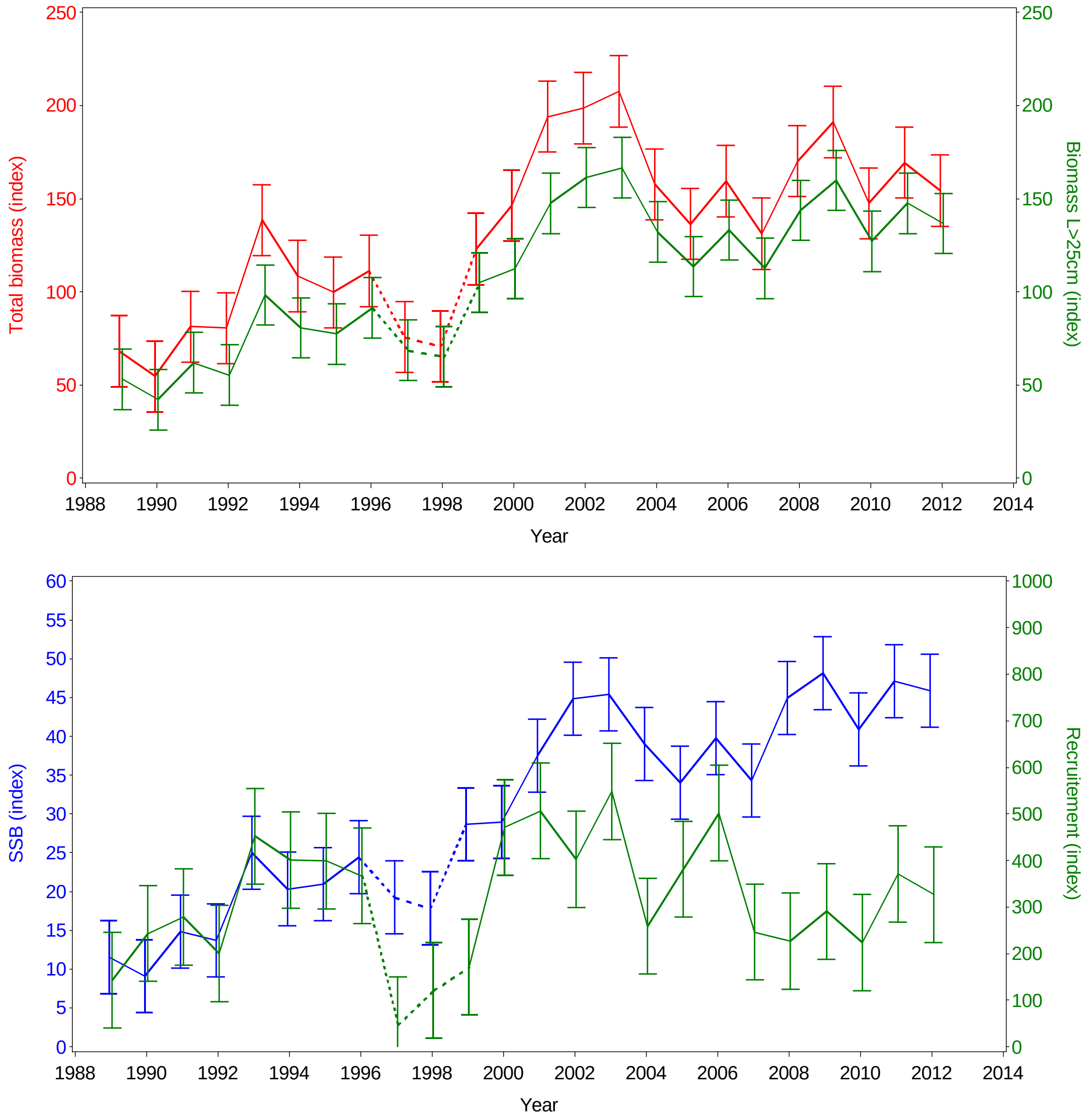


Figure 9.3. LONG ROUGH DAB. Biomass and recruitment indices from bottom trawl surveys in the Barents Sea winter 1989-2012 (in 1000 t). 1989-1992 includes only main areas A, B, C and D.

10 Distribution and abundance of capelin, polar cod and blue whiting

10.1 Capelin

Although capelin is primarily a pelagic species, small amounts of capelin are normally caught in the bottom trawl throughout most of the investigated area. In Figure 10.1 catch rates of capelin smaller and larger than 14 cm are shown for each of the winter surveys in the period 2007-2012. Capelin smaller than 14 cm during this period will mainly comprise the immature stock component, while the larger capelin constitute the prespawning capelin stock. Most years, some few trawl hauls show large capelin catches (numbers exceeding 100 000 individuals) and these can probably not be considered representative for the density in the area, because such hauls will either result from hitting a capelin school at the bottom or up in the water column. For this reason, we chose not to present swept-area based indices for capelin in this report.

At this time of the year, mature capelin have started their approach to the spawning areas along the coast of Troms, Finnmark and the Kola peninsula, while immature capelin will normally be found further north and east, in the wintering areas. This is reflected on the maps of capelin distribution all years, even though some large capelin are always found north of 75°N, and smaller capelin are found sporadically in near-coastal areas in a couple of years. The geographical coverage of the total capelin stock is incomplete in all years, but the maturing component is probably completely covered except for those years when parts of the Russian EEZ was not covered due to access restrictions.

It has been noted during several surveys that when sampling capelin from demersal and pelagic trawls, the individuals from demersal trawls are normally larger (and older) than those sampled pelagically. This has led to formation of a hypothesis saying that larger individuals tend to stay deeper than smaller individuals and some even to take up a demersal life. This hypothesis has not been tested, and during the winter surveys there are probably too few pelagic hauls to study the vertical distribution of capelin in a systematic way.

10.2 Polar cod

Polar cod are not well represented in the trawl hauls conducted during the winter surveys (Figure 10.2). This reflects the more northern and eastern distribution area of this endemic arctic species. It is seen that those years, when there was a better coverage of the eastern areas, as for instance during 2008, 2009 and 2011, much larger catches of polar cod was obtained. During this time of the year, the polar cod is known to be spawning under the ice-covered areas of the Pechora Sea and close to Novaya Semlya. It is not clear whether the concentrations found in open water these years are mature fish either on their way to spawning or from the spawning areas, or this is immature fish.

