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Survey report from the joint Norwegian/Russian Ecosystem Survey in the Barents Sea and adjacent waters, August – October 2014

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Survey report

from the joint Norwegian/Russian ecosystem Survey in the Barents Sea and adjacent waters, August – October 2014

Elena Eriksen, editor

Institute of Marine Research

Brainstorming on board G.O.Sars. Experimental pelagic trawl under development and testing

Photo: Aleksander Pavlenko (PINRO)

Bergen, December 2014

Contents

1 Background

The aim of the survey is to monitor the status and changes of the Barents Sea ecosystem. The survey plan and tasks were agreed upon at the annual IMR-PINRO Meeting in March 2014. The survey plan was changed by IMR due to budget cut in June 2014, and several components of ecosystem both biological (such as shrimps, benthos, marine mammals) and environmental (floating litter) were not covered. PINRO conducted the survey as was planned at the joint meeting in March. Therefore, the shrimps, benthos, marine mammals and floating litter presented partly, only for the surveyed area, covered by PINRO.

The 11th joint Barents Sea autumn ecosystem survey (BESS) was carried out during the period from 12th August to 3st October 2014. Research vessel tracks during the 2014 ecosystem survey are shown in Figure 1.1. Trawl, are shown in Figures 1.2 and hydrography and plankton stations are shown in Figures 1.3.

During the survey (13.08-23.08), research vessel “Johan Hjort” covered the western, central and some northern parts of the Barents Sea. “Helmer Hanssen”, initiating by “SI Arctic” project, investigated Arctic area northwest of Svalbard (Spitsbergen), and only 12 ecosystem stations were taken for “Ecosystem survey in the Barents Sea” project. Investigation area was limited in the north due to ice coverage (Figure 1.1).

Research vessels “G.O.Sars” started the survey with calibration of acoustics and control of the surveys trawls during 05-06 of September 2014 in Malangen fjord, Spilderbukta (79°25’N and 18°31’E) over a depth of 58 m. Due to high fish densities only 38kHz was calibrated, while other frequencies were checked and found. G.O. Sars covered the area along the continental slope during 06-15.09.2014. During this part in addition to ecosystem stations the following experiments were conducted: testing ruffled small mesh inside blinder, trawl geometry measurements with different rigging of standard survey trawls (“Harstad” and macro plankton), and calibration between the standard (“Harstad”) and experimental trawls. G.O.Sars covered the northern area during 15-27.09.2014, where in addition to ecosystem stations sonar investigation of capelin schools were conducted. This third part of the survey was shorted by 3 days due to ice coverage.

Russian research vessel “Vilnyus” (12.08-03.10) began the ecosystem survey from the southeastern Barents Sea and then continued to cover the REEZ from south to north up to Franz Josef Land. An area in the REEZ was closed for sailing due to military activity in the second decade of August. It led to the loss coverage along Novaya Zemlya. Moreover “Vilnyus” lost many days due to bad weather condition.

In 2014 all research vessels spent fewer days on the survey than in 2013 (129 vs 178), and the effective days at sea were less than 129 due to different reason (see above “H.Hanssen” and “Vilnyus”). The surveyed area in 2014 was smaller in the Svalbard (Spitsbergen) region due to ice coverage. Adjustment water in northern Kara Sea and Arctic basin were not observed also due to reduced Russian vessel days.

This report covers most of the survey aspects but not all of them (see above). The content will be updated and available on the Internet (www.imr.no). A website dedicated to collating all information from the ecosystem survey including all the previous reports, maps, etc. is currently under preparation (http://www.imr.no/tokt/okosystemtokt_i_barentshavet/nn-no). Post-survey information which is not included in the written report may also be found at this website.

The scientists and technicians taking part in the survey onboard the research vessels are listed in Appendix 1.

Sampling manual of this survey has been developed since 2004 and published on the Ecosystem Survey homepage by specialist and experts from IMR and PINRO (http://www.imr.no/tokt/okosystemtokt_i_barentshavet/sampling_manual/nb-no).
This manual includes the metrological and technical issues, describes equipments, the trawling and capture procedures by the samplings tools being used during the survey, and present the methods that are used in calculating the abundance and biomass for the biota. This manual is also in a process of being continuously updated.

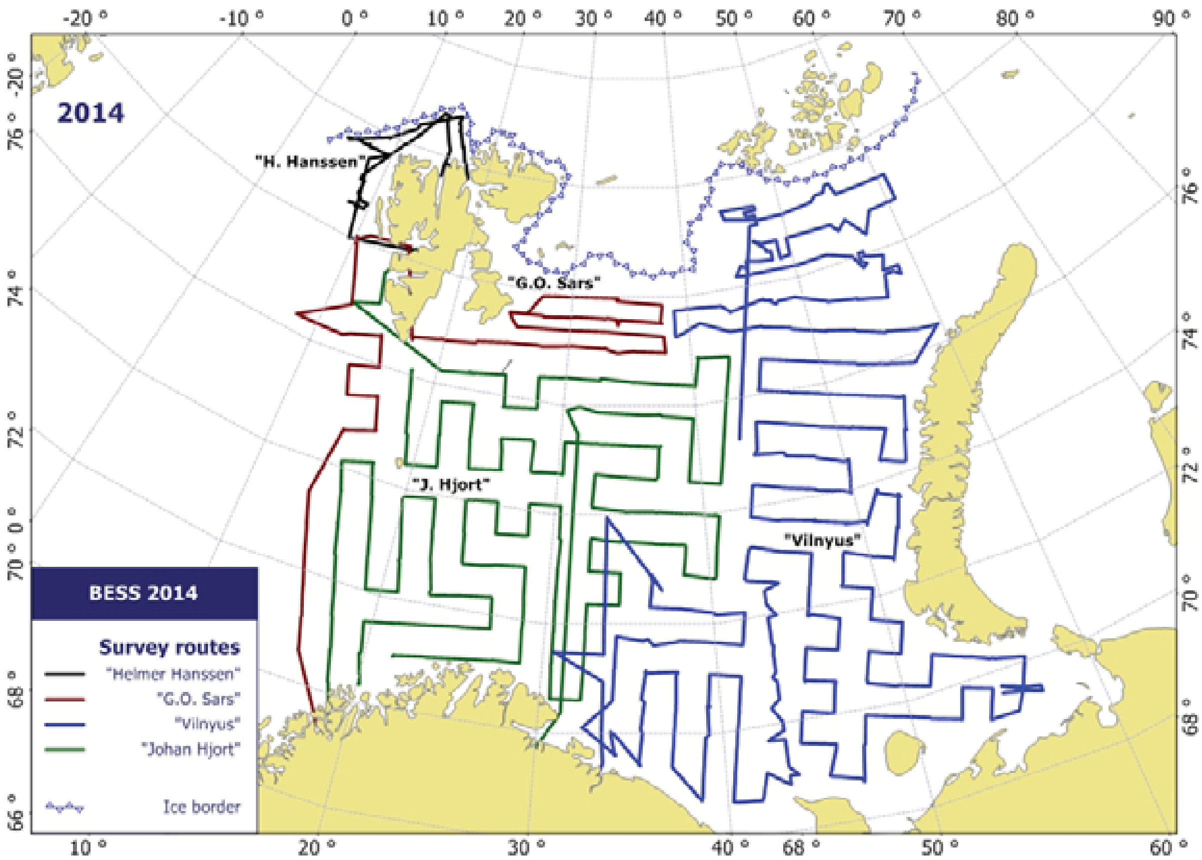


Figure 1.1. Ecosystem survey, August-October 2014. Research vessel tracks

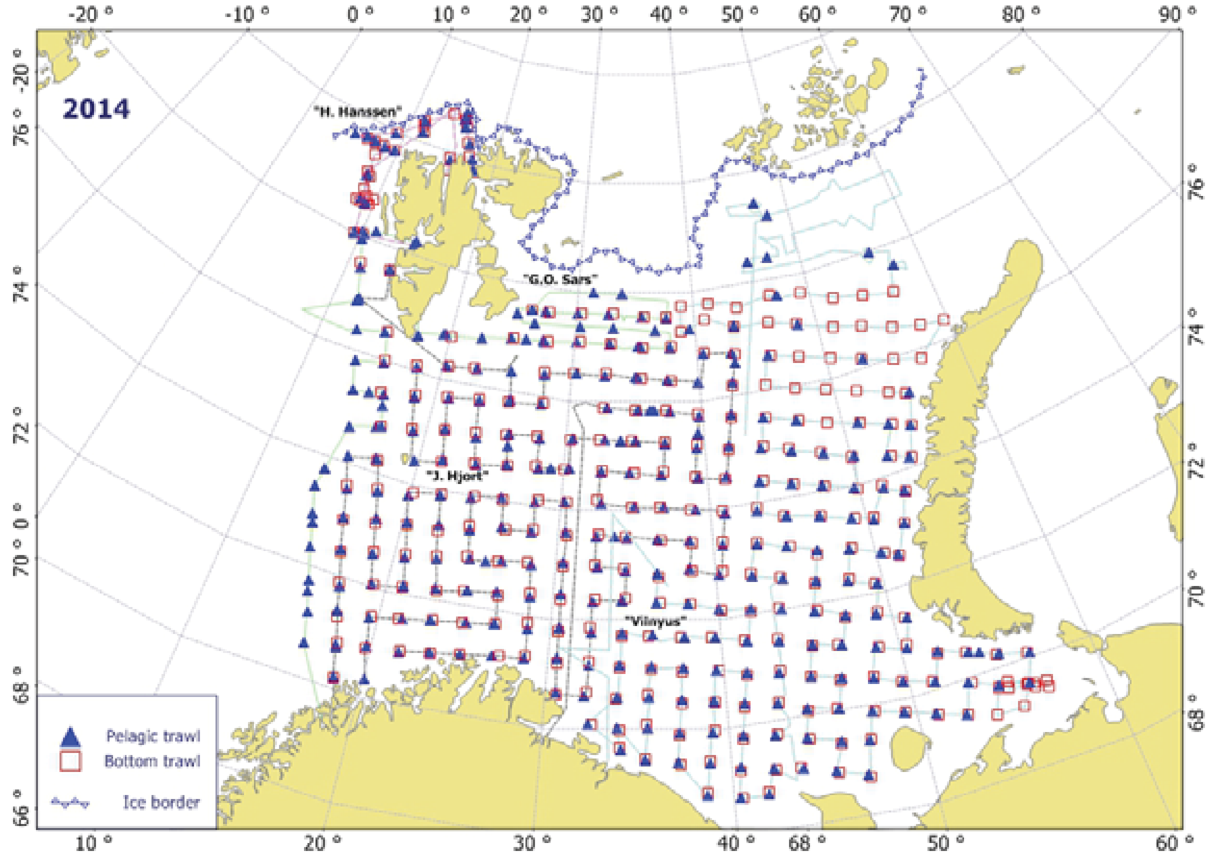


Figure 1.2. Ecosystem survey, August-October 2014. Trawl stations

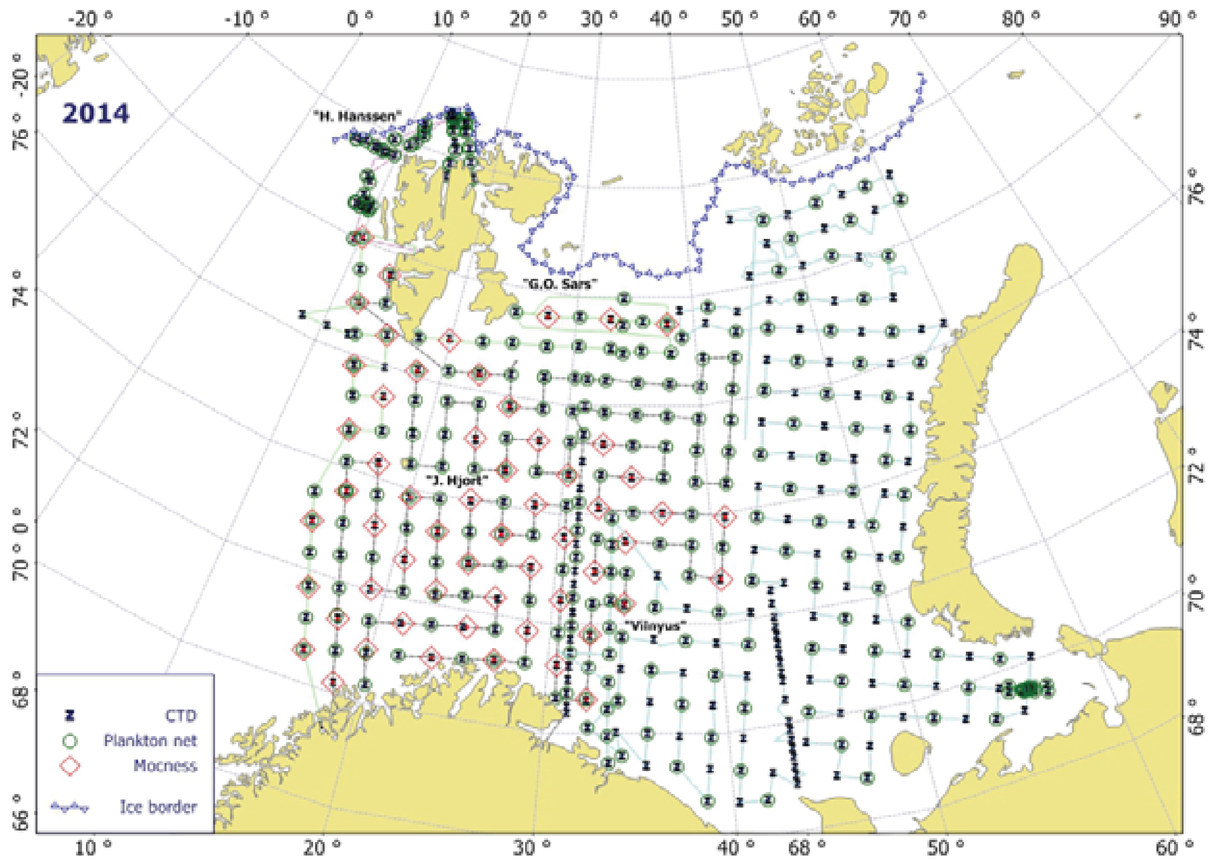


Figure 1.3. Ecosystem survey, August-October 2014. Hydrography and plankton stations.

2 Data monitoring

Text by H. Gjøsæter

Huge amounts of data are collected during the ecosystem surveys. Most data will add to those from earlier surveys to form time series, while some data belong to special investigations conducted once or to projects of short duration. Another way of classifying data is distinguishing between joint data, i.e. data collected jointly by IMR and PINRO, and data collected by visiting researchers from other institutions, using the survey vessels as a platform for data collection without being part of the overall aim with this survey.

Joint data are owned by IMR and PINRO and this joint ownership is realized through a full exchange of data during and after the survey. Since the data infrastructure is different at IMR and PINRO (see below), the data are converted to institute-specific formats before they are entered into databases on the institutes. However, some aggregated time series data are entered into a joint database called “Sjømil”, which is present both at IMR and PINRO. These data are also accessible outside of these two institutions, see below.

2.1 Data use

Joint data are contained in the databases of both PINRO and IMR and are freely accessible to all inside the institutions. At IMR, the management of the data is left to NMD, (Norsk Marint Datasenter = Norwegian marine data centre) which is a part of IMR. Norway and Russia have quite different data policy in general and this affects the accessibility to the data from outside of these institutions. In Norway, access is in principle granted to everyone for use in research while in Russia access to data collected by one institution for other persons or institutions is highly restricted. This also affects the management of data at IMR, since data collected by PINRO as part of a joint project with IMR can be used by researchers at IMR but cannot be distributed to third parties. In effect, the total amount of joint data cannot be distributed from IMR, and persons or institutions interested in using these data will have to contact IMR for access to Norwegian data and PINRO for access to Russian data.

2.2 Databases

IMR is now developing a new data-infrastructure through the project S2D. Old databases are replaced by a new family of databases administered by NMD. Although the data are split on several databases, for instance one for acoustic data, one for biological data, another for physical and yet another for chemical data, they are linked through a common reference database and all data can be seen through a common user interface. At PINRO they are also planning to move their data into a new set of databases but at present all data are placed in one database for all kinds of data. In addition to these institutional data repositories a joint database for some selected time series of aggregated data has been developed, called “Sjømil”. At present this database is present at IMR and PINRO, and the IMR database is accessible to the outside world through a web interface http://www.imr.no/sjomil/index.html . This database is general and has data from many other monitoring programs and from other areas than the Barents Sea.

3 Monitoring of marine enviroment

3.1 Hydrography

Text by A. Trofimov and R. Ingvaldsen
Figures by A. Trofimov and R. Ingvaldsen

3.1.1 Oceanographic sections

Figures 3.1.1.1 shows the temperature and salinity conditions along the standard oceanographic sections: Fugløya–Bear Island, Vardø–North, Kola, and Kanin. The mean temperatures in the main parts of these sections are presented in Table 3.1.1.1, along with historical data back to 1965.

The Fugløya–Bear Island and Vardø–North Sections cover the inflow of Atlantic and Coastal water masses from the Norwegian Sea to the Barents Sea. In 2014 the Vardø–North Section was sampled northwards until reaching the ice. The mean Atlantic Water (50–200 m) temperature in the Fugløya–Bear Island Section was 0.2°C higher than the long-term mean for the period 1965–2014 (Table 3.1.1.1). Going further east to the Vardø–North Section, the mean Atlantic Water (50–200 m) temperature anomaly increased and reached 0.9°C. The Fugløya-Bear Island section show a temperature decrease compared to 2013 while the Vardø-North section show a weak temperature increase compared to 2013.

The Kola and Kanin Sections cover the flow of Coastal and Atlantic waters in the southern Barents Sea. In August 2014, the mean temperature in the upper 50 m along the Kola Section was 0.4–1.0°C higher than the average for the period 1951–2010 but 0.7–1.7°C lower than in 2013. In the intermediate waters (50–200 m), temperature anomalies increased from values close to normal in the inner part of the section up to 1.0°C in the outer part. Compared to the previous year, Coastal waters in the 50-200 m were 0.6°C colder whereas Atlantic waters in the same layer were as warm as in 2013 in the central part of the Kola Section and 0.6°C warmer in the outer part. The shallow inner part of the Kanin Section had a temperature of 4.5°C in the 0–bottom layer, that was close to the long-term mean for the period 1965–2014 and 1.0°C lower than in 2013 (Table 3.1.1.1). The outer part had a temperature of 4.1°C in the 0–200 m, that was 0.6°C higher than the long-term mean for the period 1965–2014 and 0.5°C lower than in 2013 (Table 3.1.1.1).

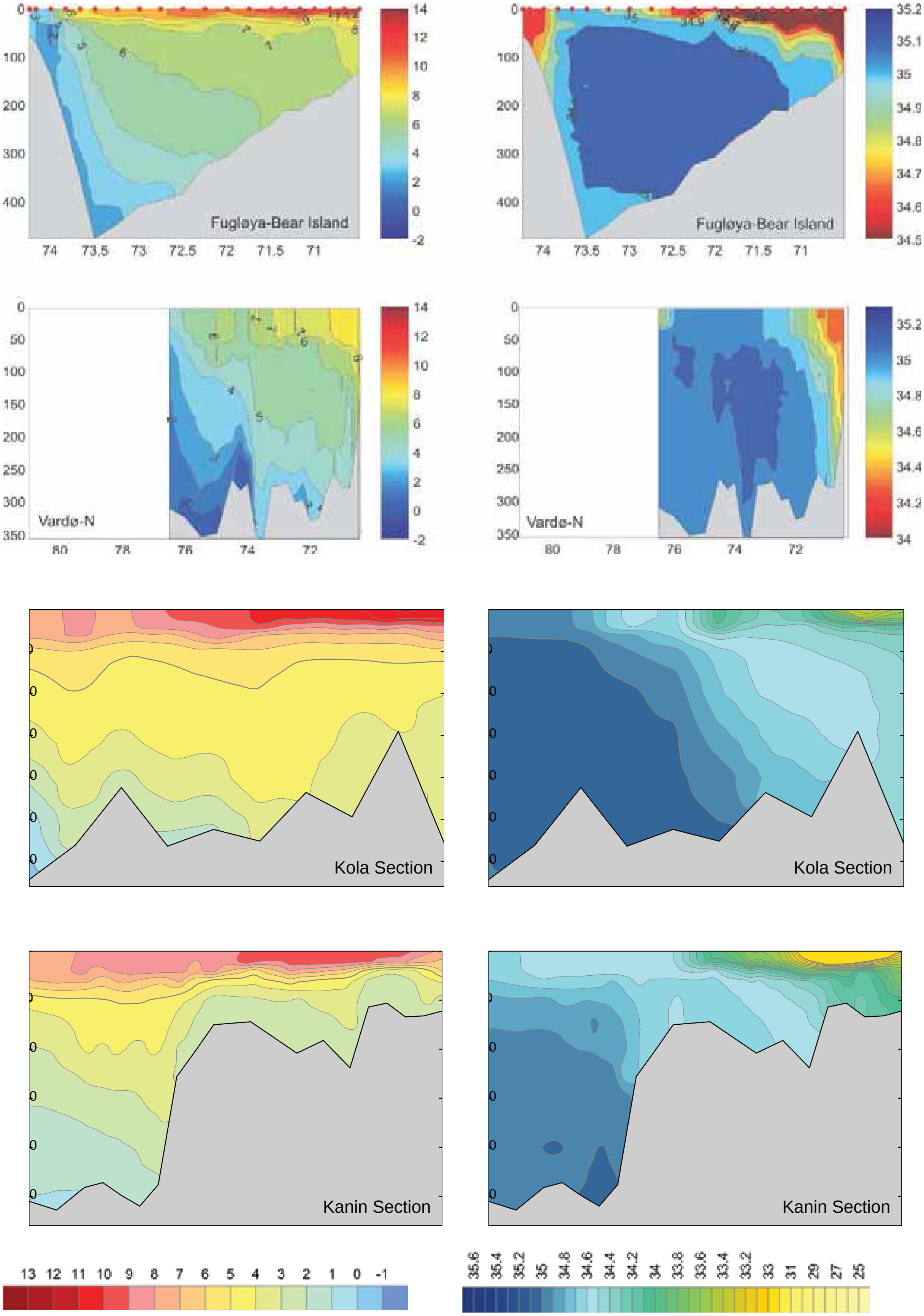


Figure 3.1.1.1. Temperature (°C, left panels) and salinity (right panels) along oceanographic sections in August–October 2014

Table 3.1.1.1. Mean water temperatures in the main parts of standard oceanographic sections in the Barents Sea and adjacent waters in August–September 1965–2014. The sections are: Kola (70º30´N – 72º30´N, 33º30´E), Kanin S (68º45´N – 70º05´N, 43º15´E), Kanin N (71º00´N – 72º00´N, 43º15´E), North Cape – Bear Island (NCBI, 71º33´N, 25º02´E – 73º35´N, 20º46´E), Bear Island – West (BIW, 74º30´N, 06º34´E – 15º55´E), Vardø – North (VN, 72º15´N – 74º15´N, 31º13´E) and Fugløya – Bear Island (FBI, 71º30´N, 19º48´E – 73º30´N, 19º20´E)

Year	Section and layer (depth in metres)								
	Kola	Kola	Kola	Kanin S	Kanin N	NCBI	BIW	VN	FBI
	0–50	50–200	0–200	0–bot.	0–bot.	0–200	0–200	50–200	50–200
1965	6.7	3.9	4.6	4.6	3.7	5.1	-	3.8	5.2
1966	6.7	2.6	3.6	1.9	2.2	5.5	3.6	3.2	5.3
1967	7.5	4.0	4.9	6.1	3.4	5.6	4.2	4.4	6.3
1968	6.4	3.7	4.4	4.7	2.8	5.4	4.0	3.4	5.0
1969	6.7	3.1	4.0	2.6	2.0	6.0	4.2	3.8	6.3
1970	7.8	3.7	4.7	4.0	3.3	6.1	-	4.1	5.6
1971	7.1	3.2	4.2	4.0	3.2	5.7	4.2	3.8	5.6
1972	8.7	4.0	5.2	5.1	4.1	6.3	3.9	4.6	6.1
1973	7.7	4.5	5.3	5.7	4.2	5.9	5.0	4.9	5.7
1974	8.1	3.9	4.9	4.6	3.5	6.1	4.9	4.3	5.8
1975	7.0	4.6	5.2	5.6	3.6	5.7	4.9	4.5	5.7
1976	8.1	4.0	5.0	4.9	4.4	5.6	4.8	4.4	5.8
1977	6.9	3.4	4.3	4.1	2.9	4.9	4.0	3.6	4.9
1978	6.6	2.5	3.6	2.4	1.7	5.0	4.1	3.2	4.9
1979	6.5	2.9	3.8	2.0	1.4	5.3	4.4	3.6	4.7
1980	7.4	3.5	4.5	3.3	3.0	5.7	4.9	3.7	5.5
1981	6.6	2.7	3.7	2.7	2.2	5.3	4.4	3.4	5.3
1982	7.1	4.0	4.8	4.5	2.8	5.8	4.9	4.1	6.0
1983	8.1	4.8	5.6	5.1	4.2	6.3	5.1	4.8	6.1
1984	7.7	4.1	5.0	4.5	3.6	5.9	5.0	4.2	5.7
1985	7.1	3.5	4.4	3.4	3.4	5.3	4.6	3.7	5.6
1986	7.5	3.5	4.5	3.9	3.2	5.8	4.4	3.8	5.5
1987	6.2	3.3	4.0	2.7	2.5	5.2	3.9	3.5	5.1
1988	7.0	3.7	4.5	3.8	2.9	5.5	4.2	3.8	5.7
1989	8.6	4.8	5.8	6.5	4.3	6.9	4.9	5.1	6.2
1990	8.1	4.4	5.3	5.0	3.9	6.3	5.7	5.0	6.3
1991	7.7	4.5	5.3	4.8	4.2	6.0	5.4	4.8	6.2
1992	7.5	4.6	5.3	5.0	4.0	6.1	5.0	4.6	6.1
1993	7.5	4.0	4.9	4.4	3.4	5.8	5.4	4.2	5.8
1994	7.7	3.9	4.8	4.6	3.4	6.4	5.3	4.8	5.9
1995	7.6	4.9	5.6	5.9	4.3	6.1	5.2	4.6	6.1
1996	7.6	3.7	4.7	5.2	2.9	5.8	4.7	3.7	5.7
1997	7.3	3.4	4.4	4.2	2.8	5.6	4.1	4.0	5.4
1998	8.4	3.4	4.7	2.1	1.9	6.0	-	3.9	5.8
1999	7.4	3.8	4.7	3.8	3.1	6.2	5.3	4.8	6.1
2000	7.6	4.5	5.3	5.8	4.1	5.7	5.1	4.2	5.8
2001	6.9	4.0	4.7	5.6	4.0	5.7	4.9	4.2	5.9
2002	8.6	4.8	5.8	4.0	3.7	-	5.4	4.6	6.5
2003	7.2	4.0	4.8	4.2	3.3	-	-	4.7	6.2
2004	9.0	4.7	5.7	5.0	4.2	-	5.8	4.8	6.4
2005	8.0	4.4	5.3	5.2	3.8	6.7	-	5.0	6.2
2006	8.3	5.3	6.1	6.1	4.5	-	5.8	5.3	6.9
2007	8.2	4.6	5.5	4.9	4.3	6.9	5.6	4.9	6.5
2008	6.9	4.6	5.2	4.2	4.0	6.2	5.1	4.8	6.4
2009	7.2	4.3	5.0	-	4.3	-	-	5.2	6.4
2010	7.8	4.7	5.5	4.9	4.5	-	5.4	-	6.2
2011	7.6	4.0	4.9	5.0	3.8	-	-	5.1	6.4
2012	8.2	5.3	6.0	6.2	5.2	-	-	5.7	6.4
2013	8.8	4.6	5.6	5.5	4.6	-	5.6	5.0	6.3
2014	8.0	4.6	5.4	4.5	4.1	-	-	5.2	6.1
Average 1965–2014	7.5	4.0	4.9	4.5	3.5	5.8	4.8	4.3	5.9

3.2.2 Spatial variation

Horizontal distributions of temperature and salinity are shown for depths of 0, 50, 100 m and near the bottom in Figs 3.1.2.1 – 3.1.2.8, and anomalies of temperature and salinity at the surface and near the bottom are presented in Figs 3.1.2.9 – 3.1.2.12. Anomalies have been calculated using the long-term means for the period 1929–2007.

The surface temperatures were higher (on average by 0.5–1.3°C) than the long-term mean in most of the Barents Sea. Negative anomalies (0.4–0.9°C) were only found in the north-eastern sea (Fig. 3.1.2.9). Compared to 2013, the surface temperatures were much lower (by 1.5–3.0°C) all over the Barents Sea, especially in its eastern and northern parts. Only in the south-western sea, the temperatures were close to or slightly (by 0.2–0.4°C) higher than those in the previous year.

Arctic waters were, as usual, most dominant in the 50 m depth layer north of 76°N (Fig. 3.1.2.3). The temperatures were mainly higher than the long-term mean (by 0.6–1.4°C). Small negative anomalies (0.1–0.5°C) were found in some areas in the northern and south-western Barents Sea. Compared to 2013, the 50 m temperatures were mainly higher (by 0.2–0.8°C) in the central, south-eastern and north-western Barents Sea. Negative differences (0.4–1.3°C) in temperature between 2014 and 2013 prevailed in the south-western and north-eastern parts of the sea. In 2014, the area occupied by water with temperatures below –1°C was larger than in the previous year.

The temperatures at the depths below 100 m were in general above the average (by 0.5–1.1°C) throughout the Barents Sea (Fig. 3.1.2.10). Compared to 2013, the temperatures were mainly higher (by 0.2–0.6°C) in the central, south-eastern and north-western Barents Sea. Negative differences (0.3–0.8°C) in temperature between 2014 and 2013 prevailed in the south-western, northern and north-eastern parts of the sea. In 2014, the area occupied by water with temperatures below zero was close to that in the previous year. The high temperature in the Barents Sea is mostly due to the inflow of water masses with high temperatures from the Norwegian Sea.

The surface salinities were 0.2–0.6 higher than the long-term mean in most of the Barents Sea (Fig. 3.1.2.11). Negative anomalies (0.1–0.4) were found in the southern Barents Sea as a wide "road" south of 73°N and in the northern part of the sea near the ice edge which took place between 78° and 80°N in August–September 2014. The salinities at the depths below 50 m were slightly higher (by up to 0.1) than the average all over the Barents Sea (Fig. 3.1.2.12). Small negative anomalies were only found in some areas in the southern and south-eastern Barents Sea. Compared to 2013, the surface salinities were mainly lower (by 0.1–0.5) with the largest negative differences in the south-eastern and northern Barents Sea. Positive differences (0.1–0.3) in salinity between 2014 and 2013 prevailed in the western part of the sea, namely north of 73°N and west of 30°E. At a depth of 50 m, the salinities were slightly higher than in 2013 in the western part of the Barents Sea, and slightly lower – in the eastern part. At the depths below 100 m, the salinities were in general close to those in 2013.

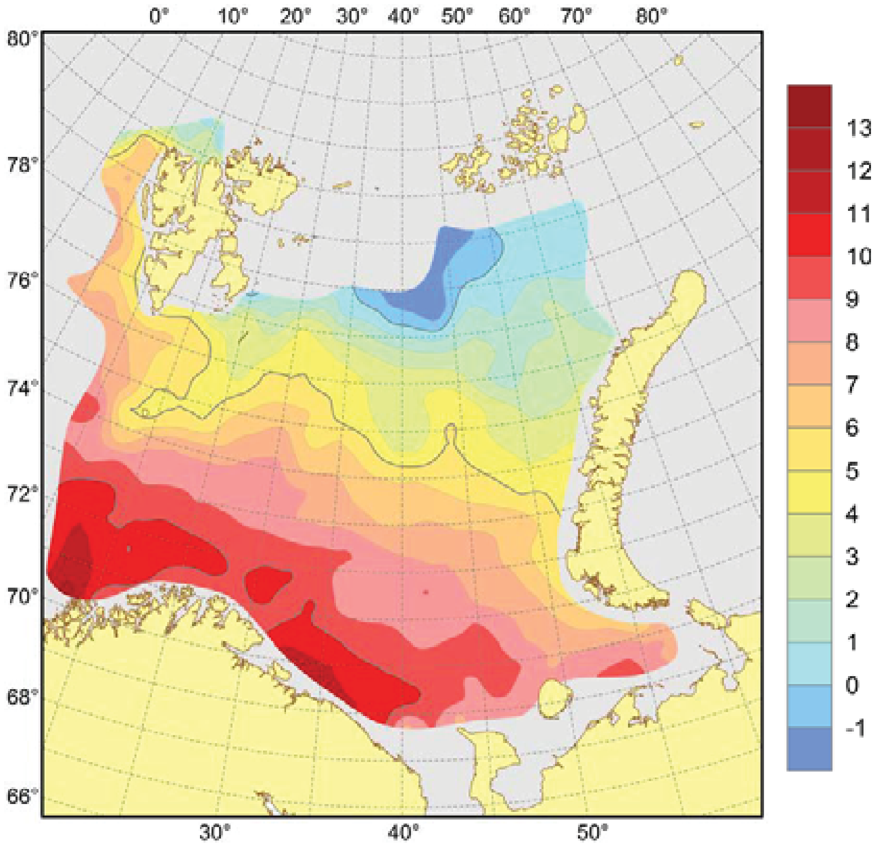


Figure 3.1.2.1. Distribution of surface temperature (°C), August– October 2014

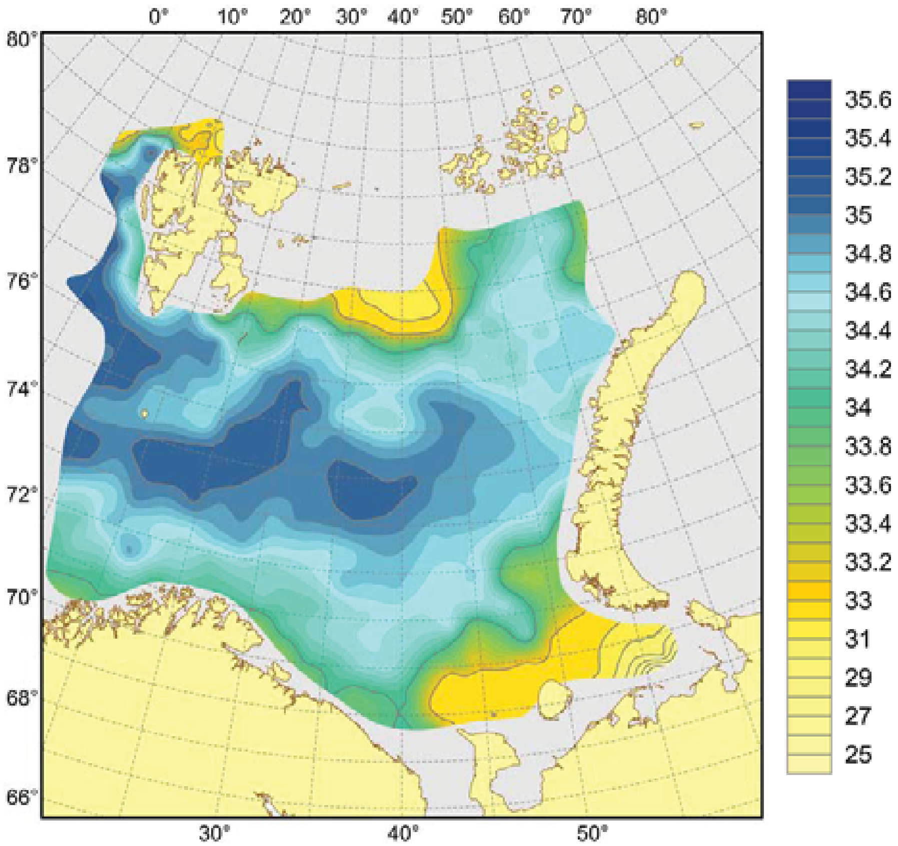


Figure 3.1.2.2. Distribution of surface salinity, August– October 2014

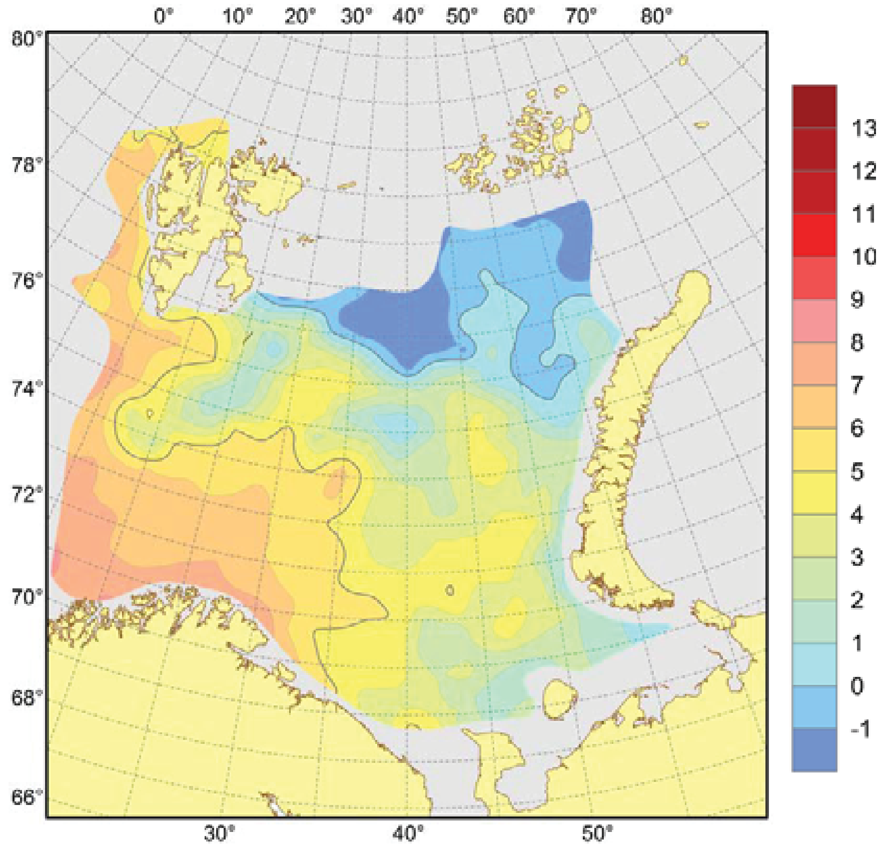


Figure 3.1.2.3. Distribution of temperature (°C) at the 50 m depth, August– October 2014

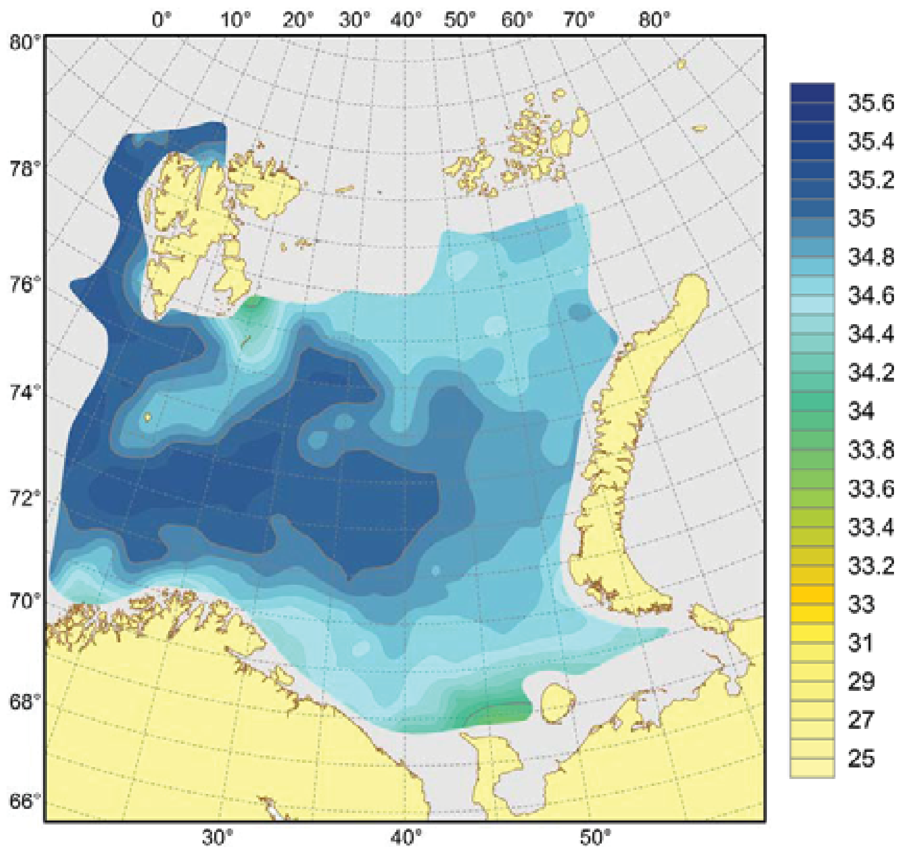


Figure 3.1.2.4. Distribution of salinity at the 50 m depth, August–October 2014

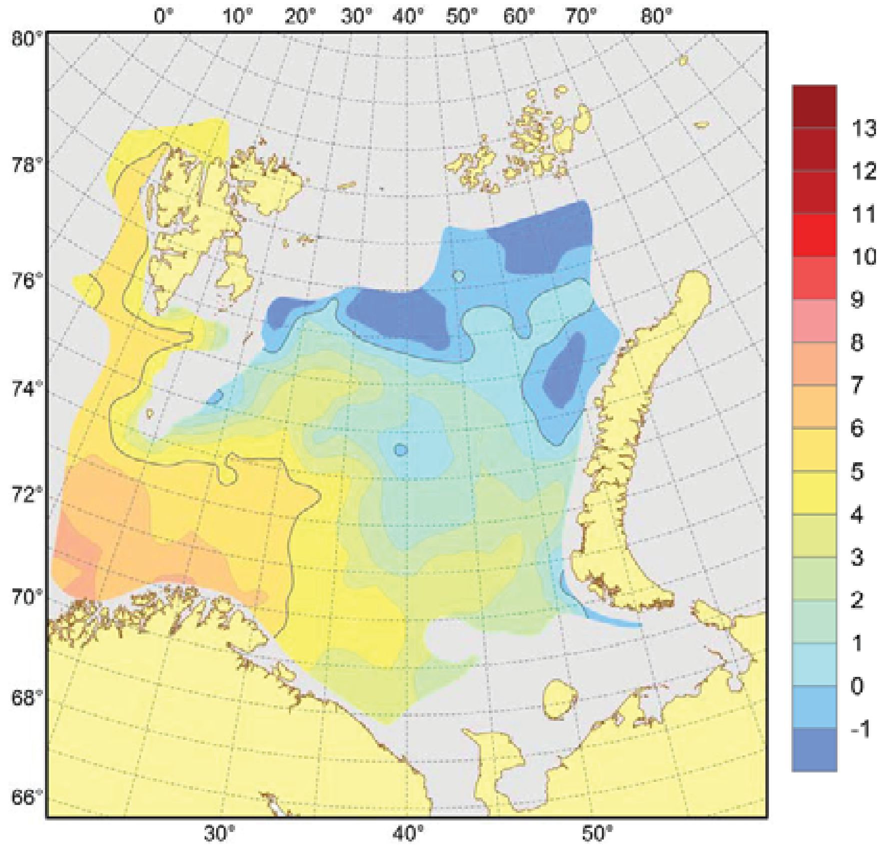


Figure 3.1.2.5. Distribution of temperature (°C) at the 100 m depth, August–October 2014

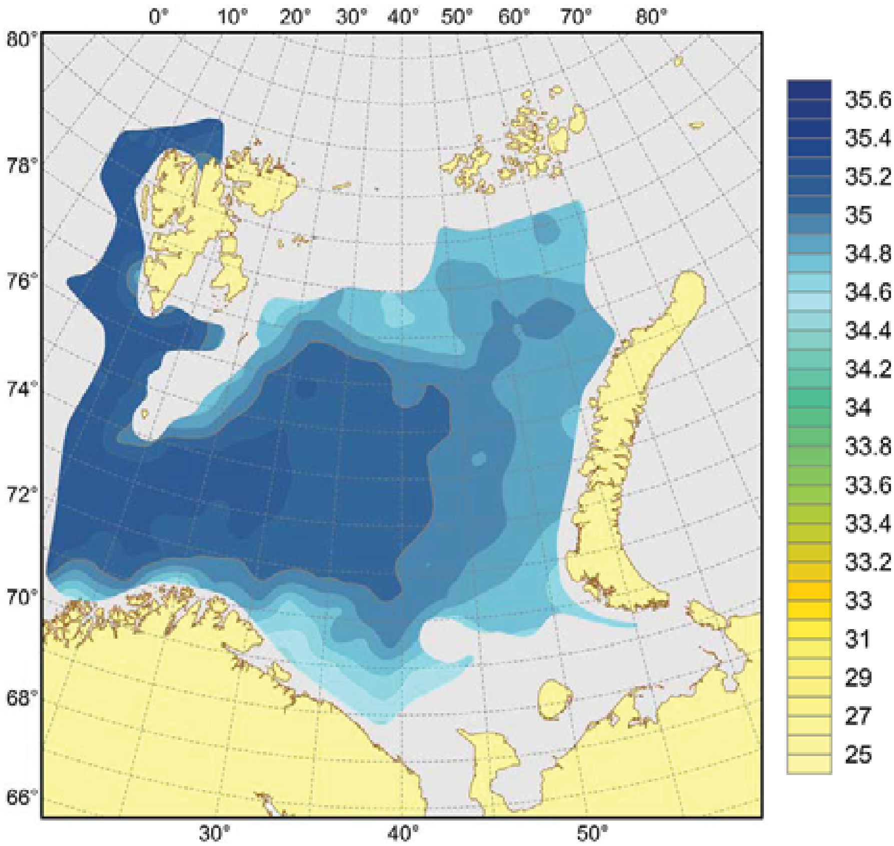


Figure 3.1.2.6. Distribution of salinity at the 100 m depth, August– October 2014

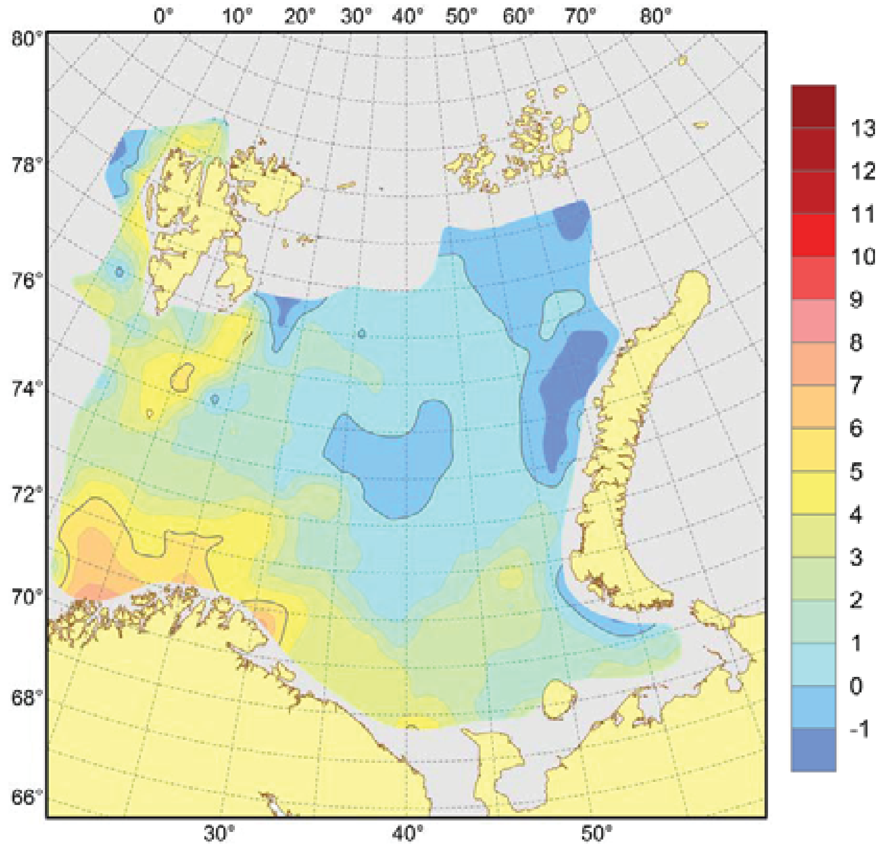


Figure 3.1.2.7. Distribution of temperature (°C) at the bottom, August– October 2014