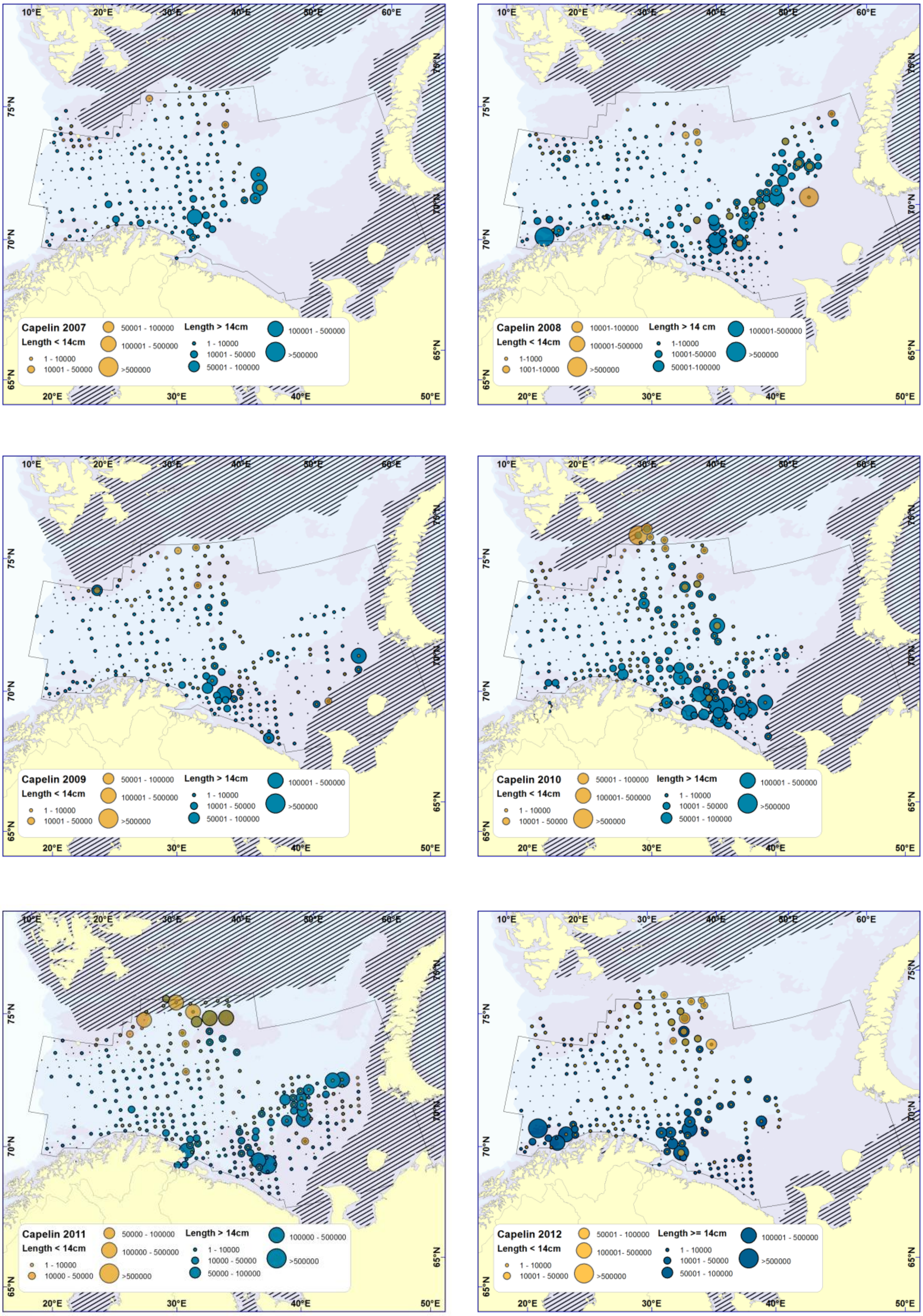


Figure 10.1. CAPELIN. Distribution in the trawl catches winter 2007-2012 (number per nm^2). Zero catches are indicated by black points.

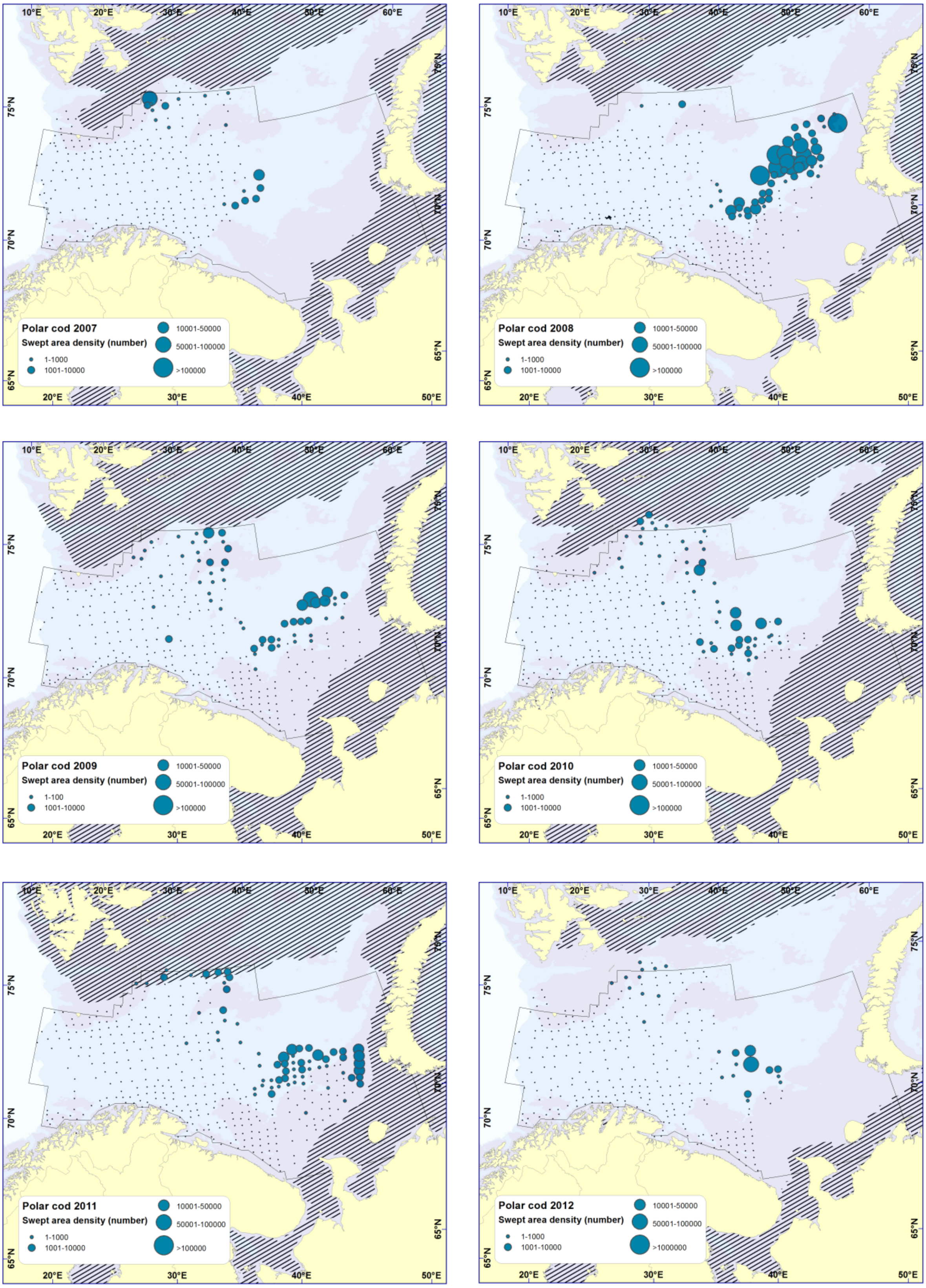


Figure 10.2. POLAR COD. Distribution in the trawl catches winter 2007-2012 (number per nm^2) . Zero catches are indicated by black points.

10.3 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 somewhat. In the 2004 survey the echo abundance increased again and peaked in 2006. Since then it has decreased considerably. Figure 10.3 shows the geographical distribution of the bottom trawl catch rates of blue whiting in 2007-2012. 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 number of pelagic hauls has, however, been too low to properly separate the pelagic recordings. During the years with high abundance of blue whiting, recordings of pelagic redfish, haddock and small cod might have been masked by dense concentrations of blue whiting.

Table 10.3 shows the bottom trawl swept area estimates by 5 cm length groups for the years 2001-2012. High abundance of fish below 20 cm in 2001, 2002, 2004, 2005 and 2012 reflects abundant recruiting (age 1) year classes. These recruits are observed in the survey as larger fish in the following years.

Table 10.3 BLUE WHITING. Abundance indices (swept area estimates) from bottom trawl surveys in the Barents
Sea winter 2001-2012 (numbers in millions).