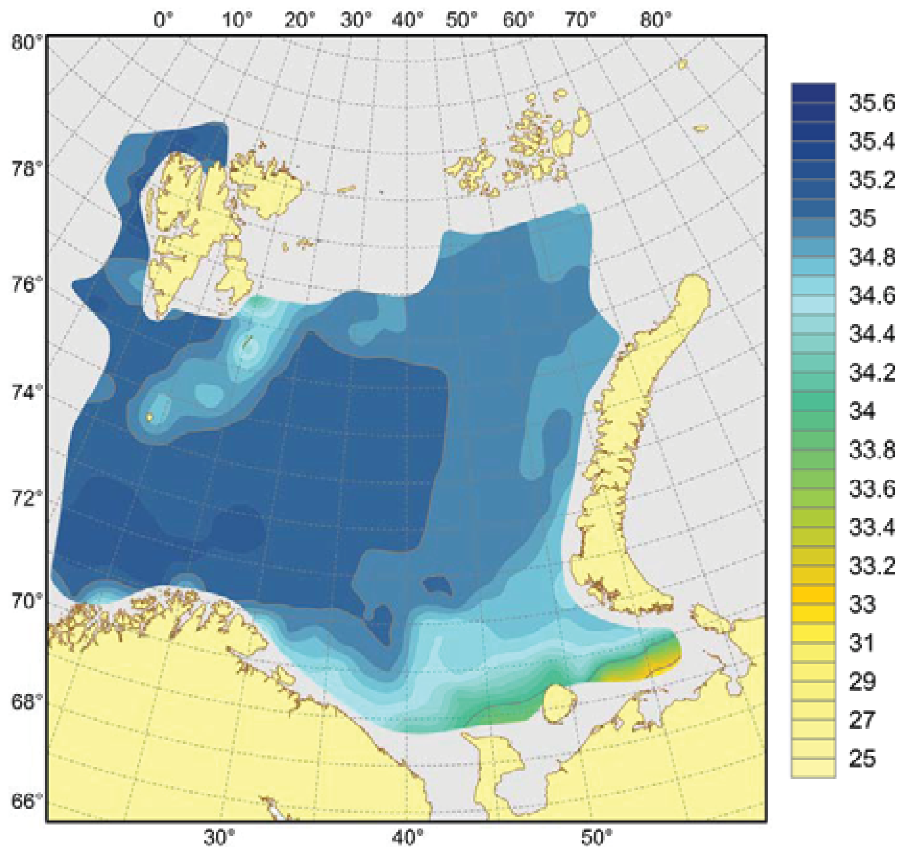


Figure 3.1.2.8. Distribution of salinity at the bottom, August– October 2014

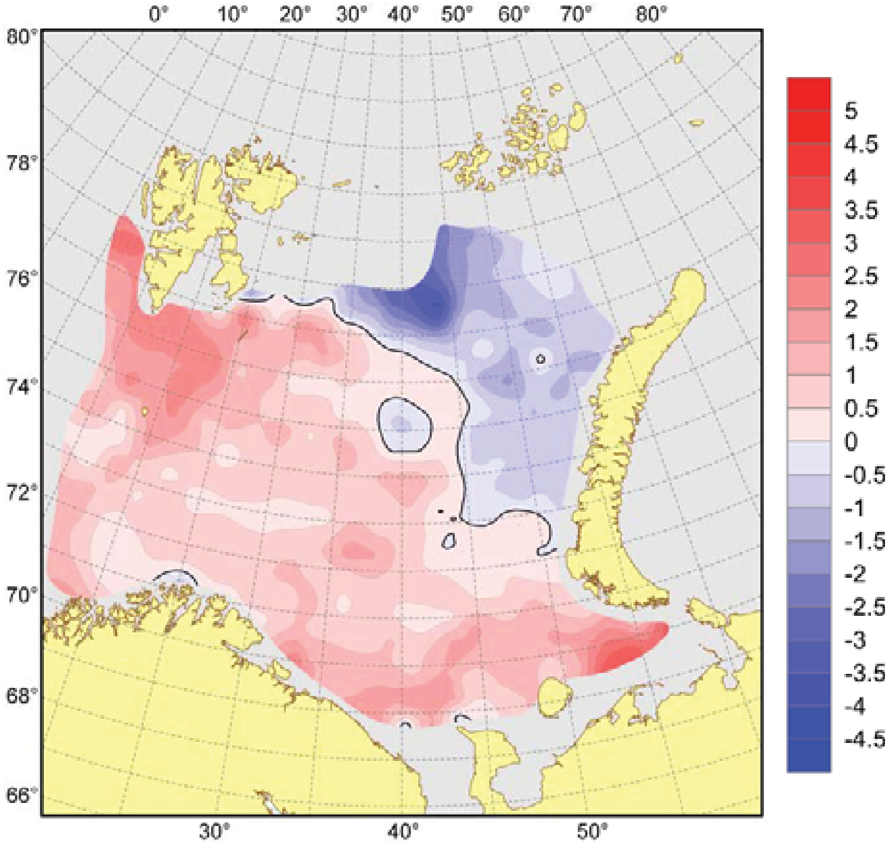


Figure 3.1.2.9. Surface temperature anomalies (°C), August– October 2014

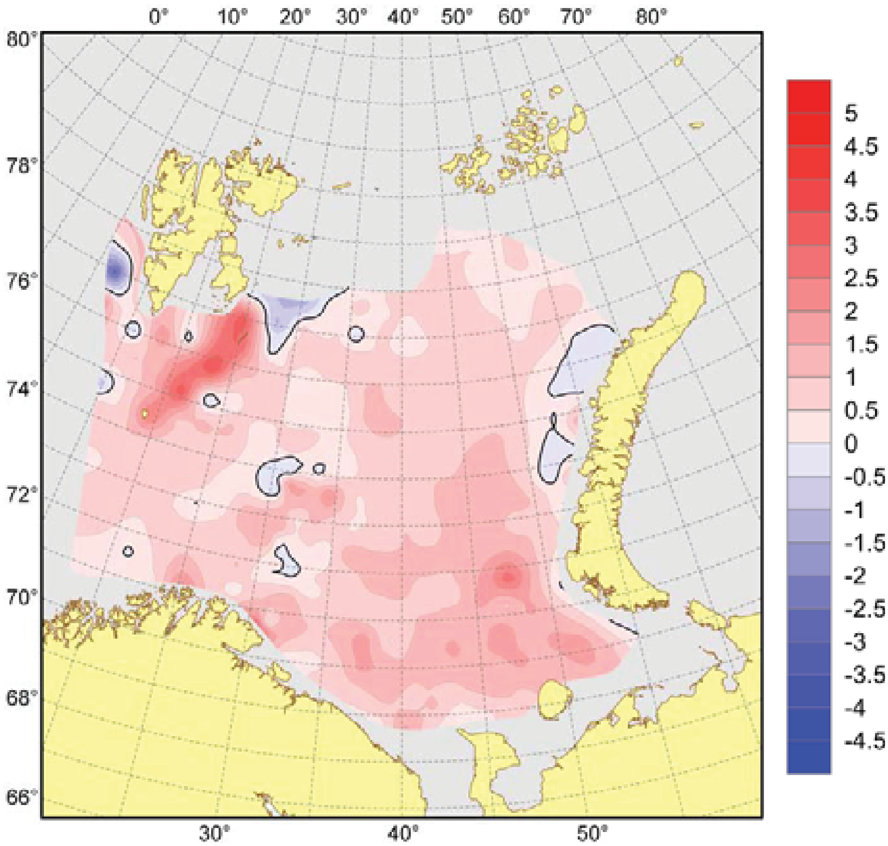


Figure 3.1.2.10. Temperature anomalies (°C) at the bottom, August– October 2014

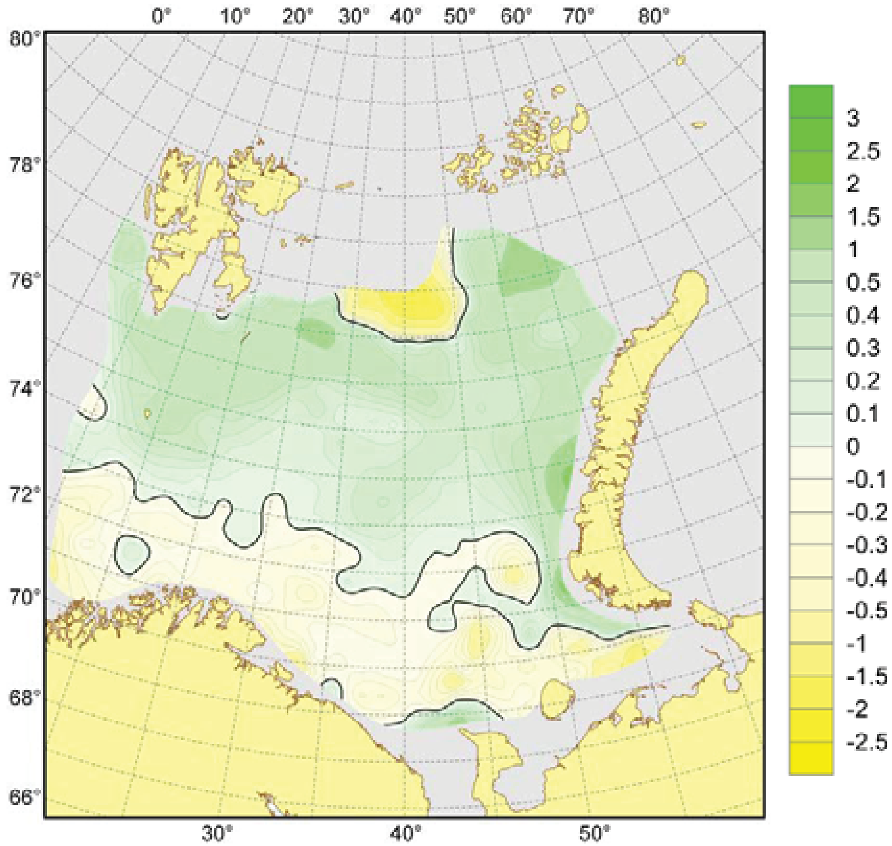


Figure 3.1.2.11. Surface salinity anomalies, August– October 2014

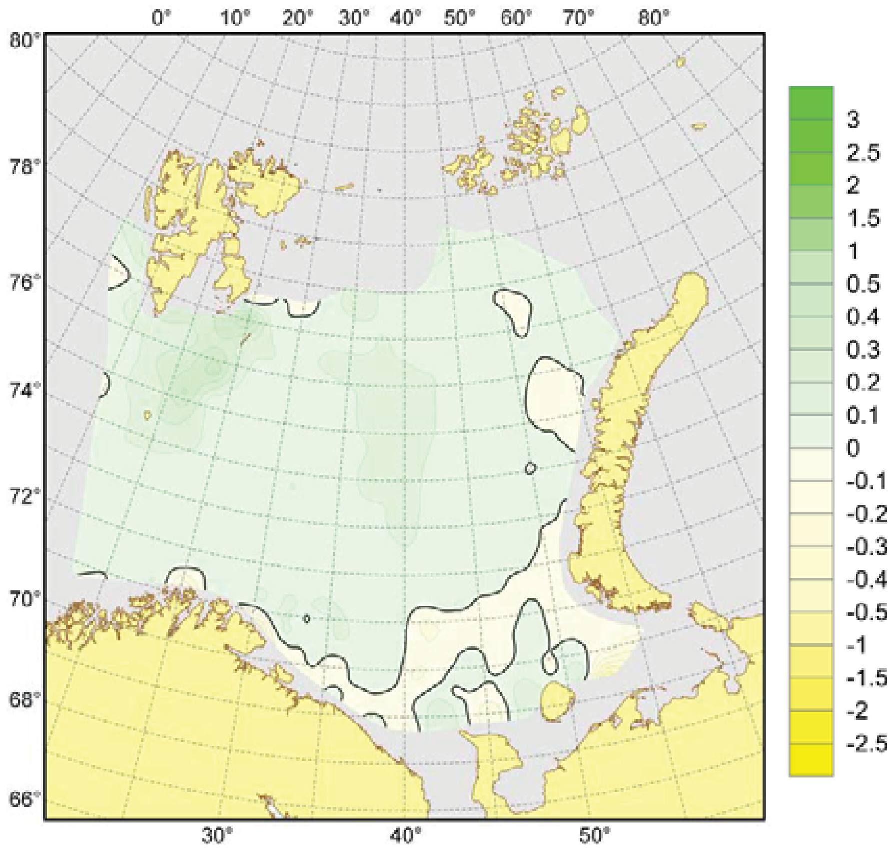


Figure 3.1.2.12. Salinity anomalies at the bottom, August–October 2014

3.2 Pollution

3.2.1 Anthropogenic matter

Text by T. Prokhorova
Figures by P. Krivosheya

Floating anthropogenic matter was observed only on the Russian research vessel «Vilnyus» during the survey. Anthropogenic matter, taken by pelagic and bottom trawls, were registered at all stations by both Russian and Norwegian vessels.

As in the previous years, visual observations showed that the surface is most polluted in areas of intensive fishery and navigation.

Plastic litter were dominated among natant garbage, as usual. (Figure 3.2.2.1). Floating garbage was distributed mostly along the main ocean currents. Floating garbage was mostly distributed along the main ocean currents. So, it might be entered the Barents Sea by ocean currents and winds or dumped directly in the sea from ships. Floating timbers were observed in the south part of the Barents Sea and compared to the previous year were absent in the central part of the Sea in 2014. Metal and paper were observed among floating garbage singly. Oil spot 300 m in diameter was found at the surface north of the Kolguev Island.

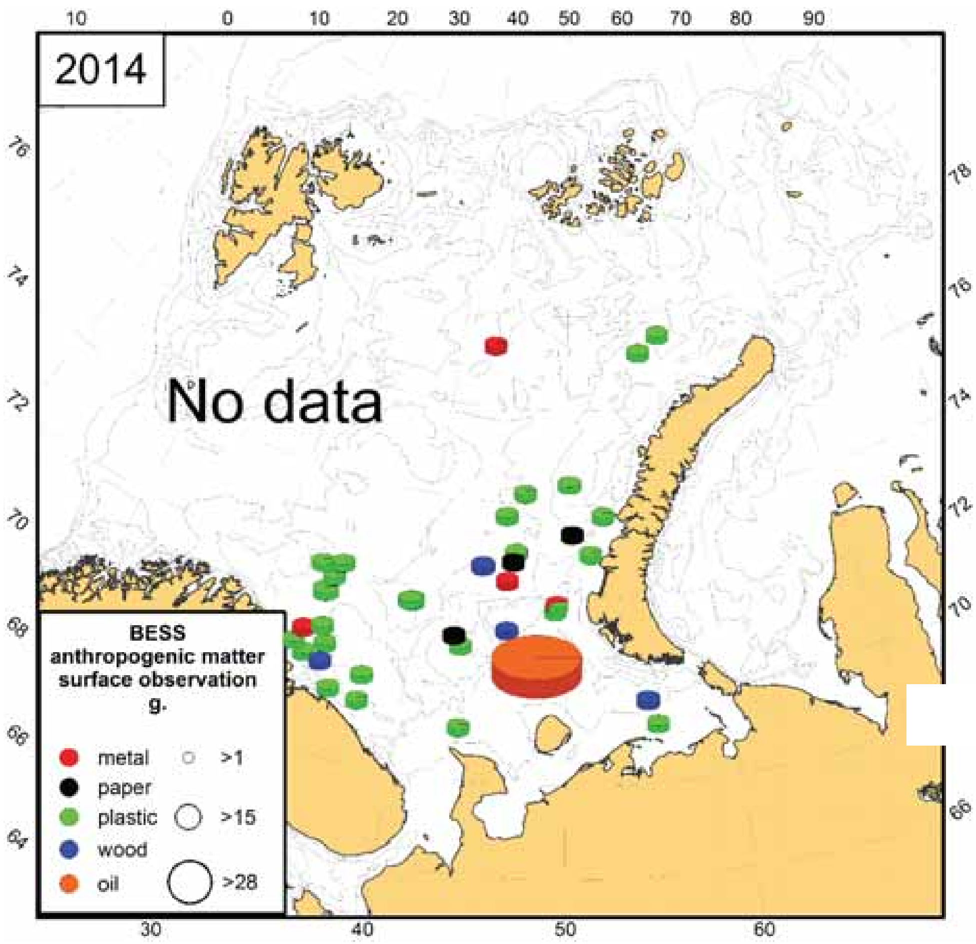


Figure 3.2.2.1. Type of observed anthropogenic matter (m^3) at the surface in the Barents Sea in August–October 2014.

Plastic litter was also dominated among man-made garbage in trawl catches, as in previous years (2010-2013) (Figure 3.2.2.2, 3.2.2.3). The number of pelagic stations, where pollutants were registered, increased in the western part of the Barents Sea and decreased along the Murman coast comparing with the previous years (Figure 3.2.2.2). It should be noted that catchability rate for polymer materials of low density is very low for pelagic trawl is low, and therefore amount of the anthropogenic garbage in the Barents Sea may be larger than that observed during the survey. Metal garbage was observed only at one station and textiles at two stations.

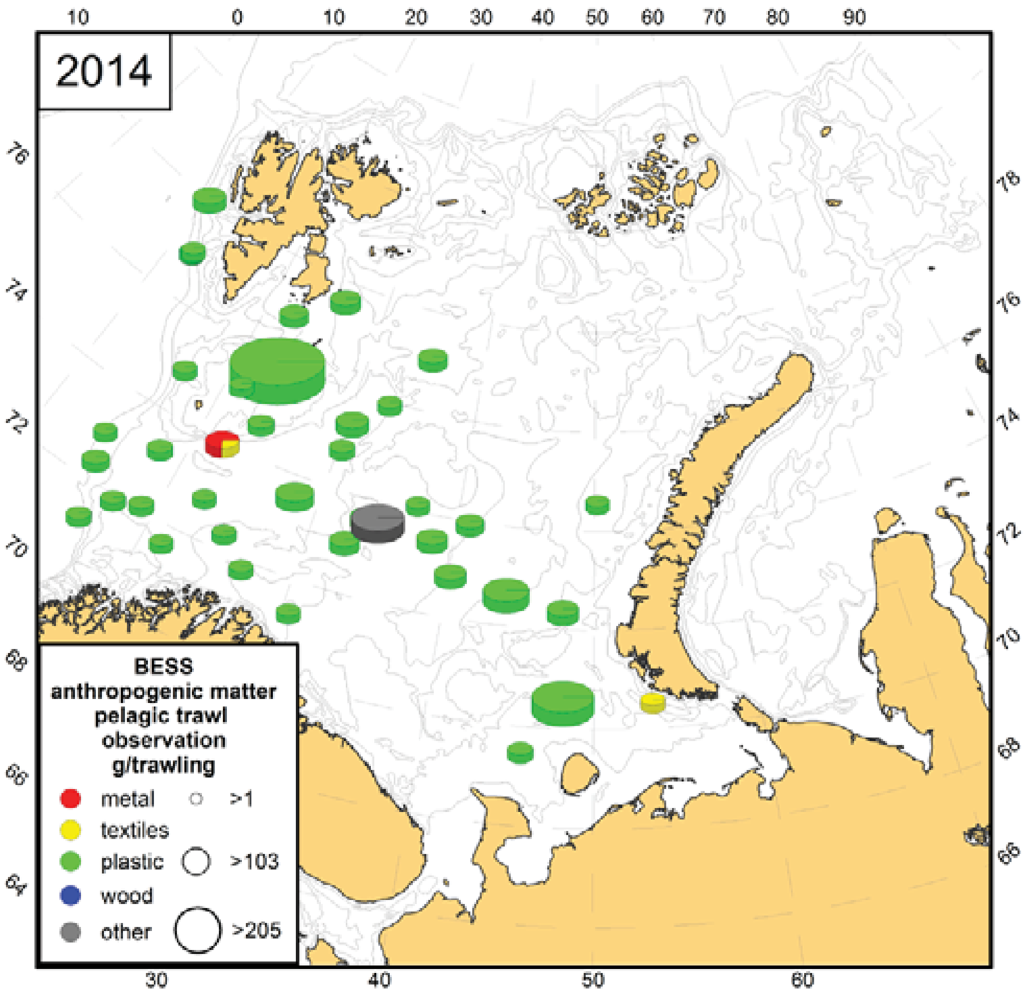


Figure 3.2.2.2. Types of garbage collected in the pelagic trawls (g) in the Barents Sea in August–October 2014.

Plastic litter was dominated in the bottom catches also (Figure 3.2.2.3). In 2014, no man-made pollutants were found in pelagic and bottom catches along the Murman coast, but they were found in previous years. Wood was found only in the two bottom stations north-west and west of the Novaya Zemlya. Wood were dominated in the bottom catches among the man-made pollutants in the southwest Barents Sea in 2010-2013, but some few observation of low value were done in 2014. Metal and textiles were observed in the bottom catches sporadically.
Pollutants, which are potentially dangerous for the marine environment were not registered in 2014. Only inactive pollutants, which are not directly harmful for the environment, were found. However, big lumps of threads, lines and nets were found during the survey. Fishing gear or part of them effect negatively both demersal fish and bottom organisms due to they are still the capable to capture organisms after they have been lost.

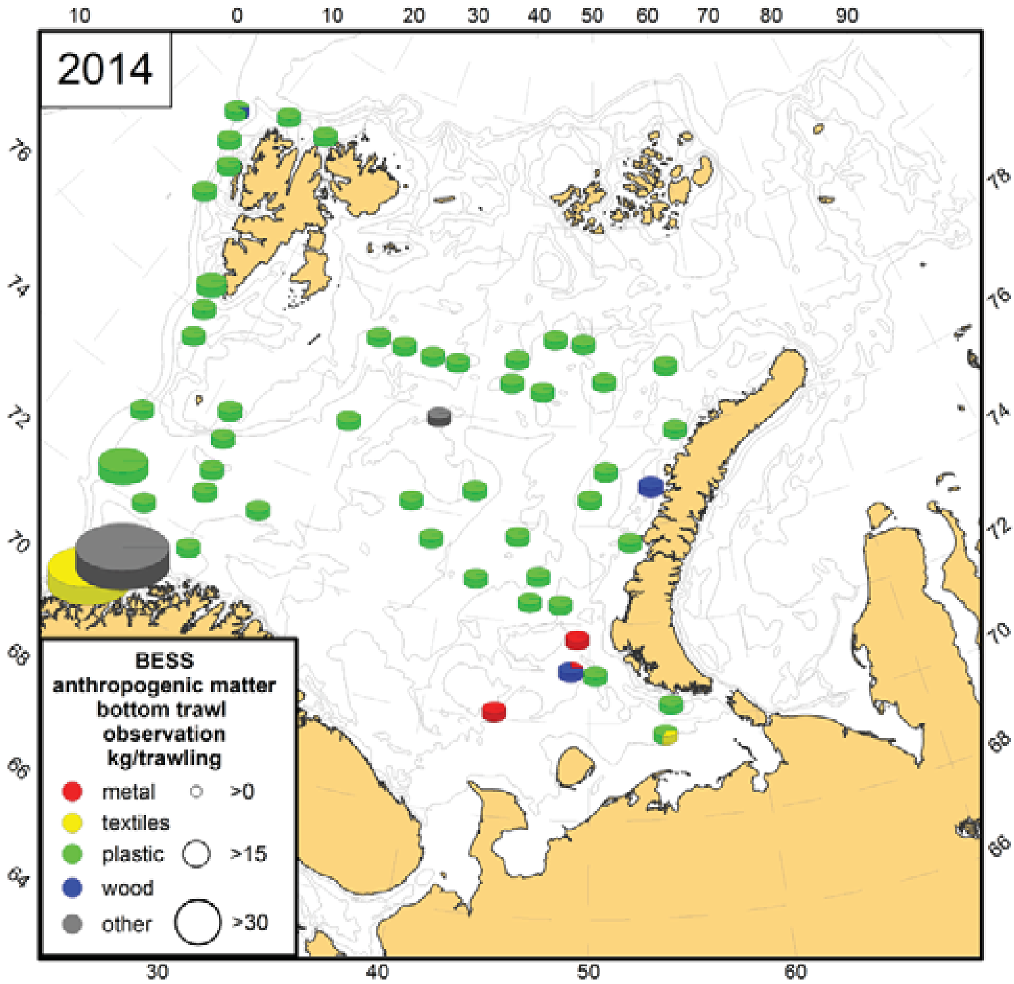


Figure 3.2.2.3. Types of garbage collected in the bottom trawls (g) in the Barents Sea in August–October.

4 Monitoring the plankton community

4.1 Nutrients and chlorophyll a

No results available. Take contact with responsible scientific group at IMR and PINRO.

4.2 Phytoplankton

No results available. Take contact with responsible scientific group at IMR and PINRO.

4.3 Zooplankton

4.3.1 Calanus composition at the Fufløya-Bear Island (FB) transect

Text and figures by P. Dalpadado and J. Rønning

The stations in the FB transect are taken at fixed positions located at the western entrance to the Barents Sea. The numbers of sampled stations are normally 5 to 8 depending on weather conditions. In this report, four stations, representing different water masses (coastal; Atlantic; and mixed Atlantic/Arctic water) from 1995 to 2014, have been analyzed for species composition of the three most abundant species *Calanus finmarchicus*, *C. glacialis* and C. hyperboreus. In addition, we have also examined the proportion of *C. finmarchicus* and *C. helgolandicus* (Stage V and adults) in the samples.

C. helgolandicus is quite similar in appearance especially to *C. finmarchicus*, but is a more southerly species with a different spawning period. *C. helgolandicus* has in recent years become more frequent in the North Sea and southern parts of the Norwegian Sea (Svinøy transect), and it is expected that it could potentially increase its abundance in the western part of the Barents Sea in the years to come. Results so far seem to indicate that the abundance of *C. helgolandicus* at the western entrance to the Barents Sea is rather low and has remained more or less unchanged during the study period (not shown).

Though *C. finmarchicus* display inter-annual variations in abundance, comparison of abundance during three periods shows somewhat stable values, with the latter period having a slight increase. (Figure 4.3.1.1, Table 4.3.1.1). The highest abundances of *C. finmarchicus* were recorded in 2010 over the whole transect except for the northernmost locality at 74º00'N, where the abundance was considerably lower (Figure 4.3.1.2). On average over all years since 2004, it is the locality at 73º30'N that shows the highest number of individuals. As expected *C. glacialis* has its highest abundance at the two northernmost stations, localities that are typical of a mixture of Atlantic and Arctic waters. The highest mean abundance (ca 15000 no.m^{-2}) was observed for the year 1997(not shown). The most stable occurrence and the highest average abundance are found at the northernmost locality a 74º00'N having a mixture of Atlantic and Arctic water masses. For *C. glacialis* there seem to be a decrease in abundance since 2007 with very low abundances in 2008, and 2012-2014 (Table 4.3.1.1). The lowest average abundance for *C. glacialis* was recorded during 2007-2014 (328 no.m^{-2}) compared to 2001-2006 (518no.m^{-2}) and 1995-2000 (1890 no.m^{-2}). The lowest average abundance for *C.*

hyperboreus was recorded during 2007-2014 (49 no.m-2) compared to 2001-2006 (177 no.m-2) and 1995-2000 (11 no.m-2).

Table 4.3.1.1. Average abundance of the 3 *Calanus* species (no.m^{-2}) for 3 different periods from 1995 to 2014.