	Length group (cm)									Biomass
Year	**5-9**	**10-14**	**15-19**	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**Total**	**(tons)**
2001	0.1	306.6	1391.3	616.0	44.6	5.3	1.5	0.1	2365	77706
2002	0.0	0.8	434.7	658.1	80.9	18.3	3.1	0.1	1196	58217
2003	0.0	3.2	192.0	488.8	81.8	29.7	6.3	1.0	803	53266
2004	0.0	7.2	716.0	827.6	277.4	37.6	1.1	0.2	1867	96647
2005	0.0	125.5	715.4	980.1	222.7	31.5	0.1	0.2	2076	106230
2006	0.0	0.0	162.9	1486.8	591.2	68.3	2.0	0.1	2311	171380
2007	0.0	0.0	4.0	594.6	276.1	21.5	1.5	0.3	898	73233
2008	0.0	0.0	0.3	12.0	125.5	19.7	1.3	0.1	159	19166
2009	0.0	0.0	0.02	2.7	50.0	21.0	1.4	0.02	75	10221
2010	0.0	0.0	0.71	1.9	9.4	15.1	0.8	0.0	28	4278
2011	0.0	0.0	0.05	0.2	2.5	4.7	2.1	0.0	9	1788
2012	0.0	84.3	663.9	1.1	1.5	4.6	1.9	0.3	758	18758

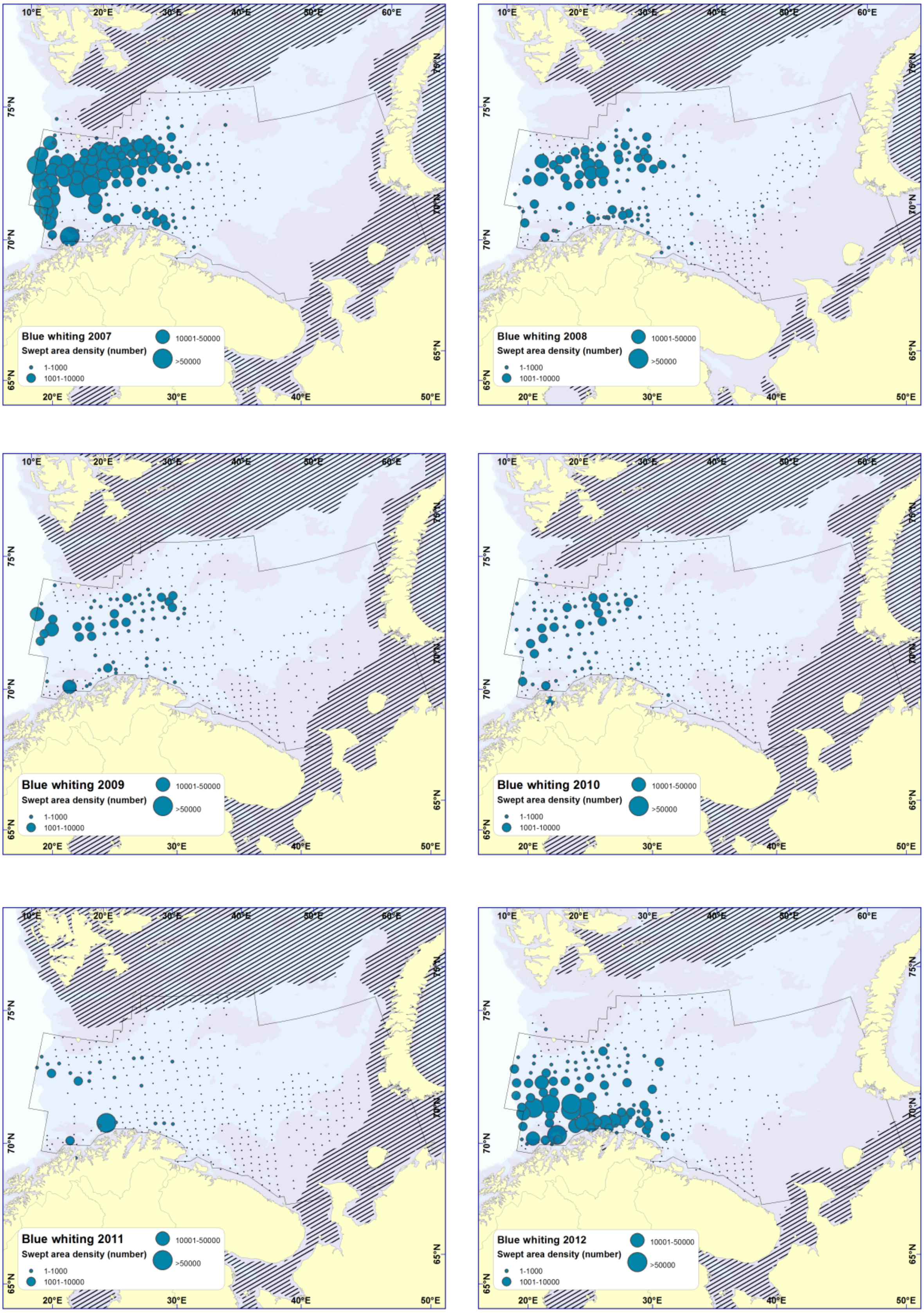


Figure 10.3. BLUE WHITING. Distribution in the trawl catches winter 2007-2012 (number per nm^2). Zero catches are indicated by black points.

11 Registrations of other species

During the survey 2007-2012 88 fish taxa were recorded (Table 11.1). These include 4 genera and 84 species belonging to 30 families. Of the 88, 45 were recorded all years. Distribution maps of all species caught at the winter survey 2007-2012 will be presented as a separate report (Wieneroither et al. in prep) similar to the Atlas of the Barents Sea fishes (Wieneroither *et al*. 2011, based on data from the ecosystem survey). Since the start of the winter survey (1981) the number of fish taxa recorded at the survey has increased mostly due to expansion of the area surveyed and better taxonomic skills and identification keys (Johannesen *et al*. 2009). During the six years considered in this report, there was no increasing trend in the number of taxa recorded. Due to dedicated workshops on identification, better identification keys and routines for freezing difficult specimens for later identification on land by taxonomists the fish species identification was good. Still there are some groups that remain problematic, mainly liparids and eelpouts.

Table 11.1. Fish species recorded at the winter survey 2007-2012, all gears included. The number of years each species were recorded is shown and for species not caught all years the capture history (1= caught and 0=not caught) are shown in parenthesis for consecutive years 2007-2012. Some clear misidentifications have been left out and some may be uncertain (see comment).

Order	Family	Species	Number of years caught	Comment
Myxiniformes	Myxinidae	*Myxine glutinosa*	3 (0,1,0,1,1,0)	
Squaliformes	Dalatiidae	*Etmopterus spinax*	4 (1,1,0,0,1,1)	
		Somniosus microcephalus	3 (1,0,1,0,1,0)	
Rajiformes	Rajidae	*Bathyraja spinicauda*	6	
		Amblyraja hyperborean	6	
		Amblyraja radiate	6	
		Dipturus linteus	3 (0,1,1,0,1,0)	
		Rajella fyllae	6	
Chimaeriformes	Chimaeridae	*Chimaera monstrosa*	6	
Clupeiformes	Clupeidae	*Clupea harengus*	6	
		Clupea pallasii suworowi	2 (0,1,0,0,1,0)	
Osmeriformes	Argentinidae	*Argentina silus*	6	
	Osmeridae	*Mallotus villosus*	6	
Stomiiformes	Sternoptychidae	*Argyropelecus hemigymnus*	2 (0,0,0,1,0,1)	
		Maurolicus muelleri	6	
Aulopiformes	Paralepididae	*Arctozenus risso*	6	
Myctophiformes	Myctophidae	*Benthosema glaciale*	4 (0,0,1,1,1,1)	Myctophidae sp. rec. all years
Gadiformes	Macrouridae	*Macrourus berglax*	6	
	Gadidae	*Boreogadus saida*	6	
		Gadiculus argenteus	6	
		Gadus morhua	6	
		Melanogrammus aeglefinus	6	
		Merlangius merlangus	6	
		Micromesistius poutassou	6	
		Pollachius virens	6	
		Trisopterus esmarkii	6	

Order	Family	Species	Number of years caught	Comment
		Trisopterus minutus	1 (0,0,0,1,0,0)	
	Lotidae	*Brosme brosme*	6	
		Enchelyopus cimbrius	6	
		Gaidropsarus argentatus	2 (0,0,1,0,1,0)	
		Molva molva	6	
	Phycidae	*Phycis blennoides*	4 (0,0,1,1,1,1)	
Lophiiformes	Lophiidae	*Lophius piscatorius*	5 (1,1,1,1,0,1)	
Gasterosteiformes	Gasterosteidae	*Gasterosteus aculeatus*	6	
Syngnathiformes	Syngnathidae	*Entelurus aequoreus*	2 (1,1,0,0,0,0)	
Scorpaeniformes	Sebastidae	*Sebastes marinus*	6	
		Sebastes mentella	6	
		Sebastes viviparus	6	
	Triglidae	*Eutrigla gurnardus*	5 (1,1,1,0,1,1)	
	Cottidae	*Artediellus atlanticus*	6	
		Gymnocanthus tricuspis	2 (0,1,1,0,0,0)	
		Icelus sp	6	*I. bicornis* and *I. spatula*
		Myoxocephalus scorpius	5 (1,1,1,1,0,1)	
		Triglops murrayi	6	
		Triglops nybelini	4 (1,1,1,1,0,0)	
		Triglops pingelii	4 (1,1,0,1,1,0)	
	Psychrolutidae	*Cottunculus microps*	6	
	Agonidae	*Leptagonus decagonus*	6	
		Aspidophoroides olrikii	3 (0,1,0,1,1,0)	
	Cyclopteridae	*Cyclopterus lumpus*	6	
		Eumicrotremus derjugini	2 (0,0,0,0,1,1)	
		Eumicrotremus spinosus	6	
		Careproctus spp.	6	
	Liparidae	*Liparis fabricii*	5 (1,1,0,1,1,1)	
		Liparis batyarcticus	3 (1,1,0,0,0,1)	
		Liparis tunicatus	1 (0,0,0,1,0,0)	
		Liparis liparis	6	might be misidentified
		Liparis montagui	1 (0,0,0,1,0,0)	might be misidentified
Perciformes	Zoarcidae	*Gymnelus spp.*	5 (1,0,1,1,1,1)	
		Lycenchelys muraena	1 (0,0,0,1,0,0)	might be misidentified
		Lycenchelys sarsii	1 (0,0,0,0,0,1)	might be misidentified
		Lycodes esmarkii	6	
		Lycodes eudipleurostictus	6	
		Lycodes gracilis	6	
		Lycodes pallidus	6	
		Lycodes polaris	1 (0,1,0,0,0,0)	
		Lycodes reticulatus	6	
		Lycodes rossi	6	
		Lycodes seminudus	6	
		Lycodes squamiventer	2 (1,0,0,0,0,1)	
	Stichaeidae	*Anisarchus medius*	5 (1,0,1,1,1,1)	
		Leptoclinus maculatus	6	

Order	Family	Species	Number of years caught	Comment
		Lumpenus fabricii	1 (0,1,0,0,0,0)	
		Lumpenus lampretaeformis	6	
	Anarhichadidae	*Anarhichas denticulatus*	6	
		Anarhichas lupus	6	
		Anarhichas minor	6	
		Ammotydes spp.	2 (0,1,0,1,0,0)	
	Centrolophidae	*Schedophilus medusophagus*	1 (0,0,1,0,0,0)	
Pleuronectiformes	Pleuronectidae	*Glyptocephalus cynoglossus*	6	
		Hippoglossoides platessoides	6	
		Hippoglossus hippoglossus	6	
		Limanda limanda	5 (0,1,1,1,1,1)	
		Microstomus kitt	6	
		Pleuronectes platessa	6	
		Reinhardtius hippoglossoides	6	
	Scophthalmidae	*Lepidorhombus whiffiagonis*	6	

12 Discussion, comments and summary

12.1 Original purpose and objectives of investigation, data not yet reported

In 1970 IMR initiated a project to find the most suitable time of the year to estimate the abundance of prerecruits of Northeast Arctic cod and haddock in the Barents Sea by an acoustic survey (Hylen and Smedstad, 1972). It was found that the period January to the middle of March was most favourable for applying acoustic methods. From 1974 increasing effort was gradually put into assessing abundance of recruits of cod and haddock and since 1976 the survey has followed a detailed and well-defined schedule and working plan (Dalen and Smedstad, 1979). In 1981 a stratified random bottom trawl survey was started in the same area at the same time of the year (Dalen *et al*. 1982). The bottom trawl survey was originally regarded as a supplement to the acoustic survey, as one expected so low future stock levels that the acoustic method might become insufficient. Gradually, however, the bottom trawl survey has become at least as important as the acoustic survey. The target species were originally cod and haddock, but since the mid-1980s abundance indices have also been estimated for the redfish species and Greenland halibut. The main objectives have for most of the time series been:

- to obtain indices of abundance of the target species by length and age groups
- to estimate mean length, weight and maturity at age for cod and haddock
- to collect stomach samples of cod for studies of growth processes in cod and cod predation on important prey species, itself included (cannibalism)

Since 2005 distribution and swept-area estimates of blue whiting have been presented, and in later years maping the distribution of maturing/ prespawning capelin have been included in the objectives.

There is a number of other ecologically important species (see Chapter 11) that should be given more attention both when planning, performing and reporting the survey. This year long rough dab was added, and in years to come other species will be considered. However, due to several factors (see Chapter 12.2 below), there are strong limitation for the use of data for many species.

12.2 Changes in area coverage, vessels, methods, gear etc.

Changes in survey design, area coverage, vessels, methods, gear etc are described in detail in Jakobsen *et al*. (1997) and Johannesen *et al*. (2009), for later years in Chapter 1 and 2 in the present report and are summarize in Appendix 2. The procedures for handling of the catch is less well documented. Electronic weights were introduced in the late 1980 on research vessels. Prior to that and on commercial vessels catch weights are missing for many catches. The electronic measure board was introduced 1997 and became standard soon after. In 2004 it was decided that at least 20 specimens of all fish species from all haul should be length measured which increased the proportion of length measured individuals. The number of different species recorded per year has increased and so has the average number of species per station (Johannesen *et al*. 2009). Also the number of specimens identified to the species level increased. More species has been identified on the research vessel compared to the commercial vessels. This puts strong limitations on the use of the data from the whole time series for ecosystem considerations, e.g. estimation of biodiversity indices.

When using the abundance indices for stock assessment it is especially 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 a standardised fine meshed cod-end in 1994 also lead to more small fish relative to larger fish.

Adjustments, associated with large uncertainties, are applied to the estimates in order to compensate for the lack of coverage. The results for those years may therefore not be comparable to the results for other years.

In later years it has again become obvious that not all species and age groups are properly covered in the enlarged survey area, e.g. young age groups of the strong 2004 and 2005 year-classes of cod. This will have strong implications on both the consistency of the time series and the quality and uncertainty of the whole assessment and management advice. Good coverage of the whole available distribution area is therefore essential.

12.3 Trawl testing and intercalibration of trawls and echo sounders

Until 1988 the trawl was equipped with rubber bobbins but in 1989 a rockhopper ground gear was introduced. This improved the capture efficiency of the trawl, particularly for small fish (Engås and Godø, 1989). The survey indices (both acoustic and bottom trawl indices) for cod and haddock from 1981-1988 have later been corrected for this change (Godø and Sunnanå, 1992; Aglen and Nakken, 1997). A large number of trawl experiments and vessel comparisons lay behind these corrections. Several experiments have been done to explore the effects of other changes, e.g. strapping, trawl doors and tow duration. For these cases no significant effects have been revealed, but some of these experiments were insufficient for detecting moderate or small effects. The effects of better acoustic equipment, have not neither been corrected for.