Periode	***C. finmarchicus***	***C. glacialis***	***C. hyperboreus***
1995-2000	27961	1890	110
2001-2006	20421	518	177
2007-2014	35469	328	52

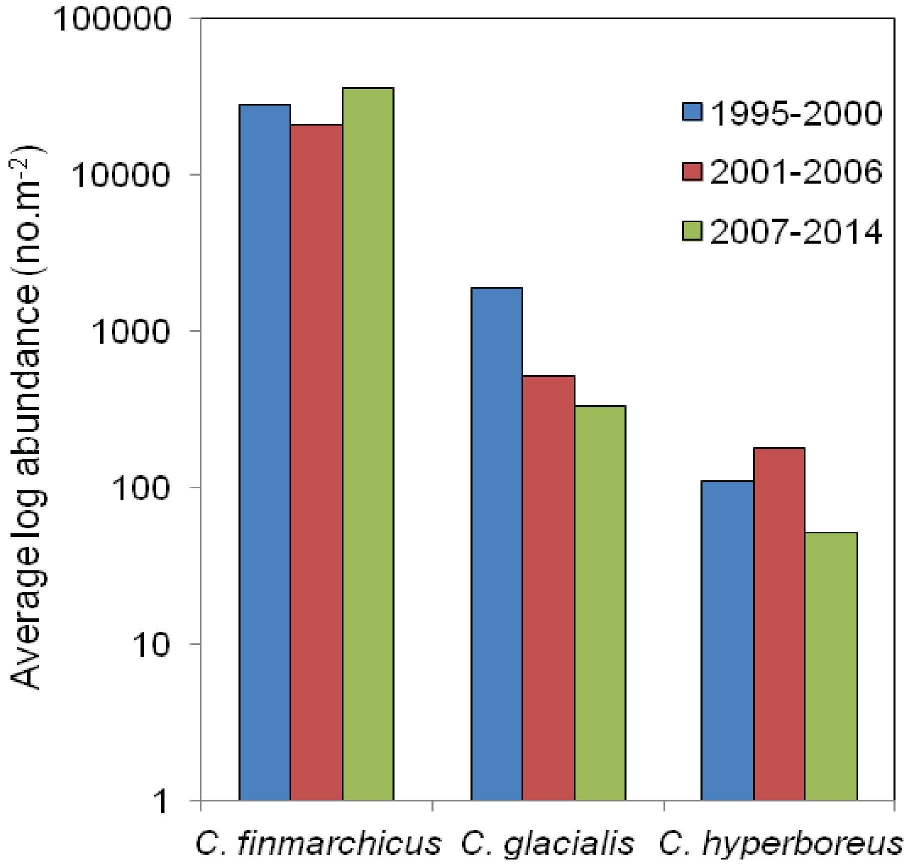


Figure 4.3.1.1. Abundance of *Calanus* species at the FB section during three periods: 1995-2000, 2001-2006 and 2007-2014

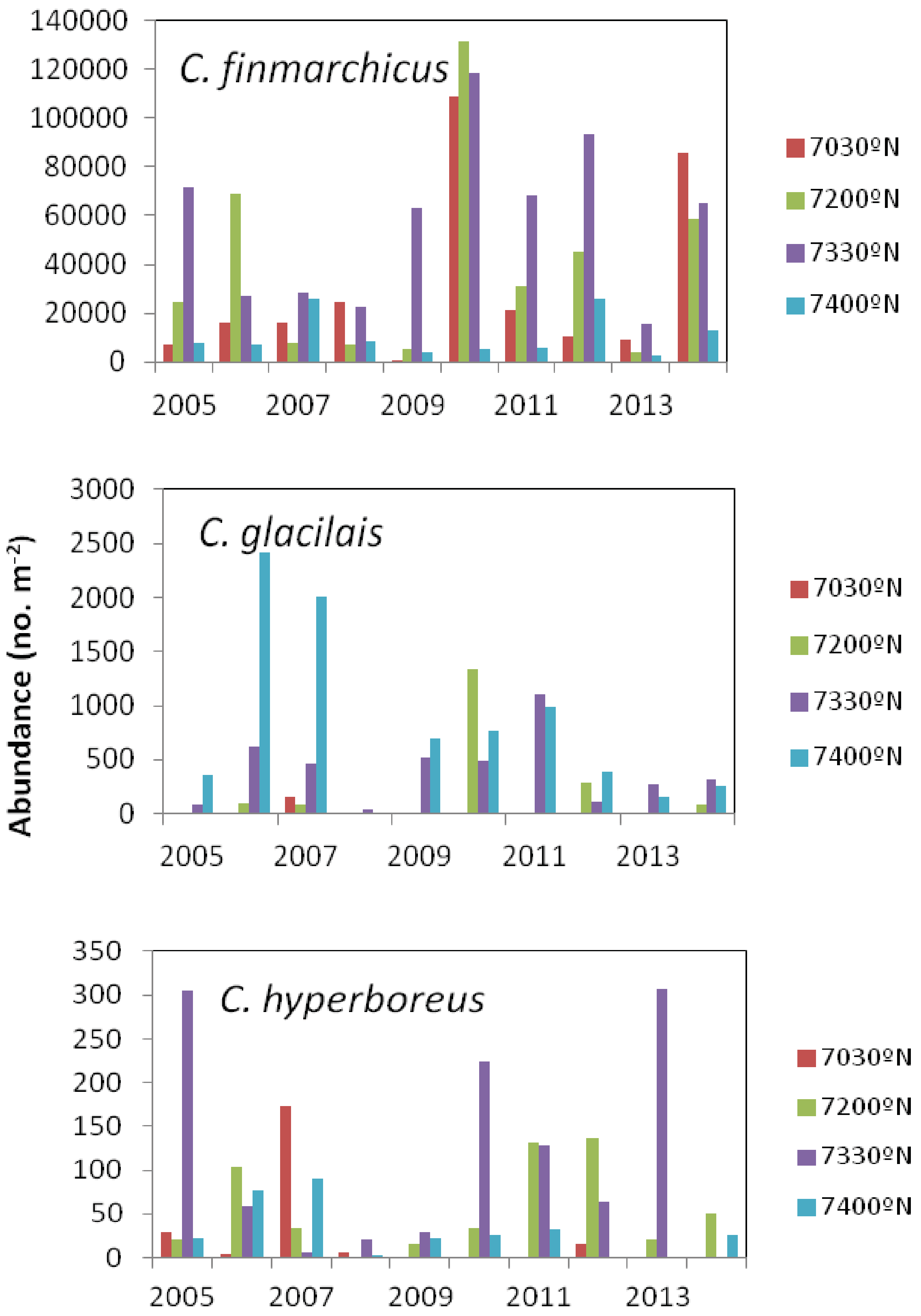


Figure 4.3.1.2. Development of copepod abundance along the FB section during the period 2005 - 2014. On a few occasions, when stations were lacking at a particular position, stations closest to that position were analyzed.

4.3.2 Spatial distribution and biomasses

Text by P. Dalpadado
Figures by P. Dalpadado

IMR sector only, figure and text will be updated when PINRO data are available (most likely in January 2015)

In 2014, MOCNESS sampling intensity was increased. We have excluded sampling from 100- 0m by the WP2 gear and concentrated only in taking bottom to surface samples. In addition, the number of WP2 stations was also reduced to allow more MOCNESS hauls as it provides valuable biomass depth distribution profiles. Previous investigations show that the total zooplankton biomass by the two gears is comparable.

Biomass distribution from autumn 2014 shows (Figure 4.3.2.1) that in general, the values in central and eastern parts monitored by Norway were rather low (< 2 gm^{-2} dry wt.), similar to observed in 2013. However, the biomass in the western and west and north of Svalbard waters was much higher (>10 gm^{-2} dry wt.) in 2014 compared to 2013. The area coverage in the north was somewhat limited due to ice cover during the ecosystem cruise. Results on *Calanus* abundance from the Fugløya-Bjørnøya section from the western entrance to the Barents Sea also seem to indicate a much higher *Calanus finmarchicus* abundance in 2014 compared to 2013. The average biomass in 2014 higher was higher (6.87 gm^{-2} dry wt.) contra 2013 (5.16^{-2} dry wt.).

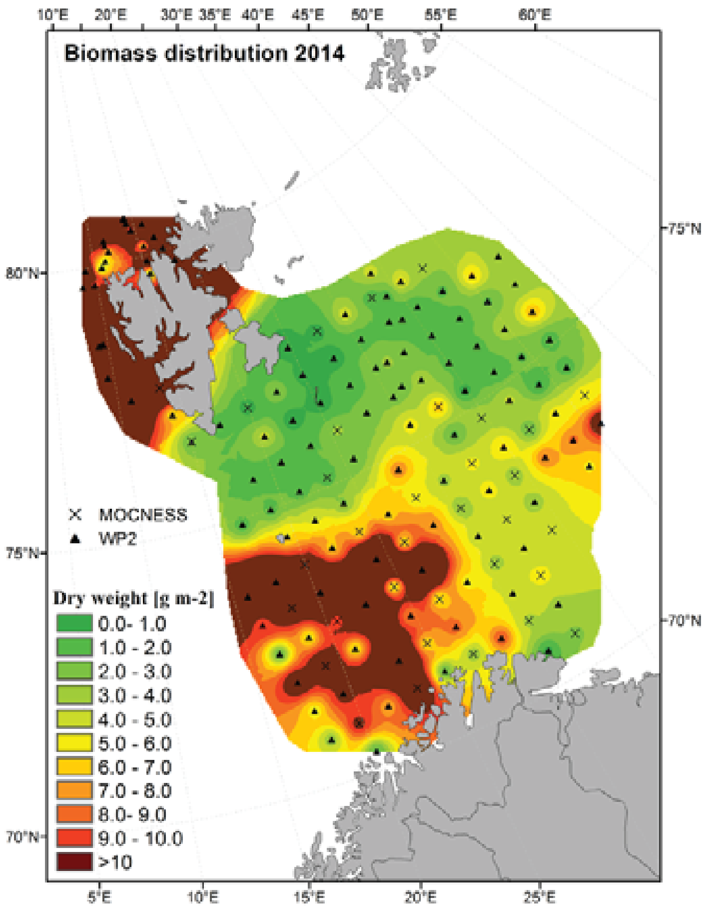


Figure 4.3.2.1. Distribution of zooplankton dry weight (g/m -2) from bottom-0 m in 2014. Data based on Norwegian WP2 samples.

4.3.3 Biomass indices and distribution of krill and amphipods

by E. Eriksen, P. Dalpadado and A. Dolgov
Figure by E. Eriksen

In 2014 the krill and amphipods were species identified on board the Norwegian vessels at 80% of all stations. In 2014 krill were distributed in the western, central areas and north for Svalbard/Spitsbergen (Figure 4.3.3.1). In 2013 the highest catches were mostly distributed in the central area, while in the western area in 2014. The night catches, with average of 4.85 gram per m^2, were lower in 2014 than in 2013 (13.2 gram per m^2). The number of the night stations was half of the day stations during the survey (Table 4.3.3.1). During the night most of krill migrate to upper water layer, and therefore better available for the capturing.

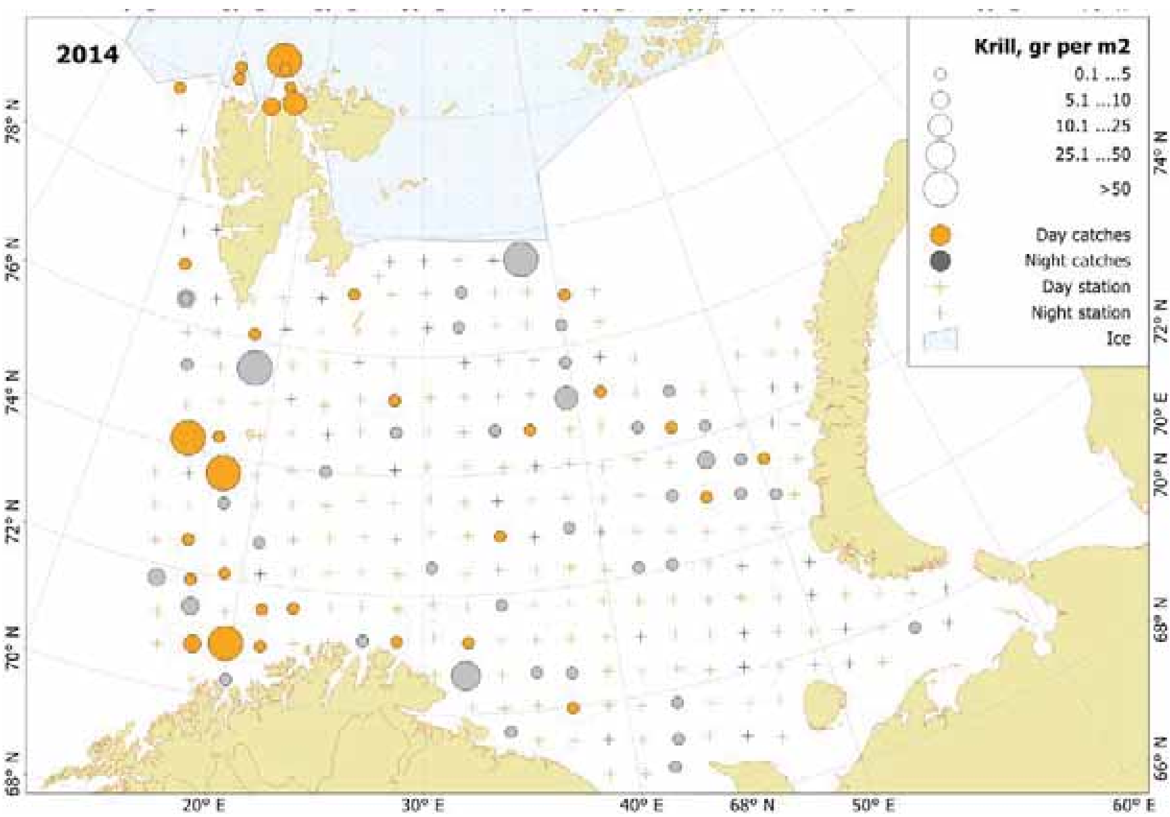


Figure 4.3.3.1. Krill distribution, based on trawl stations covering 0-60m, in the Barents Sea in August-October 2014.

In 2014 the krill were species identified on board the Norwegian vessels at 80% of all stations. *Meganyctiphanes norvegica* were mostly observed in the western and central area, while *Thysanoessa inermis* in the central and northern areas. Outside of continental slope in the western track of surveyed area NEMATOSCELIS were observed at one station (71˚48’ N and 15˚31’E), and Thysanopoda were observed at one station (75˚25’ N and 15˚17’E).

In 2014 the biomass of krill was lower than long term mean (8.7 million tonnes) and was 6.0 million tonnes after the heavy feeding summer season. In 2014 the biomass of krill continued to decrease since 2008.

In 2014, amphipods were found in the western area and north for Svalbard/Spitsbergen (Figure 4.3.3.2). The highest catches were taken north for Svalbard/Spitsbergen, and were mostly represented by *Themisto libebula*, while Themisto com were mostly found in small catches near the Norwegian coast. In 2014 the mean catches taken during the day were higher than night catches, and were 5.8 and 0.3 gram per m^2. In 2012 and 2013 no catches of amphipods were taken.

Table 4.3.3.1. Day and night catches (gram per m^2) of krill taken by the pelagic trawl within 0-60 m.

Year	Day			Night		
	N	Mean gm-2	Std Dev	N	Mean gm-2	Std Dev
1980	237	1.49	11.38	90	4.86	23.96
1981	214	1.19	9.14	83	7.95	21.53
1982	192	0.18	1.19	69	6.29	22.57
1983	203	0.32	2.76	76	0.39	1.91
1984	217	0.15	1.64	66	1.72	9.17
1985	217	0.07	0.54	75	0.80	4.42
1986	229	3.03	11.70	76	11.90	37.82
1987	200	4.90	22.44	88	3.82	13.08
1988	207	2.69	30.16	81	11.84	55.84
1989	296	1.99	8.45	129	3.71	13.01
1990	283	0.11	0.76	115	1.18	6.32
1991	284	0.03	0.33	124	7.03	25.11
1992	229	0.11	1.18	77	0.92	2.92
1993	194	1.21	6.69	79	2.23	7.36
1994	175	3.01	10.23	72	7.27	18.78
1995	166	4.86	18.86	80	9.13	34.46
1996	282	4.34	26.62	118	9.32	21.53
1997	102	4.12	22.71	167	3.58	12.94
1998	176	2.24	16.00	185	5.68	23.95
1999	140	1.50	9.64	90	4.64	13.09
2000	202	1.52	9.53	67	3.54	11.49
2001	212	0.07	0.63	66	5.77	19.60
2003	203	1.26	9.54	74	2.84	11.23
2004	229	0.34	2.94	80	6.49	22.47
2005	314	3.50	30.53	86	9.02	24.78
2006	227	1.23	6.66	103	9.66	31.54
2007	192	1.79	10.93	112	9.04	39.29
2008	199	0.11	1.02	77	16.92	43.57
2009	241	0.42	2.56	131	10.29	25.02
2010	198	1.76	13.00	105	14.98	43.35
2011	212	0.13	0.69	95	19.46	77.70
2012	243	4.00	12.35	84	11.48	34.21
2013	222	0.11	0.88	83	13.23	42.16
2014	196	4.16	27.85	98	4.85	27.36
1980-2014	216	1.70		94	7.11	

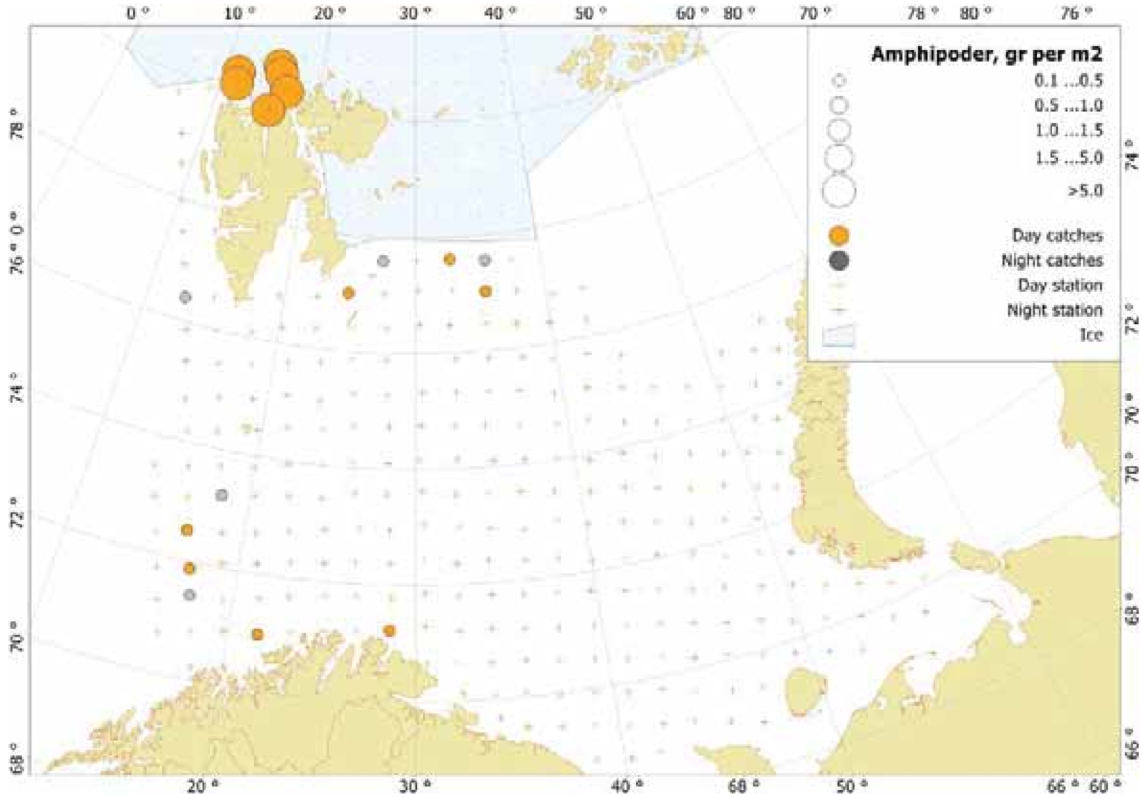


Figure 4.3.3.2. Amphipods distribution, based on trawl stations covering 0-60m, in the Barents Sea in August-October 2014.

4.3.4 Biomass indices and distribution of jellyfish

by Eriksen E., Falkenhaug T., Prokhorova T. and Dolgov A.

In August-September 2014, jellyfish, mostly the Lion's Mane jellyfish (*Cyanea capillata*), were found in the entire studied area of the Barents Sea. Jellyfish biomass increased from southwest to northeast and southeast (Figure 4.3.4.1). It seems that higher surface temperature and wider area of Atlantic Water had a positive influence on the jellyfish biomass and distribution in 2014. The highest catches were taken in the southern, eastern and central areas, and one third of the catches were more than 100 kg per haul, corresponding to about 50 tonnes per nautical mile.

The calculated jellyfish biomass, mostly *Cyanea capillata,* caught by pelagic trawls at 0-60 m depth was 4.8 million tonnes in the Barents Sea in August-September 2014 (Figure 4.3.4.2). This is close to the record high biomass of jellyfish of 4.9 million tonnes observed in 2001. No strong year classes of cod, haddock, capelin and herring occurred in 2001, and only strong year classes of cod was found in 2014.

C. capillata preys on zooplankton, fish eggs and fish larvae, and have a life span of approximately 1 year. The jellyfish utilize an unknown amount of plankton during the summer period, however in order to reach such high biomasses in a few months they most likely consume considerable amount of plankton. Therefore, a study on the role of jellyfish in the trophic webs of the Barents Sea is needed.

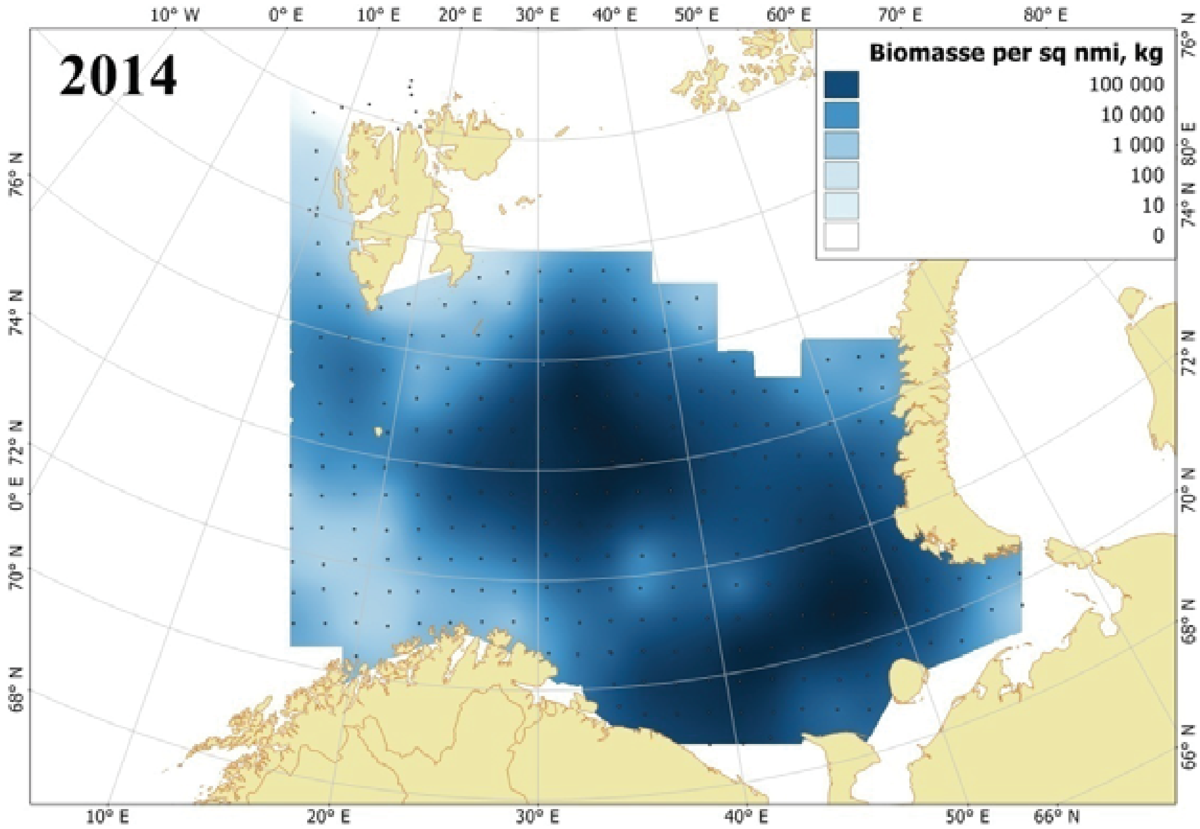


Figure 4.3.4.1. Distribution of jellyfish, August-September 2014.