In some earlier years, trawl comparisons and intercalibrations between vessels were often included in the survey (record “T” in Table 3.3). Since 2009 the trawl calibration has been limited to testing of the bottom trawl performance at the start of the survey, the so called “shake down”, to verify that the geometry is according to the prescribed standards. This has been done at a standard location, towing the trawl with open cod end and measuring doorspread, bottom contact and vertical opening at 2-3 repeated tows (at different towing directions) for each of the trawls planned to be used in the survey. In some cases these tests has revealed deviations that lead to correction of rigging or the trawl has been rejected for use, and further inspected and corrected later. In more recent years only a sphere calibration of the echo sounder is performed if needed. Bad weather and limited vessel time is probably the main reason for the reduced effort on trawl comparisons and acoustic intercalibrations. Together with other factors it may reduce the quality of the data and add to the uncertainty in the estimates of abundance indices. These factors are especially important to keep in mind when new vessels are introduced in the investigations. In addition to requiring equipment and experience as close to the used "standards", extensive testing and comparison of the equipment and use of it should be done prior to the survey.

12.4 Trends in stock distribution and development in 2007-2012

Cod

Over this 6 year period we observe a gradually increasing abundance of older cod leading to record high abundance of ages 7 and older in 2012. The year-classes 2003 to 2006 appeared in the survey at a low to moderate strength at ages 1 to 4, but have gradually improved at older ages. This is partly caused by a considerably reduced fishing mortality since 2007 (ICES 2012), and partly by the younger ages being distributed far outside the survey area in these years, while the older ages have been better covered by the survey. Mean length and mean weight has declined since about 2008 for most age groups. Mean weights at age are now close to the lowest observed in the time series. The condition factors are, however, rather close to normal. The weight reductions are thus mainly caused by reduced growth in length.

Haddock

Both the acoustic and bottom trawl indices of haddock have been record high since 2008. The exceptionally strong 2004-2006 year-classes can be followed through the time series and still have a strong contribution to the total abundance. In later years, the 2009 and 2011 year-classes seem to be fairly strong. The distribution of haddock extends further to the north and to the east than what was usual in the 1990s. To a certain degree, one can follow the high densities through the size groups, especially the northern and eastern distributions. This indicates that the distribution is more cohort-dependent than age-dependent. Length estimates have been variable with no specific trends in the latest years. However, the variation is less than what it has been in earlier periods. Weight estimates also show less variation in later years with a slight trend of decreasing weights of 4 years and older haddock for the last decade. Estimates of coefficients of variation from bottom trawl hauls are variable and show that indices above age 7 are not reliable.

Redfish

Indices of *Sebastes marinus* (Golden redfish) have remained at a low level over the period, and at least the last fifteen year classes are very weak. There are weak signs of a more south-eastern distribution in 2007-2012. In all years the distribution is completely covered except towards west.

S. mentella (Beaked redfish) is not completely covered in the north western part of the surveyed area. The distribution has been quite similar from year to year in the period 2008-2012. Since 2007-2008 both recruitment and the number of larger *S. mentella* has been at a fairly high level.

Greenland halibut

The most important distribution areas for the adult fish are not covered by the survey. The observed distribution pattern in 2007-2012 was similar to those observed in previous years' surveys. Abundance indices have been low in the whole period, with few signs of improved recruitment in the covered area. However, recruitment from more northern areas has lead to an increase in abundance indices of length groups above 30 cm since about 2005.

Long rough dab

Long rough dab was caught on almost every station in 2007-2012. There was an increase in abundance until about 2002, since then most abundance indices have been relatively stable. The recruitment index has been more variable, with highest values between 2000 and 2006.

Capelin

No quantitative acoustic or trawl indices have been calculated for capelin. Capelin is normally found throughout the investigated area; mainly immature fish is found north of 74°N while maturing, prespawning fish is found south of this latitude. The mapped distribution confirm the general picture of capelin approaching the spawning area either from the east, or in some years both from the east towards eastern Finnmark and from northwest towards western Finnmark and Troms.

The mapped distribution of capelin in bottom trawl seems to correspond well with the distribution of capelin in cod stomachs. An interesting feature is that the smallest cod, which generally eat small amount of capelin, seem to contain more capelin in the northern areas than in the southern. This probably reflects the length distribution of capelin: smaller capelin in the north are more suitable as food for smaller cod, while small and large capelin in the total distribution area constitute a major prey item for larger cod.

Blue whiting

The echo abundance peaked in 2006. Since then it has decreased considerably. High abundance of fish below 20 cm in 2001, 2002, 2004, 2005 and 2012 reflects abundant recruiting (age 1) year classes. These recruits are observed in the survey as larger fish in the following years.

13 References

Aglen, A. and Nakken, O. 1997. Improving time series of abundance indices applying new knowledge. Fisheries Research, 30: 17-26.

Aglen, A., Dingsør, G., Mehl, S., Murashko, P. and Wenneck, T. de L. 2012. Results from the Joint IMR-PINRO Barents Sea demersal fish survey 21 January – 15 March 2012. WD #3 ICES Arctic Fisheries Working Group, Copenhagen, Denmark 20-26 April 2012.

Bogstad, B., Fotland, Å. and Mehl, S. 1999. A revision of the abundance indices for cod and haddock from the Norwegian winter survey in the Barents Sea, 1983-1999. Working Document, ICES Arctic Fisheries Working Group, 23 August - 1 September 1999.

Dalen, J., Hylen, A., Jakobsen, T., Nakken, O., Randa, K. and Smedstad, O. 1982. Norwegian investigations on young cod and haddock in the Barents Sea during the winter 1982. ICES CM 1982/G: 41, 20 pp.

Dalen, J. and Nakken, O. 1983. On the application of the echo integration method. ICES CM 1983/B: 19, 30 pp.

Dalen, J. and Smedstad, O. 1979. Acoustic method for estimating absolute abundance of young cod and haddock in the Barents Sea. ICES CM 1979/G:51, 24pp.

Dalen, J. and Smedstad, O. 1983. Abundance estimation of demersal fish in the Barents Sea by an extended acoustic method. *In* Nakken, O. and S.C. Venema (eds.), Symposium on fisheries acoustics. Selected papers of the ICES/FAO Symposium on fisheries acoustics. Bergen, Norway, 21-24 June 1982. FAO Fish Rep., (300): 232-239.

Dickson, W. 1993a. Estimation of the capture efficiency of trawl gear. I: Development of a theoretical model.Fisheries Research 16: 239-253.

Dickson, W. 1993b. Estimation of the capture efficiency of trawl gear. II: Testing a theoretical model. Fisheries Research 16: 255-272.

Dolgov, A. V., Yaragina, N.A., Orlova, E.L., Bogstad, B., Johannesen, E., and Mehl, S. 2007. 20^{th} anniversary of the PINRO-IMR cooperation in the investigations of feeding in the Barents Sea – results and perspectives. Pp. 44-78 in 'Long-term bilateral Russian-Norwegian scientific cooperation as a basis for sustainable management of living marine resources in the Barents Sea.' Proceedings of the 12th Norwegian- Russian symposium, Tromsø, 21-22 August 2007. IMR/PINRO report series 5/2007, 212 pp.

Engås, A. 1995. Trålmanual Campelen 1800. Versjon 1, 17. januar 1995, Havforskningsinstituttet, Bergen. 16 s. (upubl.).

Engås, A. and Godø, O.R. 1989. Escape of fish under the fishing line of a Norwegian sampling trawl and its influence on survey results. Journal du Conseil International pour l'Exploration de la Mer, 45: 269-276.

Engås, A. and Ona, E. 1993. Experiences using the constraint technique on bottom trawl doors. ICES CM 1993/B:18, 10pp.

Foote, K.G. 1987. Fish target strengths for use in echo integrator surveys. Journal of the Acoustical Society of America, 82: 981-987.

Godø, O.R. and Sunnanå, K. 1992. Size selection during trawl sampling of cod and haddock and its effect on abundance indices at age. Fisheries Research, 13: 293-310.

Hylen, A. And Smedstad, O. 1972. Norwegian investigations on young cod and haddock in the Barents Sea and adjacent waters 1970-1972. ICES CM 1972/F:38, 18pp.

ICES 2007. Report of the Arctic Fisheries Working Group, Vigo, Spain 19-28 April 2007. ICES CM 2007/ACFM: 16. 651 pp.

ICES 2012. Report of the Arctic Fisheries Working Group, ICES Headquarters, Copenhagen 20-26 April 2012. ICES CM 2012/ACOM: 05. 633 p.

Jakobsen, T., Korsbrekke, K., Mehl, S. and Nakken, O. 1997. Norwegian combined acoustic and bottom trawl surveys for demersal fish in the Barents Sea during winter. ICES CM 1997/Y: 17, 26 pp.

Johannesen, E., Wenneck, T. de L., Høines, Å., Aglen, A., Mehl, S., Mjanger, H., Fotland, Å., Halland, T. I. and Jakobsen, T. 2009. Egner vintertoktet seg til overvåking av endringer i fiskesamfunnet i Barentshavet? En gjennomgang av metodikk og data fra 1981-2007. Fisken og Havet nr. 7/2009. 29s.

Korneliussen, R. J., Ona, E., Eliassen, I., Heggelund, Y., Patel, R., Godø, O.R., Giertsen, C., Patel, D., Nornes, E., Bekkvik, T., Knudsen, H. P., Lien, G. 2006. The Large Scale Survey System - LSSS. Proceedings of the 29th Scandinavian Symposium on Physical Acoustics, Ustaoset 29 January – 1 February 2006.

Korsbrekke, K. 1996. Brukerveiledning for TOKT312 versjon 6.3. Intern program dok., Havforskningsinstituttet, september 1996.

Korsbrekke, K., Mehl, S., Nakken, O. og Sunnanå, K. 1995. Bunnfiskundersøkelser i Barentshavet vinteren 1995. Fisken og Havet nr. 13 - 1995, Havforskningsinstituttet, 86 s.

Knudsen, H.P. 1990. The Bergen Echo Integrator: an introduction. - Journal du Conseil International pour l'Exploration de la Mer, 47: 167-174.

MacLennan, D.N. and Simmonds, E.J. 1991. Fisheries Acoustics. Chapman Hall, London, England. 336pp.

Mehl, S., and Yaragina, N.A. 1992. Methods and results in the joint PINRO-IMR stomach sampling program. Pp. 5-16 in Bogstad, B. and Tjelmeland, S. (eds.): Interrelations between fish populations in the Barents Sea. Proceedings of the fifth PINRO-IMR Symposium, Murmansk, 12-16 August 1991. Institute of Marine Research, Bergen, Norway.

Mjanger, H., Hestenes, K., Svendsen, B.V., and Wenneck, T. deL. 2011. Håndbok for prøvetaking av fisk og krepsdyr. Versjon 3.16 oktober 2011. Havforskningsinstituttet, Bergen. 195s.

Wienerroither R., Johannesen E., Dolgov A., Byrkjedal I., Bjelland O, Drevetnyak K., Eriksen, K. B., Høines Å., Langhelle G., Langøy H., Prokhorova T., Prozorkevich D., Wenneck T., 2011. Atlas of the Barents Sea Fishes. IMR/PINRO Joint Report Series 1-2011, ISSN 1502-8828. 272 pp.

APPENDIX 1. Annual survey reports 1981-2012

Dalen, J., Hylen, A. og Smedstad, O. M. 1981. Intern toktrapport unummerert. Havforskningsinstituttet.

Dalen, J., Hylen, A., Jakobsen, T., Nakken, O., Randa, K. and Smedstad, O. 1982. Norwegian investigations on young cod and haddock in the Barents Sea during the winter 1982. ICES CM 1982/G: 41, 20 pp.

Dalen, J., Hylen, A., Jakobsen, T., Nakken, O., Randa, K., and Smedstad, O. 1983. Preliminary report of the Norwegian investigations on young cod and haddock in the Barents Sea during the winter 1983. ICES CM 1983/G:15, 23 pp

Dalen, J., Hylen, A., Jakobsen, T., Nakken, O. and Randa, K. 1984. Preliminary report of the Norwegian Investigations on young cod and haddock in the Barents Sea during the winter 1984. ICES CM 1984/G:44, 26 pp

Hylen, A., Jakobsen, T., Nakken, O. and Sunnanå, K. 1985. Preliminary report of the Norwegian Investigations on young cod and haddock in the Barents Sea during the winter 1985. ICES CM 1985/G:68, 28 pp.

Hylen, A., Jakobsen, T., Nakken, O., Nedreaas, K. and Sunnanå, K. 1986. Preliminary report of the Norwegian Investigations on young cod and haddock in the Barents Sea. ICES CM 1986/G:76, 25 pp.

Godø, O. R., Hylen, A., Jacobsen, J. A., Jakobsen, T., Mehl, S., Nedreaas, K. and Sunnanå, K. 1987. Estimates of stock size of Northeast Arctic cod and haddock from survey data 1986/1987. ICES CM 1987/G: 37.

Hylen, A., Jacobsen, J.A., Jakobsen, T., Mehl, S., Nedreaas,K. and Sunnanå, K. 1988. Estimates of stock size of Northeast Arctic cod and haddock, *Sebastes mentella* and *Sebastes marinus* from survey data, winter 1988. ICES CM 1988/G: 43.

Jakobsen,T., Mehl,S., Nakken,O., Nedreaas,K. and Sunnanå,S. 1989. Estimates of stock size of Norteast Arctic cod and haddock, *Sebastes mentella* and *Sebastes marinus* from survey data, winter 1989. ICES CM 1989/G: 42.

Jakobsen, T., Mehl, S. og Nedreaas, K. 1990. Kartlegging av mengde og utbredelse av torsk, hyse og uer i Barentshavet januar mars 1990. Intern toktrapport, Senter for marine ressurser, Havforskningsinstituttet, Bergen. Engelsk abstract, tabell og figurtekster. 29 s. (upubl.).

Hylen, A., Jakobsen, T., Mehl, S., og Nedreaas, K. 1991. Undersøkelser av torsk, hyse og uer i Barentshavet vinteren 1991. Intern toktrapport nr. 1 -1992, Senter for marine ressurser, Havforskningsinstituttet, Bergen. Engelsk abstract, tabell og figurtekster. 30 s. (upubl.).

Godø, O.R., Jakobsen, T., Mehl, S., Nedreaas, K. og Raknes, A. 1992. Undersøkelser av torsk, hyse og uer i Barentshavet vinteren 1992. Intern toktrapport 39/92, Senter for marine ressurser, Havforskningsinstituttet, Bergen. Engelsk abstract, tabell og figurtekster. 33 s. (upubl.).

Korsbrekke, K., Mehl, S., Nakken, O. and Nedreaas, K. 1993. Bunnfiskundersøkelser i Barentshavet vinteren 1993. Rapp. Senter Marine Ressurser nr. 14-1993. Engelsk abstract, tabell- og figurtekster. 47s. Havforskningsinstituttet, Bergen.

Mehl, S. og Nakken, O. 1994. Bunnfiskundersøkelser i Barentshavet vinteren 1994. Fisken Hav (6) 1994. 72 s. Havforskningsinstituttet, Bergen.

Korsbrekke, K., Mehl, S., Nakken, O. og Sunnanå, K. 1995. Bunnfiskundersøkelser i Barentshavet vinteren 1995. Fisken Hav (13) 1995. 86 s. Havforskningsinstituttet, Bergen.