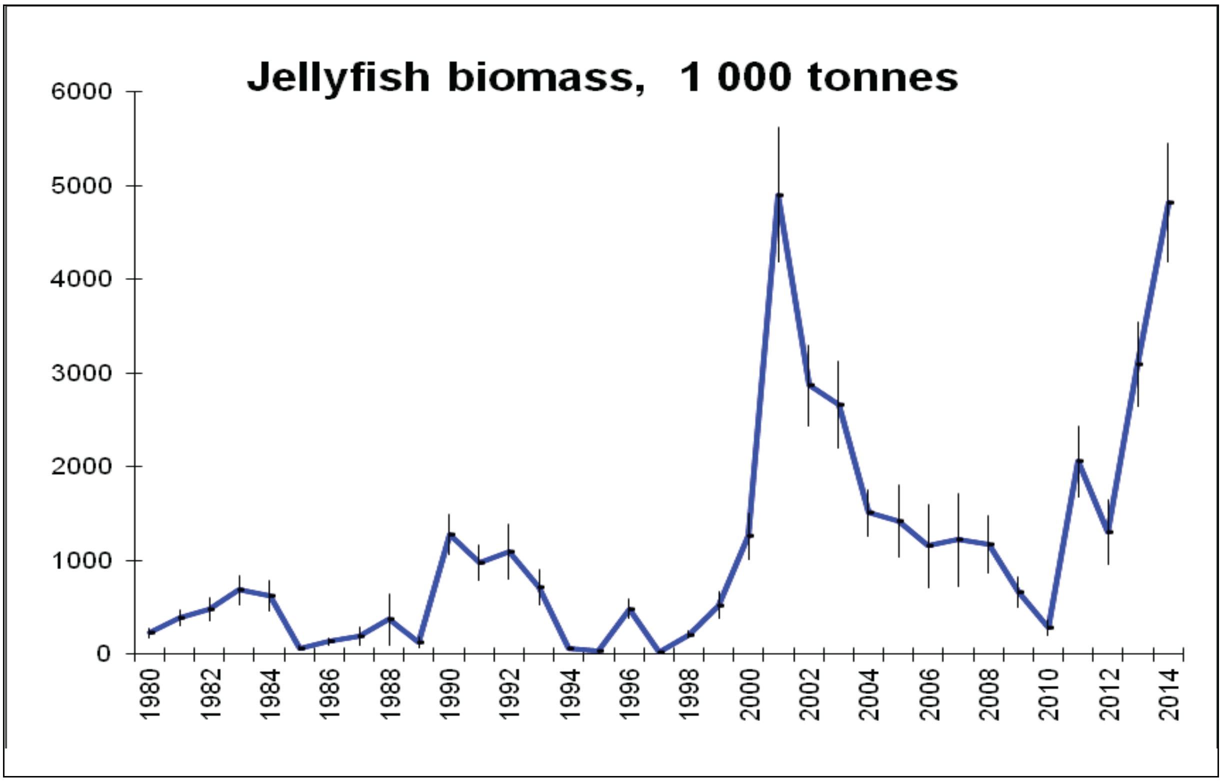


Figure 4.3.4.2. The estimated jellyfish biomass, mostly *Cyanea capillata*, in 1000 tonnes with 95% confidence interval for the period 1980-2014.

Single specimens of Blue stinging jellyfish *Cyanea lamarckii*, from the genus Cyanea, were found at three stations (70°42’N and 16°23’E, 74°42’N and 14°44’E, 77°58’N and 10°12’E) in deeper (more than 1000 m depth) western part of the surveyed area. To our knowledge this is the northernmost record of *C. lamarckii*. The species is considered to have a more southern distribution than *C. capillata*, and has previously been reported as far north as the Faeroes and Iceland and off the Norwegian coast at Harstad. *C. lamarckii* is not reproducing in the Barents Sea, and the presence of this warm-temperate species may be linked to the inflow of Atlantic water masses.

Single species of Helmet jelly *Periphylla periphylla*, from the genus Periphylla, were found in deeper (more than 1000 m depth) western part of the surveyed area.

Other species of gelatinous plankton, such as Moon’s jellyfish *Aurelia aurita,* and species of the class Hydrozoa and the phylum Ctenophora, were recorded during the survey. This small and fragile gelatinous plankton may be easily destroyed by other organisms (such as larger fish or/and invertebrates) in the trawl cod end.

5 Monitoring the pelagic fish community

5.1 Fish recruitment: fish distribution and abundance/biomass indices

Text by E. Eriksen, T. Prokhorova and D. Prozorkevich
Figures by E. Eriksen

During this survey the main distribution of most of 0-group species were covered. However survey coverage were limited north and east of Svalbard due to ice coverage, and therefore some fish species, especially polar cod were covered incompletely.

The 2014 year class of cod was estimated as a strong and redfish was above long term mean level. The 2014 year class of haddock, are close to the long term mean level. Poor year classes of capelin, saithe, long rough dab, Greenland halibut and polar cod were observed. Abundance indices calculated for nine 0-group commercial fish species from 1980-2014 are shown in Tables 5.1.1 and 5.1.2.

The total biomass of the four most abundant 0-group fish (cod, haddock, herring and capelin) was 0.4 million tonnes in August-September, which is lowest since 2003 and about four times lower than long term mean of 1.5 million tonnes. Cod contributed to 66% of the total 0-group fish biomass. Low 0-group fish biomasses were as consequence of both poor year classes of herring and capelin and smaller fish length of some abundant species (see below). Most of the biomass distributes in the central part of the Barents Sea. Biomass indices calculated for four 0-group fish species from 1993-2014 are shown in Table 5.1.3.

Length measurements of 0-group fish taken on board indicated that the lengths of some of 0-group fish as codherring, saithe and long rough dab were lower than the long term mean (1980-2014), while 0-group haddock, redfish and polar cod were larger in size. Length frequency distributions of the main species are given in Table 5.1.4.

Table 5.1.1. 0-group abundance indices (in millions) with 5% confidence limits, not corrected for capture efficiency. Record high year classes in bold. LTM-long term mean of 1980-2014.

Year	Capelin			Cod			Haddock			Herring			Redfish		
	Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit	
1980	197278	131674	262883	72	38	105	59	38	81	4	1	8	277873	0	701273
1981	123870	71852	175888	48	33	64	15	7	22	3	0	8	153279	0	363283
1982	168128	35275	300982	651	466	835	649	486	812	202	0	506	106140	63753	148528
1983	100042	56325	143759	3924	1749	6099	1356	904	1809	40557	19526	61589	172392	33352	311432
1984	68051	43308	92794	5284	2889	7679	1295	937	1653	6313	1930	10697	83182	36137	130227
1985	21267	1638	40896	15484	7603	23365	695	397	992	7237	646	13827	412777	40510	785044
1986	11409	98	22721	2054	1509	2599	592	367	817	7	0	15	91621	0	184194
1987	1209	435	1983	167	86	249	126	76	176	2	0	5	23747	12740	34755
1988	19624	3821	35427	507	296	718	387	157	618	8686	3325	14048	107027	23378	190675
1989	251485	201110	301861	717	404	1030	173	117	228	4196	1396	6996	16092	7589	24595
1990	36475	24372	48578	6612	3573	9651	1148	847	1450	9508	0	23943	94790	52658	136922
1991	57390	24772	90007	10874	7860	13888	3857	2907	4807	81175	43230	119121	41499	0	83751
1992	970	105	1835	44583	24730	64437	1617	1150	2083	37183	21675	52690	13782	0	36494
1993	330	125	534	38015	15944	60086	1502	911	2092	61508	2885	120131	5458	0	13543
1994	5386	0	10915	21677	11980	31375	1695	825	2566	14884	0	31270	52258	0	121547
1995	862	0	1812	74930	38459	111401	472	269	675	1308	434	2182	11816	3386	20246
1996	44268	22447	66089	66047	42607	89488	1049	782	1316	57169	28040	86299	28	8	47
1997	54802	22682	86922	67061	49487	84634	600	420	780	45808	21160	70455	132	0	272
1998	33841	21406	46277	7050	4209	9890	5964	3800	8128	79492	44207	114778	755	23	1487
1999	85306	45266	125346	1289	135	2442	1137	368	1906	15931	1632	30229	46	14	79
2000	39813	1069	78556	26177	14287	38068	2907	1851	3962	49614	3246	95982	7530	0	16826
2001	33646	0	85901	908	152	1663	1706	1113	2299	844	177	1511	6	1	10
2002	19426	10648	28205	19157	11015	27300	1843	1276	2410	23354	12144	34564	130	20	241
2003	94902	41128	148676	17304	10225	24383	7910	3757	12063	28579	15504	41653	216	0	495
2004	16901	2619	31183	19408	14119	24696	19372	12727	26016	**136053**	97442	174664	862	0	1779
2005	42354	12517	72192	21789	14947	28631	**33637**	24645	42630	26531	1288	51774	12676	511	24841
2006	168059	103577	232540	7801	3605	11996	11209	7413	15005	68531	22418	114644	20403	9439	31367
2007	161594	87683	235504	9896	5993	13799	2873	1820	3925	22319	4517	40122	156548	46433	266663
2008	288799	178860	398738	52975	31839	74111	2742	830	4655	15915	4477	27353	9962	0	20827
2009	189747	113135	266360	54579	37311	71846	13040	7988	18093	18916	8249	29582	49939	23435	76443
2010	91730	57545	125914	40635	20307	60962	7268	4530	10006	20367	4099	36636	66392	3114	129669
2011	175836	3876	347796	**119736**	66423	173048	7441	5251	9631	13674	7737	19610	7026	0	17885
2012	**310519**	225728	395311	105176	37917	172435	1814	762	2866	26480	299	316769	58535	0	128715
2013	94673	28224	161122	90101	62782	117421	7245	4731	9759	70972	8394	133551	928	310	1547
2014	48933	5599	92267	102977	72975	132980	4185	2217	6153	16674	5671	27677	77658	35010	120306
LTM	87398			30162			4274			28857			60957		

Table 5.1.1. Continued.

Year	Saithe			Gr halibut			Long rough dab			Polar cod (east)			Polar cod (west)		
	Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit	
1980	3	0	6	111	35	187	1273	883	1664	28958	9784	48132	9650	0	20622
1981	0	0	0	74	46	101	556	300	813	595	226	963	5150	1956	8345
1982	143	0	371	39	11	68	1013	698	1328	1435	144	2725	1187	0	3298
1983	239	83	394	41	22	59	420	264	577	1246	0	2501	9693	0	20851
1984	1339	407	2271	31	18	45	60	43	77	127	0	303	3182	737	5628
1985	12	1	23	48	29	67	265	110	420	19220	4989	33451	809	0	1628
1986	1	0	2	**112**	60	164	**6846**	4941	8752	12938	2355	23521	2130	180	4081
1987	1	0	1	35	23	47	804	411	1197	7694	0	17552	74	31	117
1988	17	4	30	8	3	13	205	113	297	383	9	757	4634	0	9889
1989	1	0	3	1	0	3	180	100	260	199	0	423	18056	2182	33931
1990	11	2	20	1	0	2	55	26	84	399	129	669	31939	0	70847
1991	4	2	6	1	0	2	90	49	131	88292	39856	136727	38709	0	110568
1992	159	86	233	9	0	17	121	25	218	7539	0	15873	9978	1591	18365
1993	366	0	913	4	2	7	56	25	87	41207	0	96068	8254	1359	15148
1994	2	0	5	39	0	93	1696	1083	2309	**267997**	151917	384078	5455	0	12032
1995	148	68	229	15	5	24	229	39	419	1	0	2	25	1	49
1996	131	57	204	6	3	9	41	2	79	70134	43196	97072	4902	0	12235
1997	78	37	120	5	3	7	97	44	150	33580	18788	48371	7593	623	14563
1998	86	39	133	8	3	12	27	13	42	11223	6849	15597	10311	0	23358
1999	136	68	204	14	8	21	105	1	210	129980	82936	177023	2848	407	5288
2000	206	111	301	43	17	69	233	120	346	116121	67589	164652	22740	14924	30556
2001	20	0	46	51	20	83	162	78	246	3697	658	6736	13490	0	28796
2002	553	108	998	51	0	112	731	342	1121	96954	57530	136378	27753	4184	51322
2003	65	0	146	13	0	34	78	45	110	11211	6100	16323	1627	0	3643
2004	**1400**	865	1936	72	29	115	36	20	52	37156	19040	55271	341	101	581
2005	55	37	74	10	4	15	200	109	291	6545	3202	9888	3231	1283	5178
2006	139	56	221	11	2	21	707	434	979	26016	9997	42036	2112	465	3760
2007	53	6	100	1	0	2	262	46	479	25883	8494	43273	2533	0	5135
2008	45	22	69	6	0	13	956	410	1502	6649	845	12453	91	0	183
2009	22	0	46	7	4	10	115	51	179	23570	9661	37479	21433	5642	37223
2010	402	126	678	14	8	20	128	18	238	31338	13644	49032	1306	0	3580
2011	27	0	59	20	11	29	58	23	93	37431	15083	59780	627	26	1228
2012	69	2	135	30	16	43	173	0	416	4173	48	8298	17281	0	49258
2013	3	1	5	21	13	28	5	0	14	1634	0	4167	148	28	268
2014	1	0	2	10	3	16	309	89	528	2779	737	4820	746	79	1414
LMT	170			27			523			32980			8287		

Table 5.1.2. 0-group abundance indices (in millions) with 5% confidence limits, corrected for capture efficiency. LTM- long term mean of 1980-2014.

	Capelin			Cod			Haddock			Herring		
Year	Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit	
1980	740289	495187	985391	276	131	421	265	169	361	77	12	142
1981	477260	273493	681026	289	201	377	75	34	117	37	0	86
1982	599596	145299	1053893	3480	2540	4421	2927	2200	3655	2519	0	5992
1983	340200	191122	489278	19299	9538	29061	6217	3978	8456	195446	69415	321477
1984	275233	161408	389057	24326	14489	34164	5512	3981	7043	27354	3425	51284
1985	63771	5893	121648	66630	32914	100346	2457	1520	3393	20081	3933	36228
1986	41814	642	82986	10509	7719	13299	2579	1621	3537	93	27	160
1987	4032	1458	6607	1035	504	1565	708	432	984	49	0	111
1988	65127	12101	118153	2570	1519	3622	1661	630	2693	60782	20877	100687
1989	862394	690983	1033806	2775	1624	3925	650	448	852	17956	8252	27661
1990	115636	77306	153966	23593	13426	33759	3122	2318	3926	15172	0	36389
1991	169455	74078	264832	40631	29843	51419	13713	10530	16897	267644	107990	427299
1992	2337	250	4423	166276	92113	240438	4739	3217	6262	83909	48399	119419
1993	952	289	1616	133046	58312	207779	3785	2335	5236	291468	1429	581506
1994	13898	70	27725	70761	39933	101589	4470	2354	6586	103891	0	212765
1995	2869	0	6032	233885	114258	353512	1203	686	1720	11018	4409	17627
1996	136674	69801	203546	280916	188630	373203	2632	1999	3265	549608	256160	843055
1997	189372	80734	298011	294607	218967	370247	1983	1391	2575	463243	176669	749817
1998	113390	70516	156263	24951	15827	34076	14116	9524	18707	476065	277542	674589
1999	287760	143243	432278	4150	944	7355	2740	1018	4463	35932	13017	58848
2000	140837	6551	275123	108093	58416	157770	10906	6837	14975	469626	22507	916746
2001	90181	0	217345	4150	798	7502	4649	3189	6109	10008	2021	17996
2002	67130	36971	97288	76146	42253	110040	4381	2998	5764	151514	58954	244073
2003	340877	146178	535575	81977	47715	116240	30792	15352	46232	177676	52699	302653
2004	53950	11999	95900	65969	47743	84195	39303	26359	52246	773891	544964	1002819
2005	148466	51669	245263	72137	50662	93611	91606	67869	115343	125927	20407	231447
2006	515770	325776	705764	25061	11469	38653	28505	18754	38256	294649	102788	486511
2007	480069	272313	687825	42628	26652	58605	8401	5587	11214	144002	25099	262905
2008	995101	627202	1362999	234144	131081	337208	9864	1144	18585	201046	68778	333313
2009	673027	423386	922668	185457	123375	247540	33339	19707	46970	104233	31009	177458
2010	318569	201973	435166	135355	68199	202511	23669	14503	32834	117087	32045	202129
2011	594248	58009	1130487	448005	251499	644511	19114	14209	24018	83051	48024	118078
2012	988600	728754	1248445	410757	170242	651273	5281	2626	7936	177189	35046	2111493
2013	316020	127310	504731	385430	269640	501219	16665	11161	22169	289391	67718	511064
2014	163630	31980	295280	464124	323330	604919	11765	6160	17371	136305	42164	230447
LTM	296815			118384			11823			167941		

	Saithe			Polar cod (east)			Polar cod (west)		
Year	Abundance index	Confidence lim		Abundance index	Confidence limit		Abundance index	Confidence limit	
1980	21	0	47	203226	69898	336554	82871	0	176632
1981	0	0	0	4882	1842	7922	46155	17810	74500
1982	296	0	699	1443	154	2731	10565	0	29314
1983	562	211	912	1246	0	2501	87272	0	190005
1984	2577	725	4430	871	0	2118	26316	6097	46534
1985	30	7	53	143257	39633	246881	6670	0	13613
1986	4	0	9	102869	16336	189403	18644	125	37164
1987	4	0	10	64171	0	144389	631	265	996
1988	32	11	52	2588	59	5117	41133	0	89068
1989	10	0	23	1391	0	2934	164058	15439	312678
1990	29	4	55	2862	879	4846	246819	0	545410
1991	9	4	14	823828	366924	1280732	281434	0	799822
1992	326	156	495	49757	0	104634	80747	12984	148509
1993	1033	0	2512	297397	0	690030	70019	12321	127716
1994	7	1	12	2139223	1230225	3048220	49237	0	109432
1995	415	196	634	6	0	14	195	0	390
1996	430	180	679	588020	368361	807678	46671	0	116324
1997	341	162	521	297828	164107	431550	62084	6037	118131
1998	182	91	272	96874	59118	134630	95609	0	220926
1999	275	139	411	1154149	728616	1579682	24015	3768	44262
2000	851	446	1256	916625	530966	1302284	190661	133249	248072
2001	47	0	106	29087	5648	52526	119023	0	252146
2002	2112	134	4090	829216	496352	1162079	215572	36403	394741
2003	286	0	631	82315	42707	121923	12998	0	30565
2004	4779	2810	6749	290686	147492	433879	2892	989	4796
2005	176	115	237	44663	22890	66436	25970	9987	41953
2006	280	116	443	182713	73645	291781	15965	3414	28517
2007	286	3	568	191111	57403	324819	22803	0	46521
2008	142	68	216	42657	5936	79378	619	25	1212
2009	62	0	132	168990	70509	267471	154687	37022	272351
2010	1066	362	1769	267430	111697	423162	12045	0	33370
2011	96	0	225	249269	100355	398183	4924	218	9629
2012	229	5	453	25026	1132	48920	125306	0	357381
2013	11	4	18	11382	0	29002	1011	262	1760
2014	4	0	9	17349	5184	29515	5298	500	10096
LTM	486			266412			67169		

Table 5.1.3. Biomass indices of 0-group capelin, cod, haddock and herring (in thousand tonnes). The indices are corrected for capture efficiency.

Year	Capelin	Cod	Haddock	Herring	Total biomass
1993	3	475	34	1035	1547
1994	6	666	54	173	898
1995	2	1546	14	12	1573
1996	98	919	34	438	1489
1997	82	657	12	352	1103
1998	51	117	168	988	1323
1999	158	32	39	440	668
2000	55	319	44	404	822
2001	51	11	58	9	130
2002					
2003	149	160	115	471	894
2004	33	317	686	2243	3279
2005	60	431	749	406	1647
2006	335	181	329	1321	2166
2007	312	123	69	275	779
2008	396	632	54	106	1189
2009	197	955	346	289	1788
2010	100	786	134	254	1274
2011	228	1855	215	151	2449
2012	519	1429	39	1156	3143
2013	151	957	241	1363	2712
2014	67	254	36	29	385
Mean	145	611	165	567	1544

Table 5.1.4. Length distribution (%) of 0-group fish in the Barents Sea and adjacent waters

Length, mm	Cod	Haddock	Capelin	Herring	Saithe	Redfish	Polar cod	Gr. halibut	LRD	Sandeel
10 - 14 mm						0.9			0.9	
15 - 19 mm						2.0			6.4	
20 - 24 mm			0.6			2.5	0.1		14.8	
25 - 29 mm			3.2			2.2	0.2		13.2	
30 - 34 mm	0.1		7.3			3.8	0.9		30.7	0.1
35 - 39 mm	0.0		8.2			18.5	3.6		22.3	0.7
40 - 44 mm	0.1		9.1	1.2		24.8	13.6		8.8	12.7
45 - 49 mm	0.7		23.2	2.8		19.3	17.3		2.6	21.3
50 - 54 mm	2.0	0.5	30.9	7.6		21.0	19.9	11.5	0.2	17.7
55 - 59 mm	7.2	0.4	14.1	14.3	25.0	5.0	20.2	27.3		10.7
60 - 64 mm	14.9	1.3	2.6	14.4			17.5	12.2		6.2
65 - 69 mm	24.5	2.0	0.5	18.1			5.9	10.8		5.7
70 - 74 mm	23.3	3.3	0.2	22.9			0.8	19.8		8.6
75 - 79 mm	12.6	4.4		12.7				7.5		7.7
80 - 84 mm	7.7	7.0		4.5	25.0			11.0		4.9
85 - 89 mm	3.5	12.4		1.0						1.7
90 - 94 mm	1.9	14.5		0.3	50.0					1.2
95 - 99 mm	0.6	17.7		0.1						0.5
100 - 104 mm	0.2	10.3								0.0
105 - 109 mm	0.2	10.6								0.1
110 - 114 mm	0.1	8.5								0.1
115 - 119 mm	0.1	3.2								
120 - 124 mm		1.8								
125 - 129 mm		0.7								
130 - 134 mm		0.8								
135 - 139 mm		0.3								
140 - 144 mm		0.3								
Mean length, cm	7.0	9.5	4.7	6.6	8.1	4.3	5.1	6.6	3.1	5.7
Long term mean length, cm	7.5	9.1	4.8	7.1	9.2	3.9	4.0	6.2	3.4	5.7

5.1.1 Capelin (*Mallotus villosus*)

The 0-group capelin was distributed widely in the Barents Sea (Figure 5.1.1.1). At the same time, no capelin was found in the south, west and north for Svalbard/Spitsbergen Archipelago and in the south for Novaya Zemlya. The survey could not identify boundaries for capelin distribution in the north due to ice coverage and north east due to limited time, which will a little influence abundance indices. The density legend in the figure is based on the catches, measured as number of fish per square nautical mile. More intensive colouring indicates denser concentrations. In 2014 more dense concentrations were observed along Murman coast (most likely from summer spawning) and in the northern parts of distribution area in the Barents Sea.

The calculated density varied from 174 to 3 million fish per square nautical mile, with mean density of 174 thousand fish per square nautical mile.

In 2014 sometimes were difficult to split 0-group and 1-year fish for individuals with 6 cm length, so otoliths from such fishes were analysed. The average length was 4.7 cm which is the same level in 2013 (4.6 cm) and the long term mean (4.8 cm).

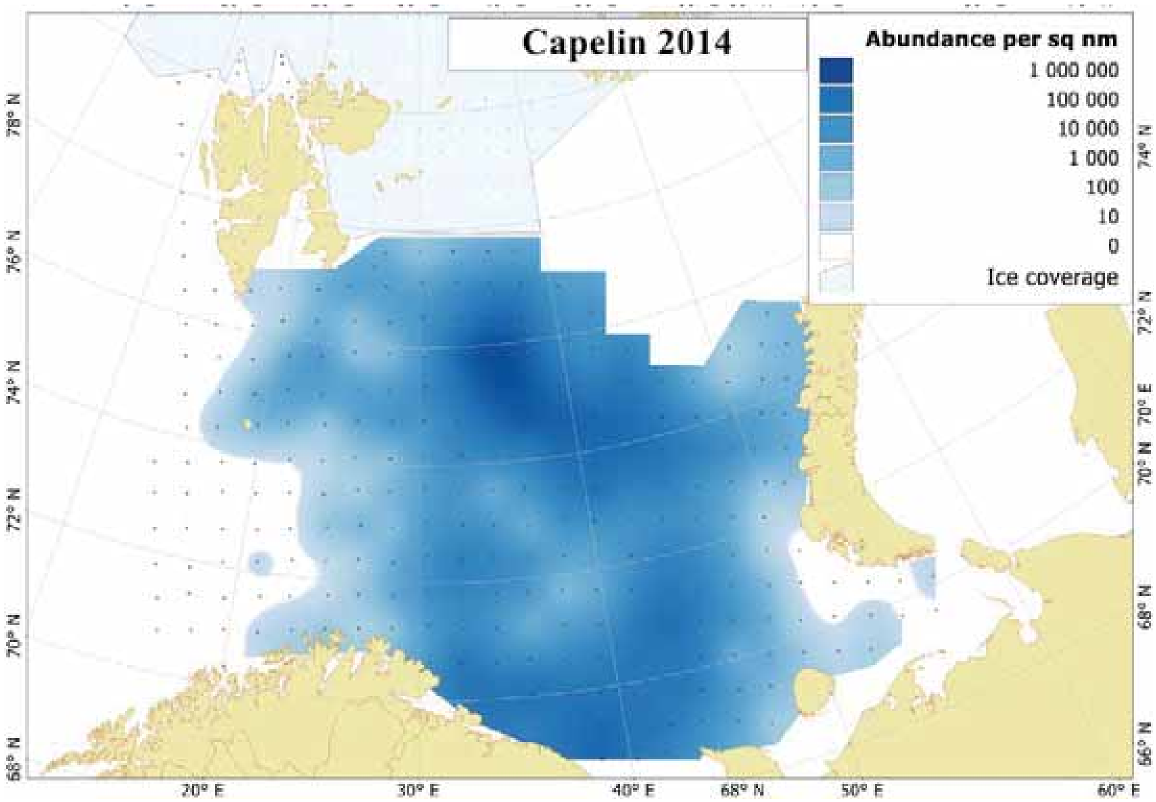


Figure 5.1.1.1. Distribution of 0-group capelin, August-September 2014.