Mehl, S. og Nakken, O. 1996. Botnfiskundersøkingar i Barentshavet vinteren 1996. Fisken Hav (11) 1996. 68 s. Havforskingsinstituttet, Bergen.

Mehl, S. 1997. Botnfiskundersøkingar i Barentshavet (norsk sone) vinteren 1997. Fisken Hav (11) 1997. 72 s. Havforskingsinstituttet, Bergen.

Mehl, S. 1998. Botnfiskundersøkingar i Barentshavet (redusert område) vinteren 1998. Fisken Hav (7) 1998. 69 s. Havforskingsinstituttet, Bergen.

Mehl, S. 1999. Botnfiskundersøkingar i Barentshavet vinteren 1999. FiskenHav (13) 1999. 70 s. Havforskingsinstituttet, Bergen.

Aglen, A., Drevetnyak, K., Jakobsen, T., Korsbrekke, K., Lepesevich, Y., Mehl, S., Nakken, O. and Nedreaas, K. 2001. Investigations on demersal fish in the Barents Sea winter 2000. Detailed report. IMR-PINRO Joint Report Series no. 5, 2001. 74 pp.

Aglen, A., Alvsvåg, J, Korsbrekke, K., Lepesevich, Y., Mehl, S., Nedreaas, K., Sokolov, K. And Ågotnes, P. 2002. Investigations on demersal fish in the Barents Sea winter 2001. Detailed report. IMR-PINRO Joint Report Series no. 2 2002, 66 pp.

Aglen, A., Alvsvåg, J., Drevetnyak, K, Høines, Å., Korsbrekke, K., Mehl, S., and Sokolov, K. 2002. Investigations on demersal fish in the Barents Sea winter 2002. Detailed report. IMR/PINRO Joint report series no 6, 2002. 63 pp.

Aglen, A., Alvsvåg, J., Halland, T.I., Høines, Å., Nakken, O., Russkikh, A., and., Smirnov, O. 2003. Investigations on demersal fish in the Barents Sea winter 2003. Detailed report. IMR/PINRO Joint report series no 1, 2003. 56pp.

Aglen, A., Alvsvåg, J., Høines, Å., Korsbrekke, K., Smirnov, O., and Zhukova, N., 2004. Investigations on demersal fish in the Barents Sea winter 2004. Detailed report. IMR/PINRO Joint report series no 5/2004, ISSN 1502-8828. 58pp.

Aglen, A., Alvsvåg, J., Grekov, A., Høines, Å., Mehl, S., and Zhukova, N. 2005. Investigations of demersal fish in the Barents Sea winter 2005. IMR/PINRO Joint Report Series, No 4/2005. ISSN 1502-8828, 58 pp.

Aglen, A., Alvsvåg, J., Høines, Å., Johannesen, E. and Mehl, S. 2008. Investigations on demersal fish in the Barents Sea winter 2006. Detailed report. Fisken og Havet nr. 13/2008. 49 pp.

Aglen, A. 2007. Report from demersal fish survey in the Barents Sea February-March 2007. WD #8 ICES Arctic Fisheries Working Group, Vigo, Spain 19-28 April 2007.

Aglen, A., Høines, Å., Mehl, S., Prozorkevich, D., Smirnov, O. and Wenneck, T. de L. 2008. Results from the Joint IMR-PINRO Barents Sea demersal fish survey 25 January – 14 March 2008. WD #16 ICES Arctic Fisheries Working Group, ICES Headquarters 21-29 April 2008.

Aglen, A., Alexandrov, D., Høines, Å., Mehl, S., Prozorkevich, D. and Wenneck, T. de L. 2009. Results from the Joint IMR-PINRO Barents Sea demersal fish survey 1 February – 15 March 2009. WD #11 ICES Arctic Fisheries Working Group, San-Sebastian, Spain 21-27 April 2007.

Aglen, A., Alexandrov, D., Gjøsæter, H., Johannesen, E., Mehl, S. and Wenneck, T. de L. 2010. Results from the Joint IMR-PINRO Barents Sea demersal fish survey 1 February – 17 March 2010. WD #15 ICES Arctic Fisheries Working Group, Lisbon, Portugal/Bergen, Norway 22-28 April 2010.

Aglen, A., Alexandrov, D., Gjøsæter, H., Johannesen, E. and Mehl, S. 2011. Results from the Joint IMR-PINRO Barents Sea demersal fish survey 1 February – 14 March 2011. WD #3 ICES Arctic Fisheries Working Group, Hamburg, Germany 28 April - 4 May 2011.

Aglen, A., Dingsør, G., Mehl, S., Murashko, P. and Wenneck, T. de L. 2012. Results from the Joint IMR-PINRO Barents Sea demersal fish survey 21 January – 15 March 2012. WD #3 ICES Arctic Fisheries Working Group, Copenhagen, Denmark 20-26 April 2012.

APPENDIX 2. Changes in survey design, methods, gear, etc.

Year	Change from	To
1984	Representative age sample, 100 per station	Stratified age sample, 5 per 5-cm length group
1986	1 research vessel, 2 commercial trawlers	2 research vessels, 1 commercial trawler
1987	60 min. tow duration	30 min. tow duration
1989	Bobbins gear	Rock-hopper gear (time series adjusted for cod and haddock)
1990	Random stratified bottom trawl stations	Fixed station grid, 20 nm distance
	Simrad EK400 echo sounder	Simrad EK500 echo sounder and BEI post processing
1993	TS = 21.8 log L – 74.9 for cod and haddock	TS = 20 log L – 68 for all demersal species (time series corrected)
	Fixed survey area (A,B,C,D), 1 strata system, 35 strata	Extended, variable survey area (A,B,C,D,D',E,S)
		2 strata systems, 53 + 10 strata
	Fixed station grid, 20 nm distance	Fixed station grid, 20/30/40 nm distance
	No constraint technique (strapping) on bottom trawl doors	Constraint technique on some bottom trawl hauls
	5 age samples per 5-cm group, 2 per stratum	2 age samples per 5-cm group, 4 per stratum (cod and haddock)
	Weighting of age-length keys by total catch	Weighting of ALK by swept area estimate
1994	35-40 mm mesh size in cod-end	22 mm mesh size in cod-end
	Strapping on some hauls	Strapping on every 3. haul
	Hull mounted transducers	Keel mounted transducers Johan Hjort
1995	Variable use of trawl sensors	Trawl manual specifying use of sensors
	Constant effective fishing width of the trawl	Fish size dependent effective fishing width (time series corrected)
	Strapping on every 3. haul	Strapping on every 2. haul
	2 research vessels, 1 commercial trawler	3 research vessels
1996	2 strata systems and 63 strata, 20/30/40 nm distance	1 strata system and 23 strata, 16/24/32 nm distance
	2 age samples per 5-cm group, 4 per stratum	1 age sample per 5-cm group, all stations with > 10 specimens (cod and haddock)
1997	16/24/32 nm distance	20 nm distance
	Hull mounted transducers	Keel mounted transducers G.O. Sars (Sarsen)
1998	Strapping on every 2. haul	Strapping on every haul
	20 nm distance	20/30 nm distance
2000	3 Norwegian research vessels	2 Norwegian and 1 Russian research vessel
2002	20/30 nm distance	16/20/24/32 nm distance
2003	Height trawl sensor for opening and bottom contact	Trawl eye for opening and bottom contact
2004	Vaco trawl doors	V- doors G.O. Sars and Johan Hjort
	EK 500 and BEI Sarsen	ER60 and LSSS G.O. Sars
2005	EK 500 and BEI	ER60 and LSSS Johan Hjort
	EK 500	ER60 Russian vessels
2008	V trawl doors	Thyborøen doors Jan Mayen
2010	V trawl doors	Thyborøen doors G.O. Sars and Johan Hjort
2011	30 min. tow duration	15 min. tow duration

APPENDIX 3. Scientific participants 2007 – 2012. Cruise leader in bold.

Norwegian vessels					
2007	**2008**	**2009**	**2010**	**2011**	**2012**
Johan Hjort	Johan Hjort	Johan Hjort	Johan Hjort	Johan Hjort	Libas
A. Aglen	O. O. Arnøy	I. M. Beck	J. Alvarez	G. Bakke	**A. Aglen**
O. O. Arnøy	I. M. Beck	J. Erices	O. O. Arnøy	I. M. Beck	G. Bakke
G. Bakke	J. Erices	M. Fonn	I. M. Beck	L. Drivenes	**G. E. Dingsør**
I. M. Beck	O. S. Fossheim	T. I. Halland	L. Drivenes	B. Ellertesen	L. Drivenes
L. Drivenes	L. Heggebakken	L. Heggebakken	B. Ellertesen	M. Fonn	K. A. Gamst
H. Gill	E. Holm	M.Johannessen	B. Endresen	H. Godøy	E. Holm
Å. Høines	**Å. Høines**	K. E. Karlsen	M. Fonn	L. Heggebakken	K. E. Karlsen
T. Jåvold	E. Johannesen	S. Lemvig	K. Gamst	E. Holm	S. Karlson
A. Leithe	M.Johannessen	**S. Mehl**	**H. Gjøsæter**	T. Hovland	J. Kristiansen
S. Lemvig	S. Lemvig	J. H. Nilsen	T. I. Halland	**E. Johannesen**	M. Kvalsund
M. Mjanger	M. Mc. Bride	J. E. Nygaard	H. Ø. Hansen	K. E. Karlsen	M. Mjanger
J. H. Nilsen	**S. Mehl**	B. Røttingen	E. Hermansen	M. R. Kleiven	J. E. Nygaard
J. E. Nygaard	H. Mjanger	S. E. Seim	E. Holm	S. Kleven	A. Rey
B. Røttingen	J. H. Nilsen	A. Storaker	J. Kristiansen	S. Kolbeinson	J. Rønning
J. Skadal	J. E. Nygaard	Ø. Torgersen	S. Lemvig	M. Kvalsund	B. Røttingen
A. Storaker	B. Røttingen	J. Vedholm	**S. Mehl**	**S. Mehl**	J. Røttingen
A. Sæverud	J. Saltskår	**T. de L. Wenneck**	M. Mjanger	A. Nieuyear	A. Sæverud
Ø. Torgersen	L. Solbakken		A. Nieuyear	J. H. Nilsen	J. Vedholm
	A. Soldal		J. H. Nilsen	J. E. Nygaard	
	Ø. Torgersen		J. E. Nygaard	B. Røttingen	
	K. Tveit		B. Røttingen	S. E. Seim	
	J. Vedholm		S. E. Seim	B. Skjold	
			A. Sæverud	J. Vedholm	
			Ø. Torgersen		
			J. Vedholm		
			T. de L. Wenneck		
G.O. Sars	**Jan Mayen**	**Jan Mayen**	**Jan Mayen**	**Jan Mayen**	**Helmer Hanssen**
J. Alvsvåg	A.K. Abrahamsen	A.K. Abrahamsen	A.K. Abrahamsen	A.K. Abrahamsen	A.K. Abrahamsen
M. Fonn	**A. Aglen**	**A. Aglen**	**A. Aglen**	**A. Aglen**	K. Hansen
H. Græsdal	G. Bakke	O. O. Arnøy	G. Bakke	O. O. Arnøy	T. Haugland
K. Hansen	A. Engås	A. Borge	H. Gill	**H. Gjøsæter**	E. Hermansen
T. Haugland	J. Erices	A. Engås	H. Godøy	T. Haugland	C. Irgens
E. Hermansen	K. A. Gamst	K. A. Gamst	T. Haugland	E. Hermansen	K. E. Karlsen
E. Holm	K. Hansen	T. Haugland	K. Hansen	E. Holm	S. Kolbeinson
A. Kristiansen	M. Johannessen	I. Henriksen	L. Heggebakken	K. A. Gamst	A. Kristiansen
M. Kvalsund	A. Kristiansen	E. Holm	**E. Johannesen**	K. Hansen	G. Lien
B. Kvinge	B. Kvinge	**Å. Høines**	K. E. Karlsen	K. E. Karlsen	**S. Mehl**
S. Mehl	A. Leithe	M. Kvalsund	A. Kristiansen	A. Kristiansen	S. E. Seim
H. Myran	G. Lien	G. Langhelle	M. Kvalsund	G. Lien	H. Senneset
W. Richardsen	F. Midtøy	A. Leithe	G. Lien	J. Røttingen	J. Skadal
P. Ågotnes	H. Myran	G. Lien	F. Midtøy	A. Sæverud	Ø. Tangen
	W. Richardsen	W. Richardsen	H. Senneset		R Wienerroither
	J. Skadal	B. Skjold	T.H. Thangstad		**T. de L. Wenneck**
	B. Skjold	A. Aasen			
	A. Storaker				
	K. Utne				
	A. Aasen				
	T. de L. Wenneck				

		Russian vessels			
2007	**2008**	**2009**	**2010**	**2011**	**2012**
	Fridtjof Nansen	Fridtjof Nansen	Fridtjof Nansen	Fridtjof Nansen	Fridtjof Nansen
	Bezink A.N.	**Aleksandrov D.I.**	**Aleksandrov D.I.**	**Aleksandrov D.I.**	Amelkin A.V.
	Chernov V.N.	Baimambetov R.A.	Bessonov A.A.	Amelkin A.V.	Baimambetov R.A.
	Dolotov S.I.	Chernov V.N.	Chernov V.N.	Bessonov A.A.	Bessonov A.A.
	Firsov I.L.	Firsov I.L.	Glebova S.E.	Chernov V.N.	Chugainova V.A.
	Ivshin V.A.	Ivleva Z.V.	Hrobostov P.M.	Firsov I.L.	Derevscikov A.V.
	Kalashnikova M.I.	Kalashnikova M.I.	Ivleva Z.V.	Hrobostov P.M.	Firsov I.L.
	Kuzmichev A.P.	Klepikovskii R.N.	Ivshin V.A.	Ivleva Z.V.	Harlin S.N.
	Muhina N.V.	Makeenko G.A.	Kliuev A.I.	Ivshin V.A.	Kalashnikova M.I.
	Nosov N.A.	Puodjunas N.G.	Krivosheia P.V.	Malkov I.V.	Klepikovskii R.N.
	Puodjunas N.G.	Roscin E.A.	Kuzmichev A.P.	Murashko P.A.	Krivosheia P.V.
	Smirnov O.V.	Russkih A.A.	Murashko P.A.	Samsonova I.N.	**Murashko P.A.**
	Zubov V.I.	Sergeeva T.M.	Nosov M.A.	Sergeeva T.M.	Nosov M.A.
	Zuikova N.V.	Velikjanin A.P.	Puodjunas N.G.	Sidorov R.A.	Russkih A.A.
		Zubov V.I	Samsonova I.N.	Tretiakov I.S.	Sergeeva T.M.
			Velikjanin A.P.	Vasilev A.V.	Sidorov R.A.
			Zubov V.I	Zubov V.I.	Velikjanin A.P.
					Zubov V.I
	Smolensk	Vilnyus			
	Bandura V.V.	Benzik A.N.			
	Harlin S.N.	Dolgolenko I.I.			
	Iurko A.S.	Harlin S.N.			
	Karsakov A.L.	Ivshin V.A.			
	Lukin N.N.	Lukin N.N.			
	Prozorkevich D.V.	Murashko P.A.			
	Trofimov I.I.	Nosov M.A.			
		Prozorkevich D.V.			
		Semenov A.V.			

JOINT REPORT

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