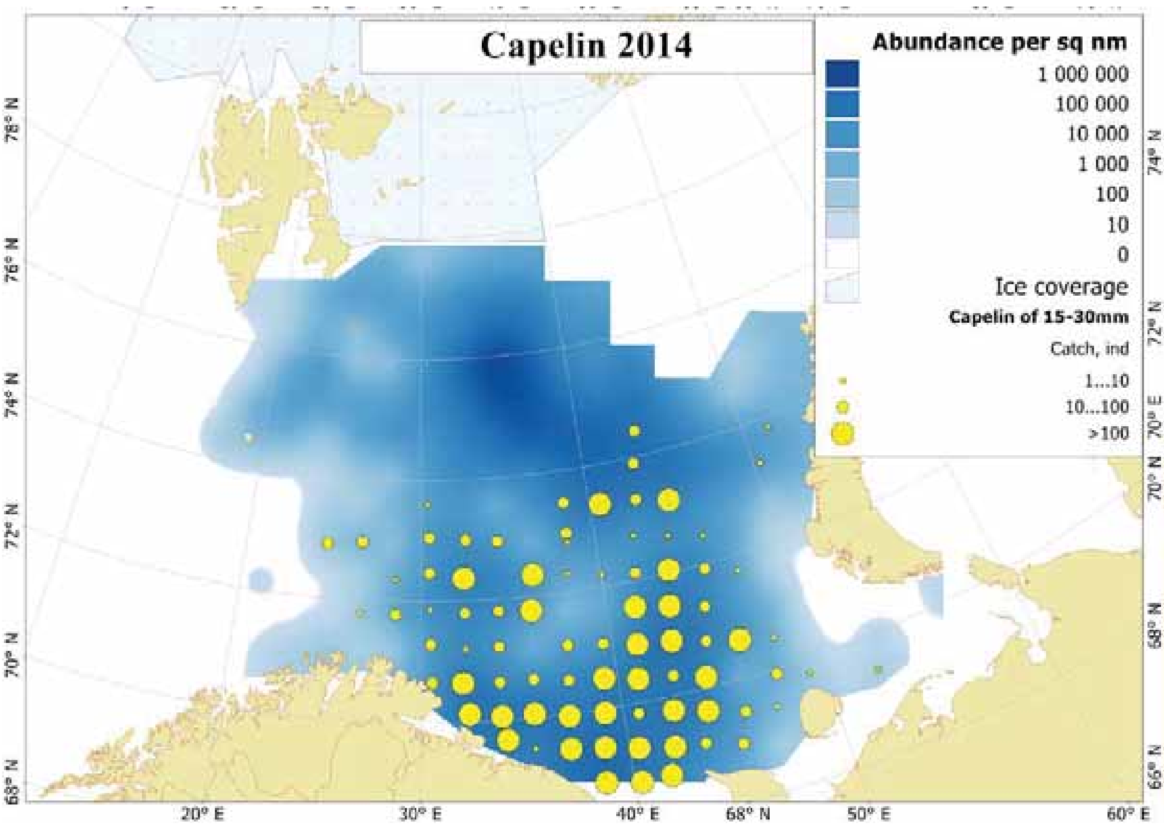


Figure 5.1.1.2. Distribution of small 0-group capelin of 15-30 mm body length, August-September 2014.

The 0-group capelin biomass was about 67 thousand tonnes, and this is about 2 times less than in 2013 (151 thousand tonnes) and the long term level (145 thousand tonnes for period 1993-2014). The capelin biomass is shown in Table 5.1.3.

Most of the 0-group capelin likely originates from late spring spawning, however an unknown part of 0-group capelin of 3 cm body length or less were most likely from summer spawning. These small fish distributed mostly in the southern Barents Sea (Figure 5.1.1.2). This part in 2014 consist 9.6 % of the studied individuals (15 % in 2013). This small 0-group capelin may probably have a worse condition for overwintering due to less time to grow up during the first feeding season.

The abundance index of 0-group capelin in 2014 was 1.9 times lower than in 2013 and 1.8 times lower than the long term mean. The 2014 year class was found as poor.

5.1.2 Cod (*Gadus morhua*)

0-group cod was widely distributed in 2014, and the main dense concentrations were found in the central part of the sea, between 72-75˚N and 27-35˚E (Fig. 5.1.2.1). The survey could not identify boundaries for cod distribution in the north due to ice coverage. Moreover during recent years the 0-group cod were observed by demersal haul outside of standard coverage by pelagic hauls, it confirmed the sediment process has been started and 0-group of cod partly distributed outside surveyed survey area.

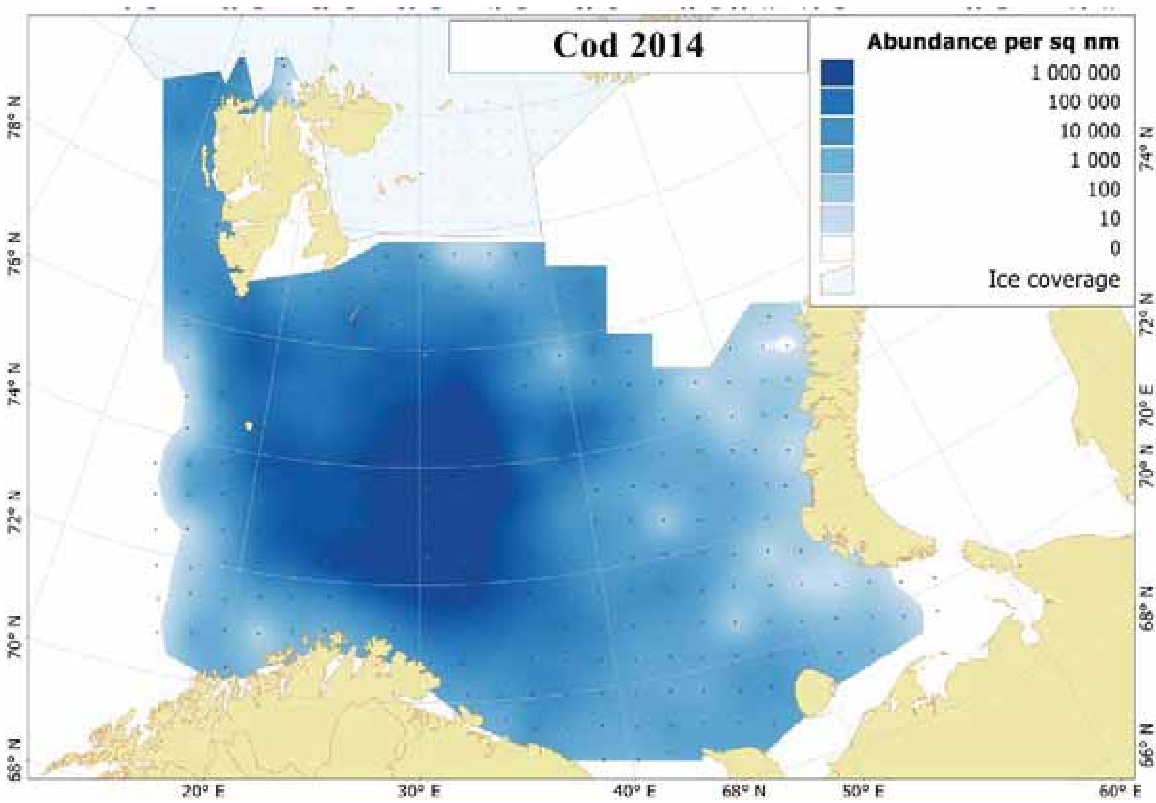


Figure 5.1.2.1. Distribution of 0-group cod, August-September 2014.

The calculated density was from 185 to 4.9 million fish per square nautical mile, with mean density of 315 thousand fish per square nautical mile.

The lengths of 0-group cod was between 1.5 and 12.0 cm. Most of the fish were between 6 and 9 cm, with a mean length of 7.0 cm which is lower than in 2011-2013 and the long term level of 7.5 cm (Table 5.1.4).

The 0-group cod biomass of 254 thousand tonnes is much lower than in 2012-2013 and the long term mean level most likely due to higher abundance of 0-group fish were smaller in size (Table 5.1.3).

The abundance index of 2014 year class is somewhat lower than record high year 2012 class. The 2014 year class may be characterized as strong.

5.1.3 Haddock (*Melanogrammus aeglefinus*)

0-group haddock was relatively widely distributed in the western part of the survey area between 10° E and 40 °E in 2014 and however it was smaller than in previous years (Figure 5.1.3.1). The main dense concentrations were found in the central part of the sea, between 72-74˚N and 20-30˚E.

The calculated density varied between 175 and 543 thousand fish per square nautical mile. The mean calculated density per trawl was 12 thousand fish.

The length of 0-group haddock varied between 3.0 and 14.5 cm, while the length of most fish was between 9.0 and 12.0 cm (Table 5.1.4). The mean length of haddock was 9.5 cm, which is some lower than in 2013 (10.7 cm) and some higher the long term mean (9.1 cm). The large 0-group haddock may most likely indicate suitable living conditions for haddock in 2014.

The 0-group haddock biomass was about 36 thousand tonnes and it is almost 7 times lower than in 2013 and 4.5 times lower than the long term mean (for period 1993-2014) (Table 5.1.3).

The number of fish belonging to the 2014 year class is lower than in 2013, while close to the long-term mean and can be characterized as average year class.

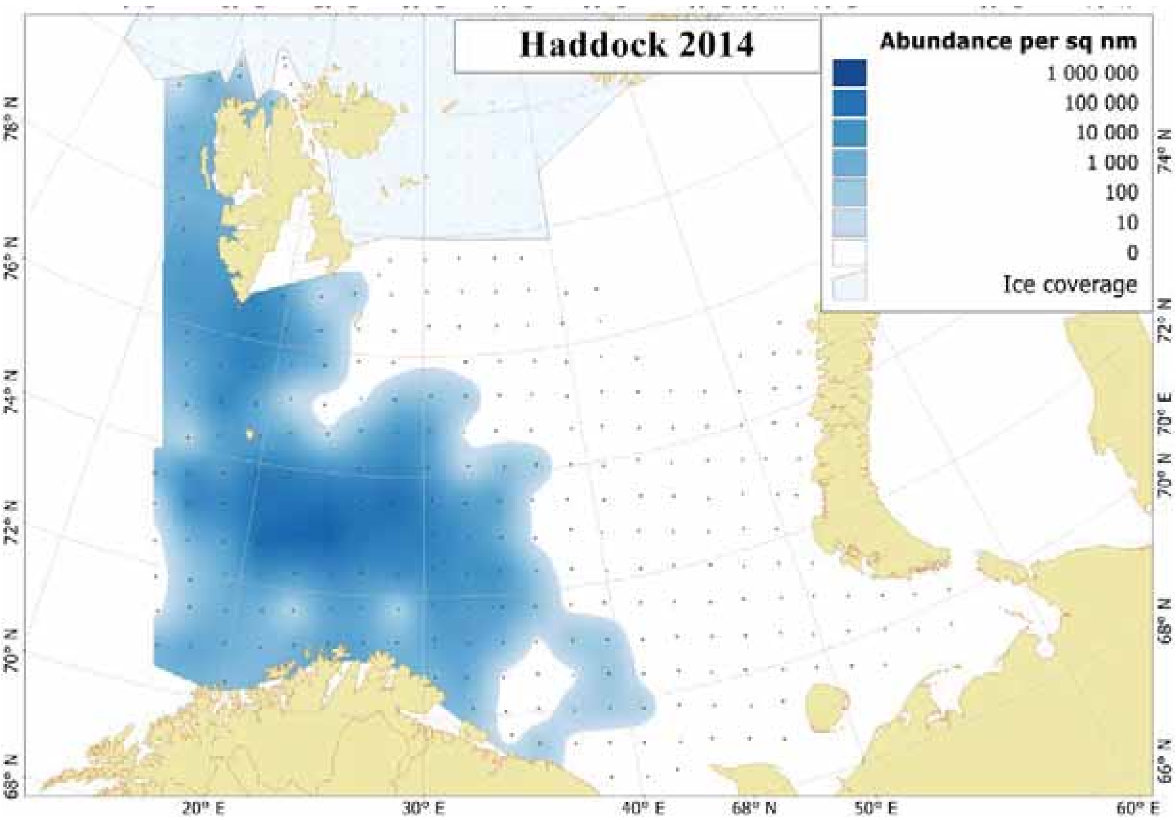


Figure 5.1.3.1. Distribution of 0-group haddock, August-September 2014.

5.1.4 Herring (*Clupea harengus*)

0-group herring were widely distributed than in 2012 and 2013, and were found from southeast to northwest of the Barents Sea in 2014. The main dense concentration of herring was located in the central area, between 70-75˚N and 20-40˚E, and west of Svalbard/Spitsbergen Archipelago (Fig. 5.1.4.1).

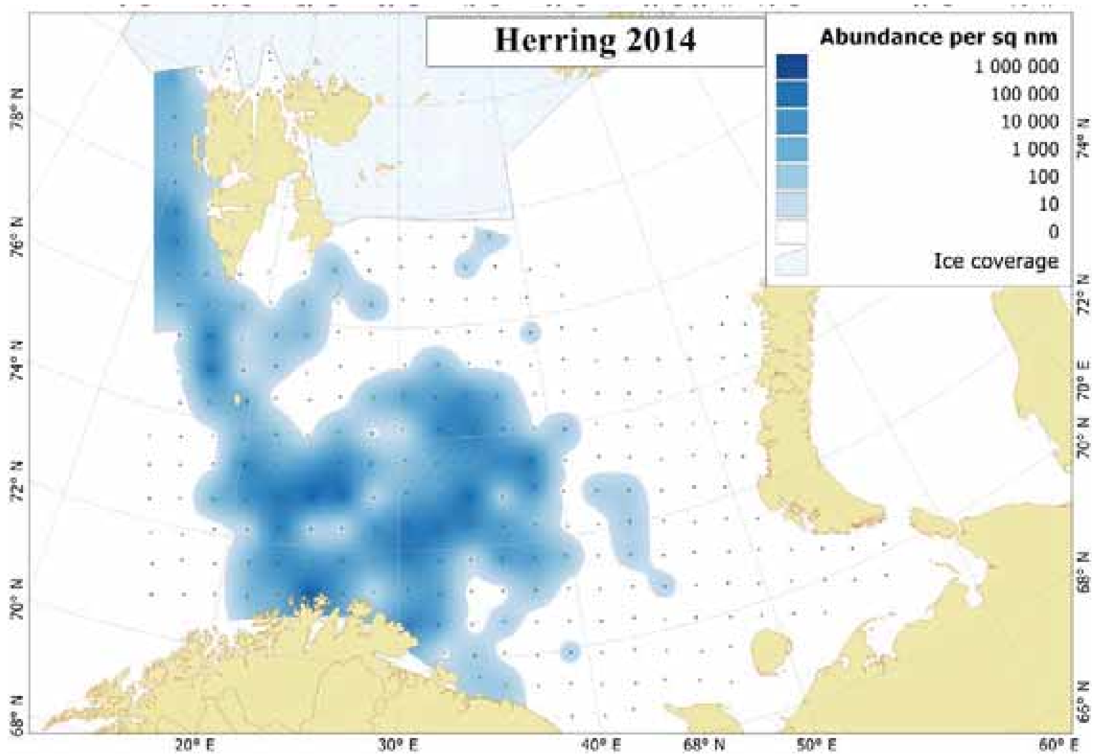


Figure 5.1.4.1. Distribution of 0-group herring, August-September 2014.

The calculated density varied from 185 to 3 million fish per square nautical mile. The mean calculated density was 49 thousand fish per square nautical mile.

Otoliths from herring of 10 cm length showed that herring was 1-year, that is unusually. The length of 0-group herring varied between 2.0 and 9.5 cm, and most of the fish were 4.0-6.0 cm long (Table 5.1.4). In 2014 the mean length of 0-group herring was 6.6 cm and it is lower than in 2013 (8.0 cm) and lower than the long term mean of 7.1 cm. During the herring larvae survey in 2014 the mean length of the herring larvae (12.37 mm) was lower than in 2013 (13.54 mm). Moreover in 2013 the majority of larvae (91.4 %) was at the 2a stage, corresponding to 10-24 days old larvae, but in 2014 only 64.4 % of larvae was at the 2a stage and 23.9 % at the 1d stage (corresponds to 8-9 days old larvae) (Stenevik et al. 2013, 2014). So later spawning in 2014 may be the reasons for the observed small mean length.

The 0-group herring biomass was 29 thousand tonnes, it was due 47 times lower than in 2013 and 20 times lower than the long term mean of 567 thousand tonnes (Table 5.1.3). The reason of low 0-group herring biomass is due to both low abundance and low mean length of individuals in 2014.

The 2014 year-class of herring is close to the 2006-2011 level and it is below than the long term mean, and therefore can be characterized as weak.

5.1.5 Polar cod (*Boreogadus saida*)

As in previous years, the distribution of 0-group polar cod was split into two components, western and eastern (Figure 5.1.5.1). The western component was observed south-east of Svalbard/Spitsbergen Archipelago and some catches were taken west and north of Svalbard/Spitsbergen Archipelago. Ice coverage north of Svalbard/Spitsbergen Archipelago limit survey coverage and therefore polar cod distribution was not covered as a previous years. Polar cod of the western component distributes usually along the western coast of Novaya Zemlya. Distribution of polar cod from the both components was wider than in 2013. The eastern component is usually denser than the western, and it was true for 2014.

The length of polar cod varied between 2.0 and 7.0 cm, and most of the fish were between 5.0 and 6.0 cm long (Table 5.1.4). The mean length of 0-group polar cod was higher than in 2013 and it was (5.1 cm opposite 4.6 cm), and it is higher than the long term mean of 4.0 cm.

The abundance index for each component was calculated separately. Calculated abundance of the eastern component was low: less than half the 2012 value, close to 2013 and less than 8% of the average (Table 5.1.1). The abundance index of western component was the long term mean. Several years the abundance indices of polar cod were extremely low, and most likely indicated worse living conditions than in 1980s and 1990s or/and significant reduce the spawning biomass in the Barents Sea.

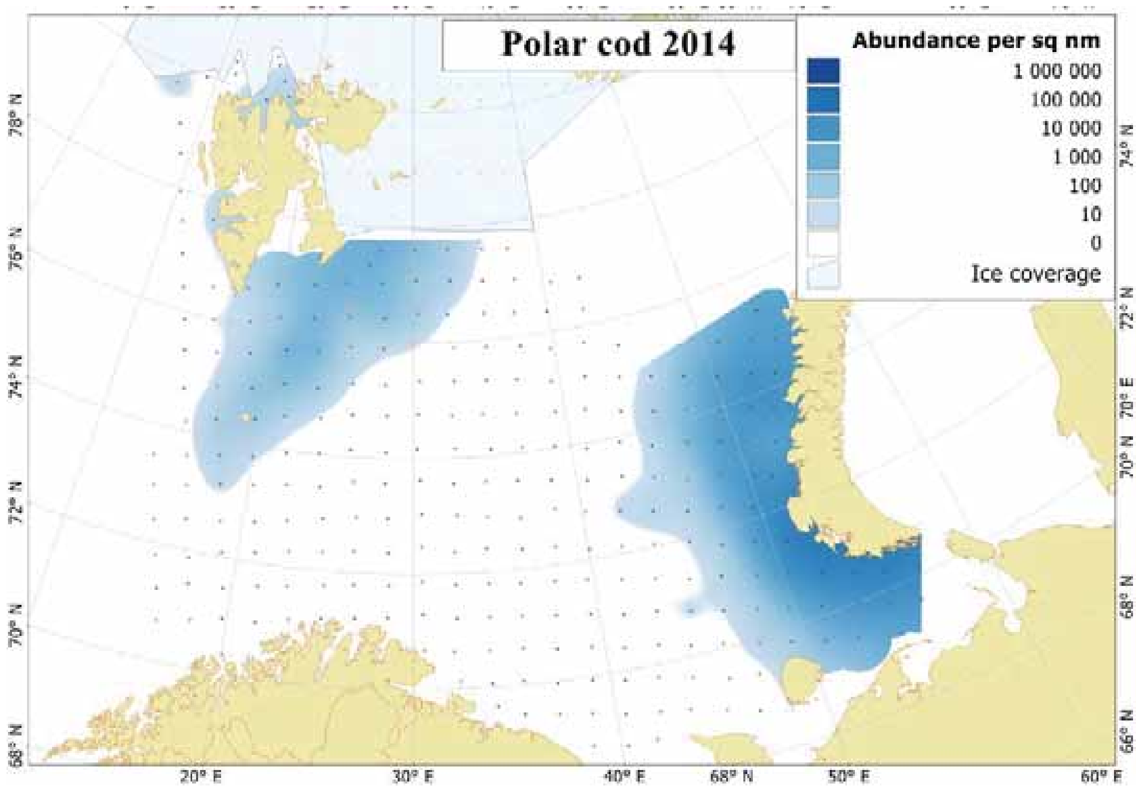


Figure 5.1.5.1. Distribution of 0-group polar cod, August-September 2014.

5.1.6 Saithe (*Pollachius virens*)

Single specimens of 0-group saithe were found only on the 3 stations in the central and northern part of the Barents Sea (Figure 5.1.6.1).

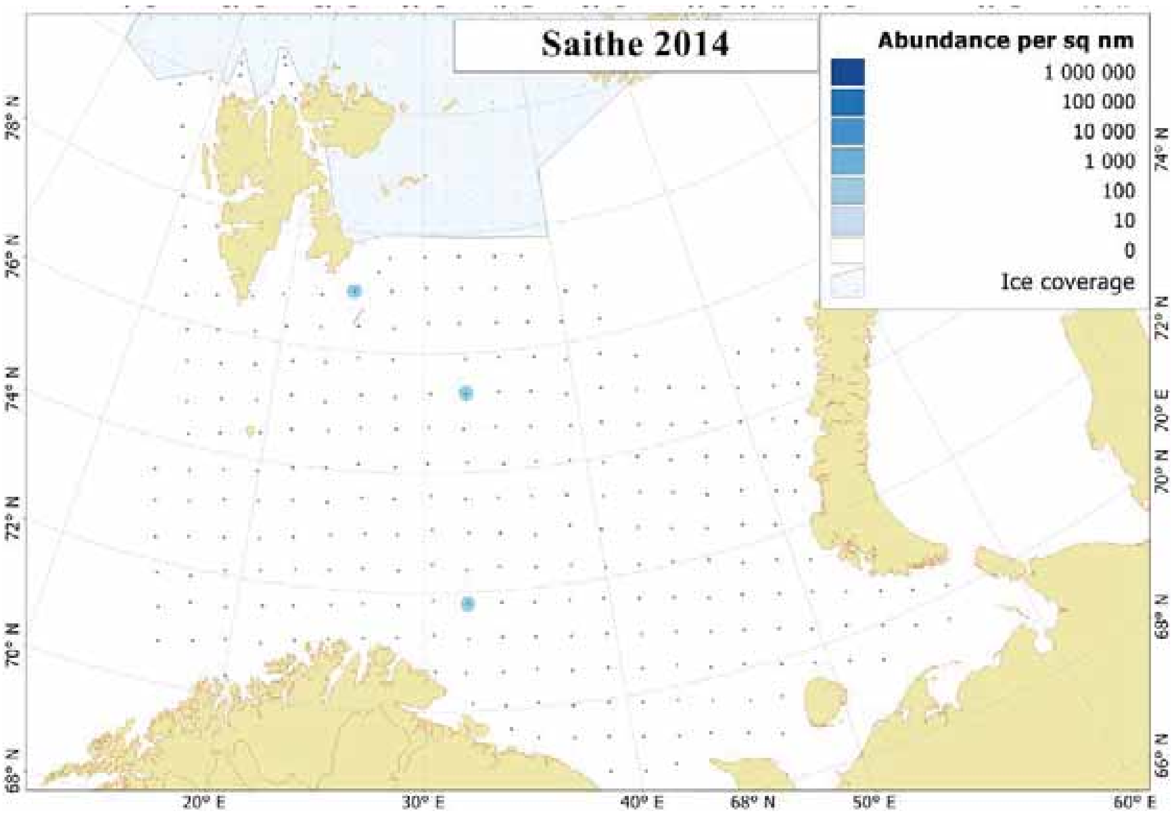


Figure 5.1.6.1. Distribution of 0-group saithe, August-September 2014.

The maximum calculated density was only 430 fish per nautical mile. Both density and catch rates were lower than in 2012-2013.

The length of 0-group saithe varied between 5.5 and 9.0 cm. The mean length of saithe was 8.1 cm. This was lower than in 2013 (8.8 cm) and the long term mean of 9.2 cm (Table 5.1.4).

Since 2005 (except in 2010) abundance indices of 0-group saithe have been lower than the long term average. The 2014 year class is less than the 2012 and 2013 year classes and much lower than the long term mean. The 2014 year class of saithe in the Barents Sea may be characterized as poor. The index of 0-group saithe in the Barents Sea is only a minor part of the total 0-group abundance, and therefore not representative as recruitment (at age 0) for the saithe stock.

5.1.7 Redfish (mostly *Sebastes mentella*)

0-group redfish was widely distributed in the western part of the Barents Sea: from the north western of the Svalbard/Spitsbergen Archipelago to the Norway coast between 70 °N and 79 °N (Figure 5.1.7.1). The densest concentrations were located west of Svalbard/Spitsbergen Archipelago and in the southern part of distribution between 71-73˚N and 15-25˚E.

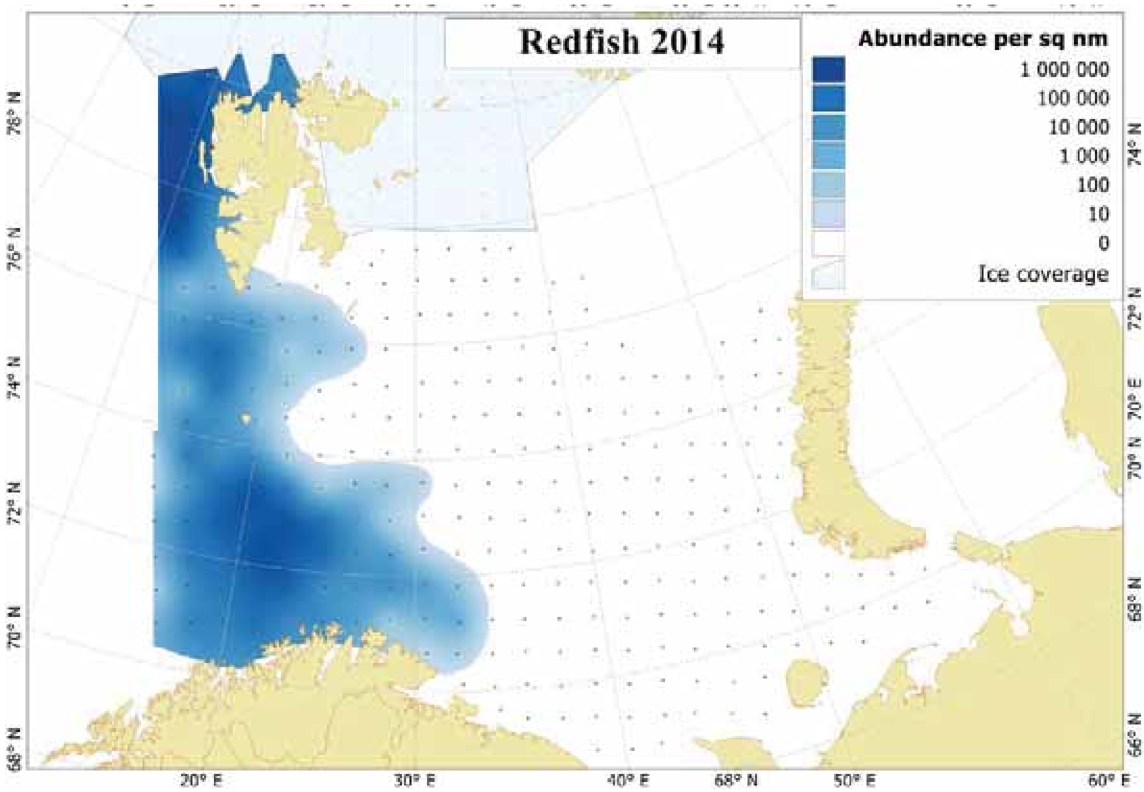


Figure 5.1.7.1. Distribution of 0-group redfishes, August-September 2014.

The calculated density was between 175 and 11 million fish per square nautical mile. Mean calculated density was 238 thousand fish, which higher than in 2012 and 2013.

In 2014 the length of 0-group redfish was 0.5-5.5 cm and the mean fish length was 4.3 cm. This mean fish length is higher than in 2012 (4.2 cm) and 2013 (3.4 cm) and the long term mean of 3.9 cm. The large abundance and size of 0-group redfish may most likely indicate both increasing the redfish spawning biomass and suitable living conditions for redfish in 2014.

The abundance of 0-group redfish is highest since 2008 and it was some higher than the long term mean. So the 2014 year-class can be characterized more than average.

5.1.8 Greenland halibut (*Reinhardtius hippoglossoides*)

As in the previous five years, 0-group Greenland halibut of very low densities were found in 2014. In 2014 as in 2012-2013 Greenland halibut were observed to the north and some catches were taken south of Svalbard/Spitsbergen (Figure 5.1.8.1). Northern part of the 0-group halibut distribution area was not covered by the survey due to ice coverage. Moreover the survey did not cover numerous of Svalbard/Spitsbergen fjords, where 0-group Greenland halibut are numerous, and therefore this index not give the real recruitment (at age 0) to the stock. However, this may reflect the minimum abundance index of the year-class strength in the standard long term surveyed area.

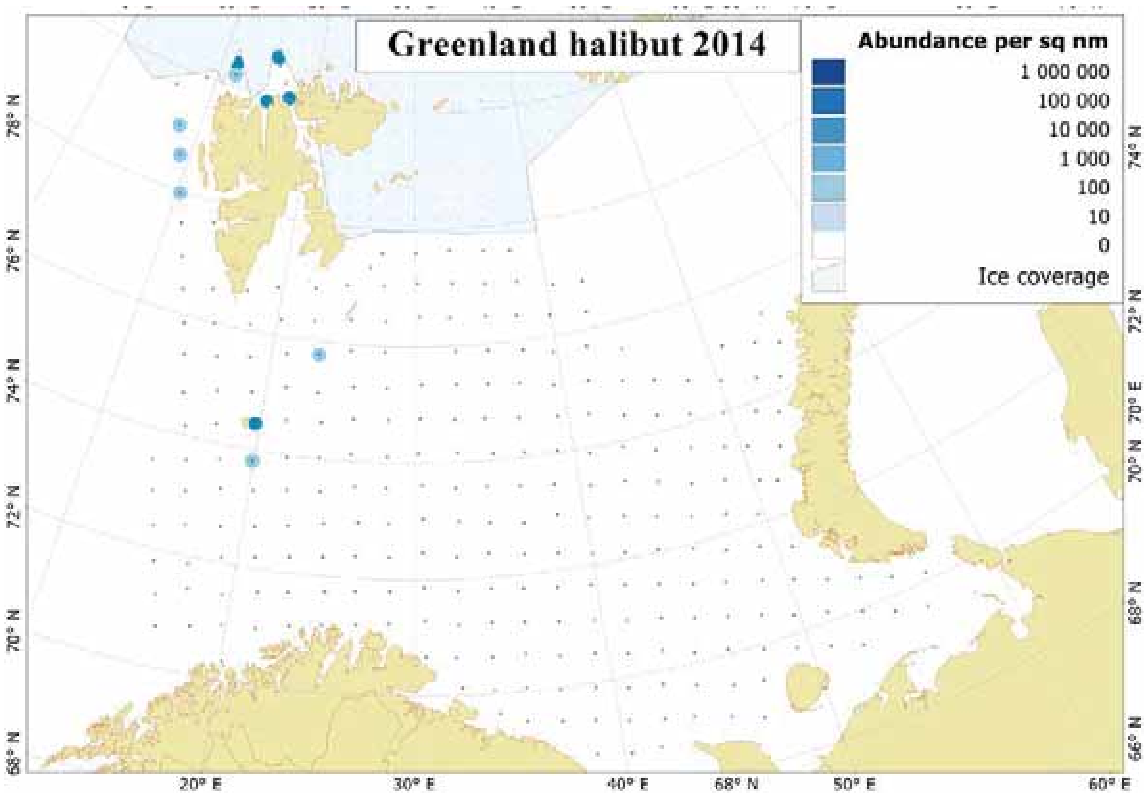


Figure 5.1.8.1. Distribution of 0-group Greenland halibut, August-September 2014.

Fish length varied between 5.0 and 8.0 cm, while most of the fish were between 5,5 and 7.0 cm. The mean length of fish was 6.6 cm which is approximately the same level as in 2012-2013 (6.6 cm and 6.3 cm respectively) and the long term mean (6.2 cm) (Table 5.1.4).

The highest calculated density concentration was only 2.1 thousand fish per square nautical mile. The highest catches were taken north of Svalbard/Spitsbergen.

Since 2012 abundance of Greenland halibut continuously decreased, and 2014 year-class index is also below the long term level.

5.1.9 Long rough dab (*Hippoglossoides platessoides*)

0-group long rough dab were found in the western, eastern and northern areas (Figure 5.1.9.1). Distribution of this species was wider than in 2013 then long rough dab were found only at 6 stations in the south and east of surveyed area. 0-group long rough dab settles to the bottom, when fish reach length of 3 cm. Thus, at two stations in the western part of the surveyed area 0-group long rough dub (30 and 16 individuals) were found only in the bottom trawls.

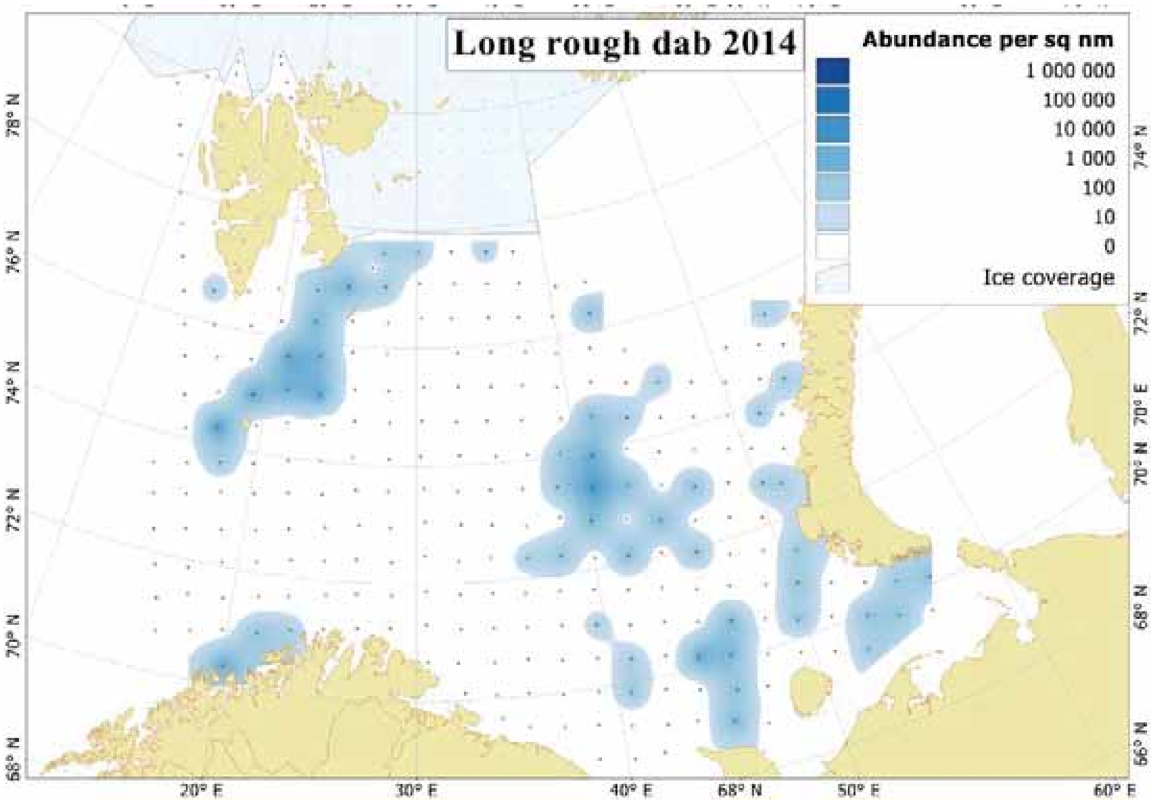


Figure 5.1.9.1. Distribution of 0-group long rough dab, August-September 2014.

The highest calculated density concentration was 74 thousand fish per square nautical mile (3.1 thousand fish per square nautical mile in 2013) with an average of 237. That was much higher than it was observed in 2013.

Fish length varied between 1.0 and 5.0 cm (Table 5.1.4). The mean length of fish was 3.1 cm. This is approximately the same as in 2012 (2.9 cm) and2013 (3.1 cm) and slightly below than the long term average (3.4 cm). The long rough dab index in 2014 was the highest since 2009. However, it is below than the long term mean, and therefore the 2014 year-class can be characterized as relative poor.

5.1.10 Wolffishes (*Anarhichas sp.*)

There are three species of wolffish found in the Barents Sea: Atlantic wolffish (*Anarhichas lupus*), Spotted wolffish (*Anarhichas minor*) and Northern wolffish (*Anarhichas denticulatus*). Distribution of three wolfish species is shown in the map (Fig. 5.1.10.1). 0-group of Atlantic wolfish were found in the western part of the surveyed area, Spotted wolfish in the western and in the central part, while Northern wolfish were found in the 3 stations in the central part.

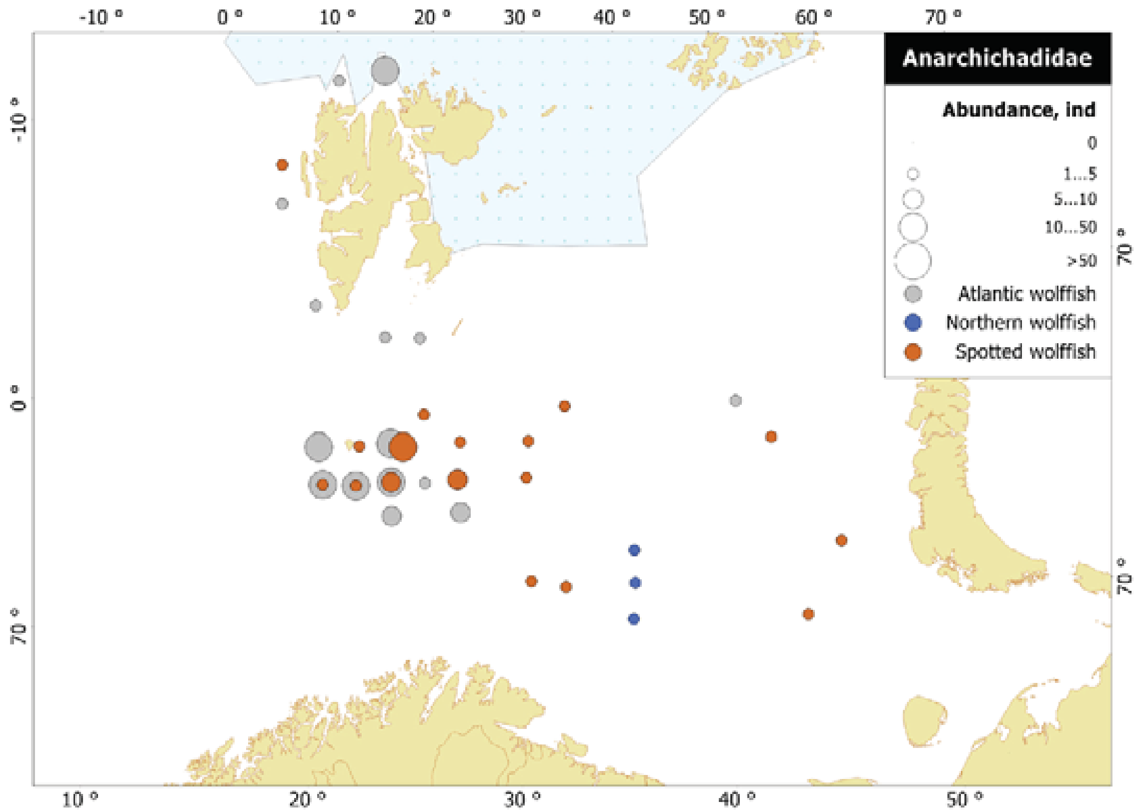


Figure 5.1.10.1. Distribution of 0-group wolffishes, August-September 2014.

The length of the 0-group Atlantic wolfish was 3.0-8.5 cm (mean length 6.2 cm), Spotted wolfish – 5.5-8.5 cm (mean length – 7.1 cm) and Northern wolfish – 5.5-8.0 cm (mean length – 7.4 cm).

No index is calculated for this species. But the distribution of 0-group 2014 year class is larger than in 2013.

5.1.11 Sandeel (*Ammodytes marinus*)

The species *Ammodytes marinus* and *Ammodytes tobianus* belong to the Family Ammodytidae in the Barents Sea. The *Ammodytes marinus* species is widely distributed in the sea, while *Ammodytes tobianus* was found to be very rare; being only distributed along the northern Norwegian coast. Thus figure 5.1.11.1. only shows the distribution of *Ammodytes marinus*.

In 2014 0-group sandeels were mostly found in the southeast part of the Barents Sea and some catches were taken in the western area. The denser concentrations were found as usually in the southern part.

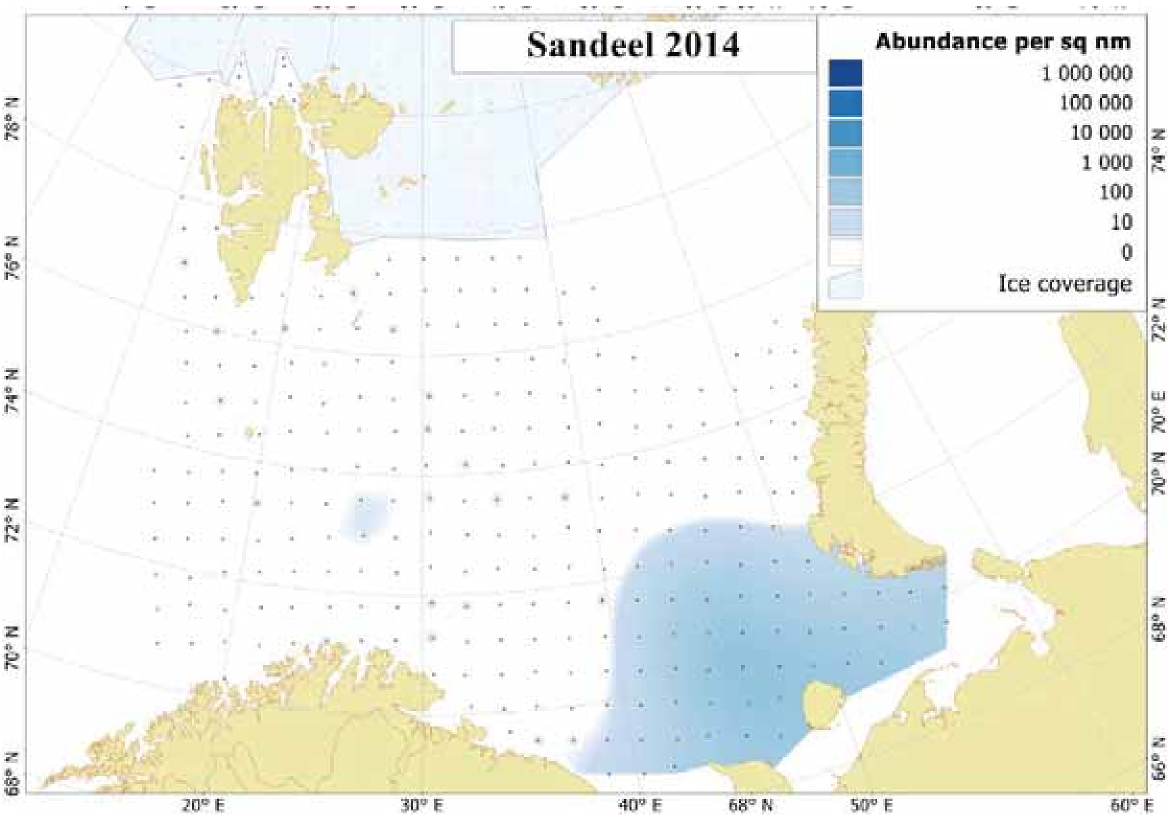


Figure 5.1.11.1. Distribution of 0-group *A. marinus*, August-September 2013.

The calculated density was from 174 to 255 thousand fish per square nautical mile, with an average of 2.6 thousand fish per square nautical miles, that is lower than in 2012 and 2013.

The most fish have length 5.0-7.0 cm (Table 5.1.4). Sometimes otolith were taken to separate 0-group and 1-year sandeel. Average length in 2014 was 5.7 cm, which is lower than in 2012 (6.2 cm) and 2013 (7.4 cm) and at same level as the long term mean.

The calculated abundance and biomass 1 229 tonnes is presented in “Biodiversity” section.

5.1.12 Mackerel (*Scomber scombrus*)

In the Barents Sea 0-group mackerel have been observed during the survey in some years, causing some extention towards the north and northwest of the mackerel spawning area and drift larvae in to the Barents Sea. Some catches of 0-group mackerel were found between 70 - 72°N and 19 25 °E (Figure 5.1.12.1).

0-group mackerel were observed at 8 stations during the survey, which is less than in 2013. The calculated mean density was 48 fish per square nautical miles, and the highest calculated densities were as high as around 5 thousand fish per station.

Fish length varied between 1.0 and 5.5 cm (Table 5.1.4). The mean length of fish was 2.5 cm and it is lower than in 2013 (4.2 cm) and the long term mean (4.3 cm).

No index is calculated for mackerel.

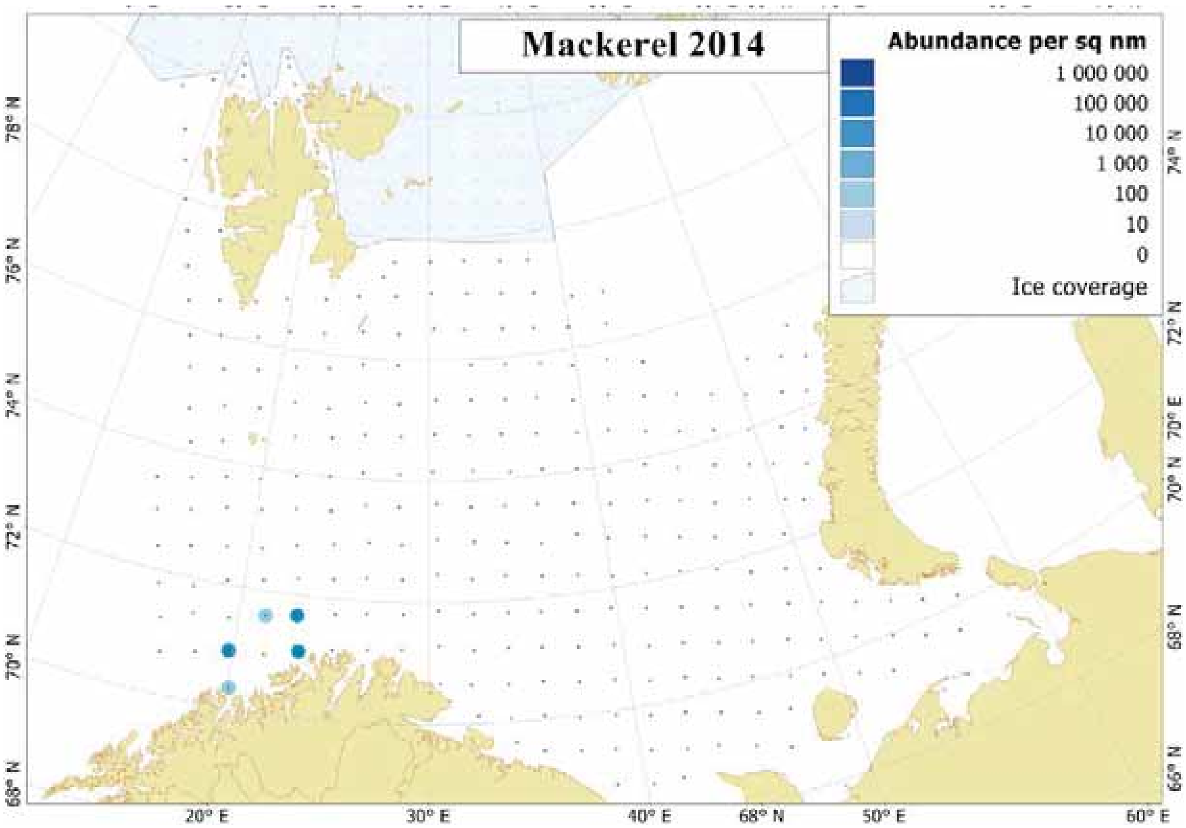


Figure 5.1.12.1. Distribution of 0-group mackerel, August-September 2013.

5.1.13 Blue whiting (*Micromesistius poutassou*)

No observations of 0-group blue whiting of 6.8 cm were recorded during the survey.

5.2 Pelagic fish abundance and distribution

Text by G. Skaret and D. Prozorkevich
Figures by J. Alvarez and D. Prozorkevich

Number of fish sampled during the survey is presented in Appendix 2.

5.2.1 Capelin (*Mallotus villosus*)

Distribution

The geographical density distribution of capelin of age group 1 and total stock are shown in Figures 5.2.1.1 and 5.2.1.2. The distribution area of capelin in the area which was covered was similar to that found in 2008-2011 and 2013, with high concentrations close to the coast east of Svalbard/Spitsbergen archipelago, and to the south-west of Frans Josef Land. Hardly any capelin were detected in the areas to the west of the Svalbard/Spitsbergen archipelago. Young capelin were mainly found to the south of 78ºN, and the total distribution area of young capelin was lower than in previous years, in particular in the eastern Barents Sea.

The area in between Svalbard/Spitsbergen archipelago and Frans Josef Land north of 78° was not accessible due to extensive broken ice cover. Both young and adult capelin were distributed here in 2013, and adult capelin regionally in high concentrations. There was also not enough available ship time to cover the area east of 60 degrees east. Adult capelin was found here in 2013.

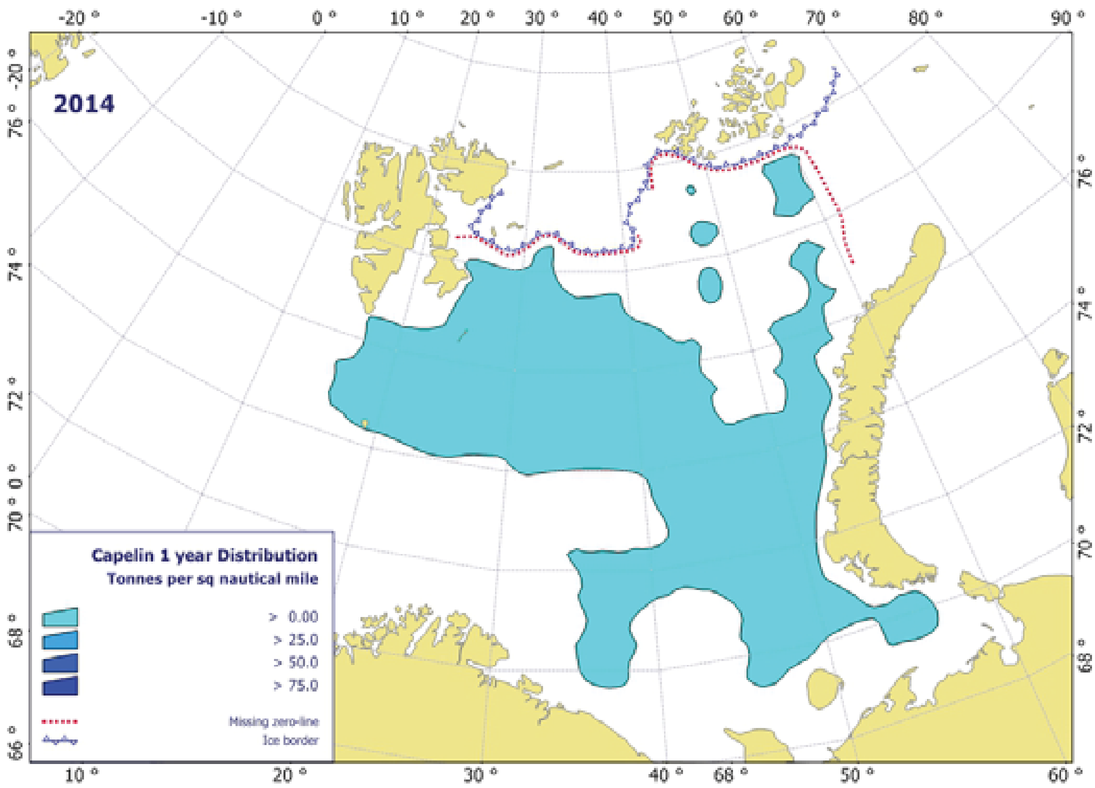


Figure 5.2.1.1 Estimated density distribution of 1-year-old capelin (t/sq nautical mile), August-October 2014.

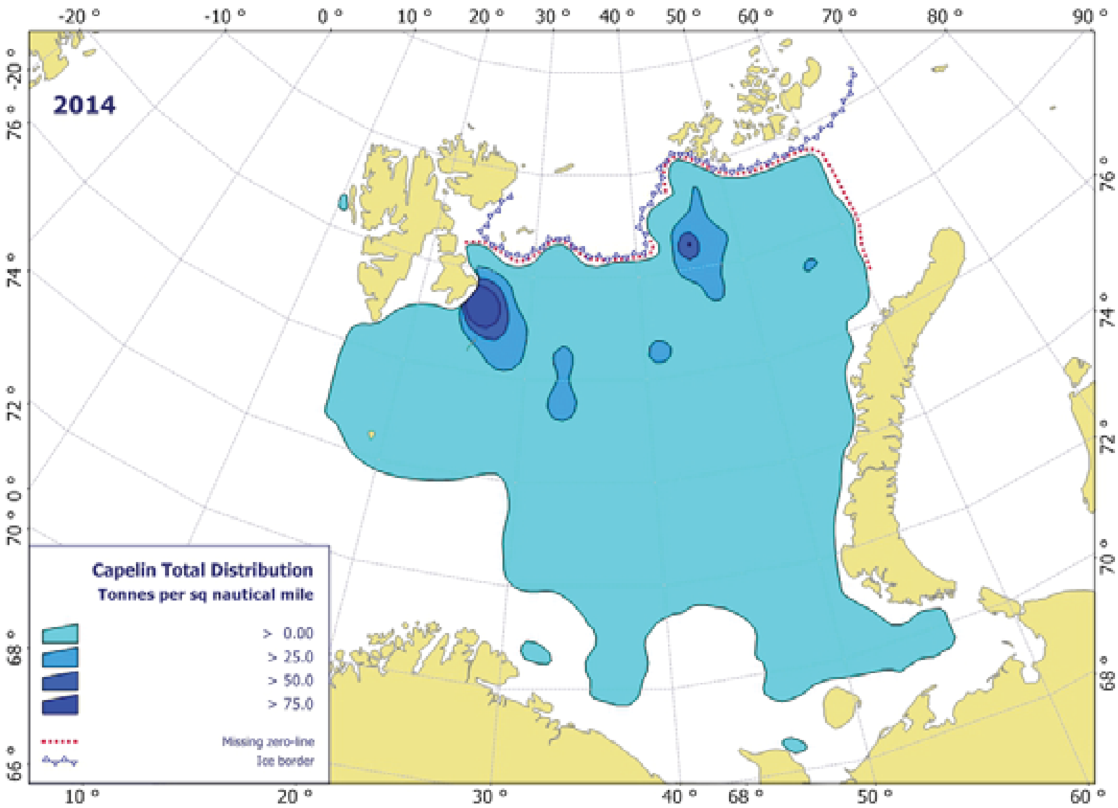


Figure 5.2.1.2. Estimated total density distribution of capelin (t/sq nautical mile), August-October 2014

Abundance estimate and size by age

A detailed stock size estimate is given in Table 5.2.1.1, and the time series of abundance estimates is summarized in Table 5.2.1.2. Note that the estimates for 2014 are not corrected for the reduced area coverage, but corrections were added for the input to the stock assessment and prognosis model for capelin (CapTool). The mature part of the stock is basis for the prognosis of spawning stock in spring 2015, where also mortality induced by predation enters into the calculations. The work concerning assessment and quota advice for capelin is dealt with in a separate report that will form part of the ICES Arctic Fisheries Working Group report for 2015.

The main results of the abundance estimation in 2014 are summarized in Table 5.2.1.3. The 2013 estimate is shown on a shaded background for comparison. The total stock is estimated at about 2 million tonnes, which is only about 50% of the stock size estimated for 2013, and lower than the long term mean level (about 3 million tonnes, Table 5.2.1.2). About 44 % (0.8 million tonnes) of this stock has length above 14 cm and is considered to be maturing. Again, these values are not compensated for reduced survey coverage, and in the management advice, the abundance is corrected based on the 2011-2013 capelin distribution in the uncovered area (See ICES Arctic Fisheries Working Group report for 2015).

The 2013 year class (1-year group) consists, according to this estimate, of about 105 billion individuals. This estimate is lower than the long-term average. The mean weight (3 g) is 0.2 g lower than that measured last year and somewhat below the long-term average (see also figure

5.2.1.3). The biomass of the 2013 year class is about 0.32 million tonnes, which is the lowest since the 2006 year class, and >50% below the long term mean. It should be kept in mind that, given the limitations of the acoustic method concerning mixed concentrations of small capelin and 0-group fish and near-surface distribution, the 1-year group estimate might be more uncertain than that for older capelin.

The estimated number for the 2012 year class (2-year group) is about 107 billion, which is >50 % of the size of the 2011 year class measured in 2013. The mean weight of this group in 2014 is 9 g. This mean weight is higher than in 2013 (8.4 g), but ca. 1.5 grams below the long-term average (Table 5.2.1.2). The biomass of the 2-year group is about 1 million tonnes in 2014; a value which is below the long term average and the lowest since 2007.

The 2011 year class is estimated at about 39 billion individuals; a figure that is 35% lower than the estimated size of three-year-olds in 2013. This age group with mean weight 16.3 g (about 3.2 g below the long-term average) has a biomass of about 0.64 million tonnes, which is a little below the long-term average. The 2010 year class (now 4 years old) is estimated at about 2 billion individuals. With a mean weight of 20.3 g, this age group makes up about 40 thousand tonnes, about 25% of the estimate of this age group last year, and well below the long term average. Practically no capelin older than four years was found.

Table 5.2.1.1. Barents Sea capelin. Acoustic estimate in August-October 2014. The figures are not compensated for incomplete survey coverage.

Length (cm)	Age/Year class 1 2013	2 2012	3 2011	4 2010	Sum (10^9)	Biomass (10^3 t)	Mean weight (g)
6-6.5	0.486	0	0	0	0.486	0.3	0.7
6.5-7	4.655	0	0	0	4.655	4.7	1
7-7.5	9.225	0	0	0	9.225	10.3	1.1
7.5-8	7.575	0.503	0	0	8.078	11.6	1.4
8-8.5	9.533	0	0	0	9.533	19.1	2
8.5-9	11.729	0	0	0	11.729	27.8	2.4
9-9.5	15.154	0.448	0	0	15.602	45.2	2.9
9.5-10	15.827	0.668	0	0	16.494	56.3	3.4
10-10.5	16.242	1.533	0	0	17.775	70.9	4
10.5-11	8.49	4.832	0	0	13.321	62.9	4.7
11-11.5	2.951	10.349	0.165	0	13.466	74.9	5.6
11.5-12	1.883	13.922	0.098	0	15.904	101.3	6.4
12-12.5	0.572	16.284	0.369	0	17.225	127.9	7.4
12.5-13	0.4	16.437	1.366	0	18.204	155.4	8.5
13-13.5	0.258	15.073	1.82	0	17.151	165.6	9.7
13.5-14	0.087	9.215	3.455	0	12.757	141.2	11.1
14-14.5	0	6.906	3.974	0.157	11.038	138.1	12.5
14.5-15	0	4.872	6.848	0.092	11.812	171.2	14.5
15-15.5	0.084	1.898	5.135	0.316	7.432	119.6	16.1
15.5-16	0	1.765	7.294	0.264	9.323	171	18.3
16-16.5	0	0.97	3.521	0.501	4.992	103	20.6
16.5-17	0	0.224	3.056	0.3	3.58	83.6	23.4
17-17.5	0	0.446	1.366	0.143	1.955	51.6	26.4
17.5-18	0	0.204	0.712	0.117	1.033	29.2	28.2
18-18.5	0	0.039	0.095	0.067	0.202	6	29.9
18.5-19	0	0.001	0.008	0.002	0.01	0.3	30.5
19-19.5	0	0	0.004	0	0.004	0.1	36.5
TSN(10^9)	105.152	106.59	39.288	1.958	252.988		
TSB(10^3 t)	316.8	954.2	638.5	39.7		1949.1	
Mean length	9.2	12.7	15.1	16.1	11.7		
Mean weight (g)	3	9	16.3	20.3	7.7		
SSN(10^9)	0.084	17.325	32.013	1.959	51.381		
SSB(10^3 t)	1.4	263.8	568.5	39.7		873.7	

Table 5.2.1.2. Barents Sea capelin. Acoustic estimates of the stock by age in autumn. Biomass (B) in 10^6 tonnes, average weight (AW) in grams. All estimates based on TS = 19.1Log L -74.0 dB

	Age										
Year	1		2		3		4		5		Sum 1+
	B	AW	B	AW	B	AW	B	AW	B	AW	B
1973	1.69	3.2	2.32	6.2	0.73	18.3	0.41	23.8	0.01	30.1	5.14
1974	1.06	3.5	3.06	5.6	1.53	8.9	0.07	20.8	+	25	5.73
1975	0.65	3.4	2.39	6.9	3.27	11.1	1.48	17.1	0.01	31	7.81
1976	0.78	3.7	1.92	8.3	2.09	12.8	1.35	17.6	0.27	21.7	6.42
1977	0.72	2	1.41	8.1	1.66	16.8	0.84	20.9	0.17	22.9	4.8
1978	0.24	2.8	2.62	6.7	1.2	15.8	0.17	19.7	0.02	25	4.25
1979	0.05	4.5	2.47	7.4	1.53	13.5	0.1	21	+	27	4.16
1980	1.21	4.5	1.85	9.4	2.83	18.2	0.82	24.8	0.01	19.7	6.71
1981	0.92	2.3	1.83	9.3	0.82	17	0.32	23.3	0.01	28.7	3.9
1982	1.22	2.3	1.33	9	1.18	20.9	0.05	24.9			3.78
1983	1.61	3.1	1.9	9.5	0.72	18.9	0.01	19.4			4.23
1984	0.57	3.7	1.43	7.7	0.88	18.2	0.08	26.8			2.96
1985	0.17	4.5	0.4	8.4	0.27	13	0.01	15.7			0.86
1986	0.02	3.9	0.05	10.1	0.05	13.5	+	16.4			0.12
1987	0.08	2.1	0.02	12.2	+	14.6	+	34			0.1
1988	0.07	3.4	0.35	12.2	+	17.1					0.43
1989	0.61	3.2	0.2	11.5	0.05	18.1	+	21			0.86
1990	2.66	3.8	2.72	15.3	0.44	27.2	+	20			5.83
1991	1.52	3.8	5.1	8.8	0.64	19.4	0.04	30.2			7.29
1992	1.25	3.6	1.69	8.6	2.17	16.9	0.04	29.5			5.15
1993	0.01	3.4	0.48	9	0.26	15.1	0.05	18.8			0.8
1994	0.09	4.4	0.04	11.2	0.07	16.5	+	18.4			0.2
1995	0.05	6.7	0.11	13.8	0.03	16.8	0.01	22.6			0.19
1996	0.24	2.9	0.22	18.6	0.05	23.9	+	25.5			0.5
1997	0.42	4.2	0.45	11.5	0.04	22.9	+	26.2			0.91
1998	0.81	4.5	0.98	13.4	0.25	24.2	0.02	27.1	+	29.4	2.06
1999	0.65	4.2	1.38	13.6	0.71	26.9	0.03	29.3			2.77
2000	1.7	3.8	1.59	14.4	0.95	27.9	0.08	37.7			4.27
2001	0.37	3.3	2.4	11	0.81	26.7	0.04	35.5	+	41.4	3.63
2002	0.23	3.9	0.92	10.1	1.04	20.7	0.02	35			2.21
2003	0.2	2.4	0.1	10.2	0.2	18.4	0.03	23.5			0.53
2004	0.2	3.8	0.29	11.9	0.12	21.5	0.02	23.5	+	26.3	0.63
2005	0.1	3.7	0.19	14.3	0.04	20.8	+	25.8			0.32
2006	0.29	4.8	0.35	16.1	0.14	24.8	0.01	30.6	+	36.5	0.79
2007	0.93	4.2	0.85	15.5	0.1	27.5	+	28.1			1.88
2008	0.97	3.1	2.8	12.1	0.61	24.6	0.05	30			4.43
2009	0.42	3.4	1.82	10.9	1.51	24.6	0.01	28.6			3.76
2010	0.74	3	1.3	10.2	1.43	23.4	0.02	26.3			3.5
2011	0.5	2.4	1.76	9.7	1.21	21.9	0.23	29.1			3.71
2012	0.54	3.7	1.37	8.8	1.62	18.5	0.06	25			3.59
2013	1.04	3.2	1.81	8.4	0.94	15.9	0.16	23.2	0	29.1	3.96
2014*	0.32	3	0.96	9	0.64	16.3	0.04	20.3	0	0	1.96
Average	0.66	3.55	1.36	10.59	0.87	19.29	0.21	24.80	0.06	26.25	3.03

*Not compensated for incomplete survey coverage

Table 5.2.1.3 Table on summary of stock size estimates for capelin. The figures are not compensated for incomplete survey coverage.

Year class		Age	Number (10^9)		Mean weight (g)		Biomass (10^3 t)	
2013	2012	1	105.2	324.5	3	3.2	316.8	1036.3
2012	2011	2	106.6	216.2	9	8.4	954.2	1810.9
2011	2010	3	39.3	59.2	16.3	16	638.5	944.1
2010	2009	4	2	7.1	20.3	23.2	39.7	164.3
Total stock in:								
2014	2013	1-4	253	606.9	7.7	6.5	1949.1	3955.7

Based on TS value: 19.1 log L – 74.0, corresponding to $\sigma = 5.0 \cdot 10^7 \cdot L^{1.91}$

Total mortality calculated from surveys

Table 5.2.1.4 shows the number of fish in the various year classes, and their "survey mortality" in transition from age one to two. As there has been no fishing on these age groups, the figures for total mortality constitute only natural mortality (M).

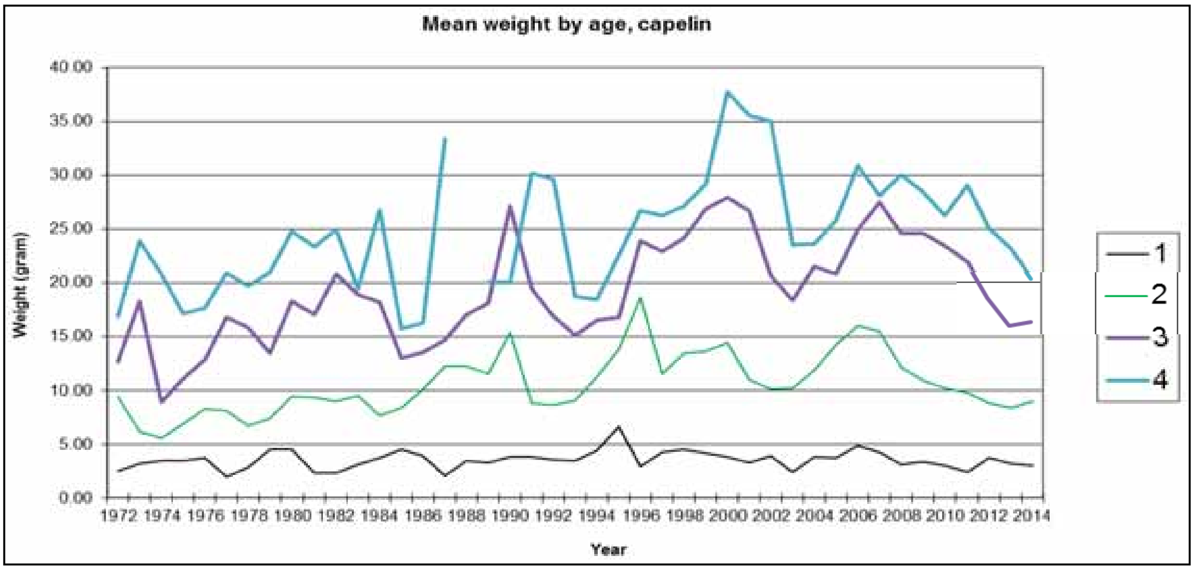


Figure 5.2.1.3. Weight at age (grams) for capelin from capelin surveys and BESS.

The estimates of M have varied considerably, but give quite good indications of the predation on capelin, given the constraints of survey uncertainties. In 2008, 2010 and 2013, M was estimated to a negative value. This shows that in those years either the one-year group was underestimated or the two-year group was overestimated or a combination of those. This year the estimate of M was the highest since 2005. It is highly likely that the estimate of 2-year-olds this year is biased low due to incomplete survey coverage, and that this will bias high the estimate of M, but the extent of this source of systematic error is not known.

Table 5.2.1.4. Barents Sea capelin. Survey mortalities from age 1 to age 2.

Year	Year class	Age 1 (10^9)	Age 2 (10^9)	Total mort. %	Total mort. Z
1984-1985	1983	154.8	48.3	69	1.16
1985-1986	1984	38.7	4.7	88	2.11
1986-1987	1985	6	1.7	72	1.26
1987-1988	1986	37.6	28.7	24	0.27
1988-1989	1987	21	17.7	16	0.17
1989-1990	1988	189.2	177.6	6	0.06
1990-1991	1989	700.4	580.2	17	0.19
1991-1992	1990	402.1	196.3	51	0.72
1992-1993	1991	351.3	53.4	85	1.88
1993-1994	1992	2.2	3.4	-	-
1994-1995	1993	19.8	8.1	59	0.89
1995-1996	1994	7.1	11.5	-	-
1996-1997	1995	81.9	39.1	52	0.74
1997-1998	1996	98.9	72.6	27	0.31
1998-1999	1997	179	101.5	43	0.57
1999-2000	1998	155.9	110.6	29	0.34
2000-2001	1999	449.2	218.7	51	0.72
2001-2002	2000	113.6	90.8	20	0.22
2002-2003	2001	59.7	9.6	84	1.83
2003-2004	2002	82.4	24.8	70	1.2
2004-2005	2003	51.2	13	75	1.39
2005-2006	2004	26.9	21.7	19	0.21
2006-2007	2005	60.1	54.8	9	0.09
2007-2008	2006	221.7	231.4	-	-
2008-2009	2007	313	166.4	47	0.63
2009-2010	2008	124	127.9	-	-
2010-2011	2009	247.7	181.1	27	0.31
2011-2012	2010	209.6	156.3	25	0.29
2012-2013	2011	145.9	216.2	-	-
2013-2014*	2012	324.5	106.6	67	1.11

*Not compensated for incomplete survey coverage

5.2.2 Herring (*Clupea harengus*)

Distribution in 2014

Young herring was widely distributed in the Barents Sea in 2014 (Figure 5.2.2.1). The eastern distribution border was at 45° E, and in the western areas along the continental slope there were mostly herring of older ages. In the central part of the Barents Sea there was dominance of herring of the age groups 1-3 years, in particular 3-year-olds which were present in large quantities. The main concentrations were found between 30° and 45° E from the Murman coast to 73° N.

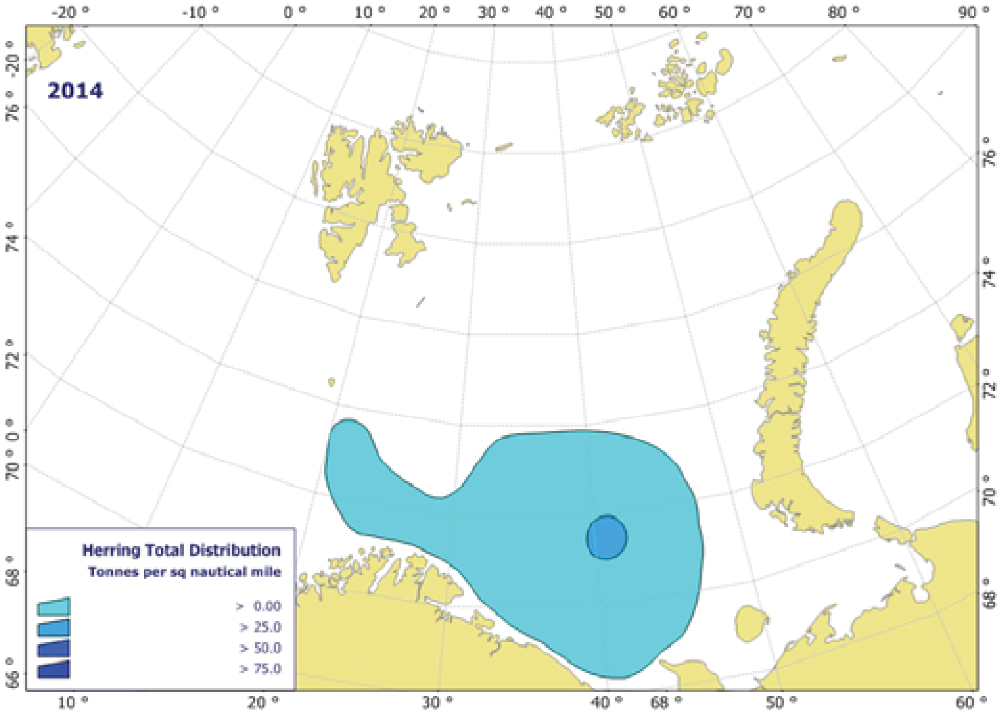


Figure 5.2.2.1. Estimated total density distribution of herring (t/nautical mile^2), August-October 2014.

Abundance estimation

During the last few years there has been a low abundance of juvenile herring in the Barents Sea. In 2010, herring were practically absent in the eastern and central parts of the Barents Sea. In 2011, the herring abundance further decreased, and the level of the juvenile stock proportion was only 10% of average annual level.

In 2012-2013, the abundance of young herring increased, and biomass continued to increase in 2014, but numbers decreased, and abundance is still below the average annual level. Estimated abundance of herring based on acoustics is shown in Table 5.2.2.1.

The total number of herring in the Barents Sea (ages 1-4) in 2014 was estimated at 7.1 billion individuals, which is somewhat lower than in 2013 (12.8 billion individuals). Estimated herring biomass increased by 30 %. The increase in biomass is due to increased weight of the dominant 2011 yearclass. Comparative estimates of abundance and biomass of herring are shown in Table 5.2.2.2.

Table 5.2.2.1. Norwegian spring spawning herring. Acoustic estimate in the Barents Sea in Aug-Oct 2014.

Length (cm)	Age /Year class				Sum (10^6)	Biomass (10^3 t)	Mean weight (g)
	1/2013	2/2012	3/2011	4+/>2010			
9.5	49.14				49.15	0.26	5.35
10.0	245.72				245.72	1.55	6.31
10.5	208.87				208.87	1.54	7.39
11.0	442.30				442.30	3.80	8.59
11.5	159.97	12.04			172.01	1.71	9.91
12.0	430.02				430.02	4.89	11.38
12.5	12.29				12.29	0.16	12.99
13.0	12.29				12.29	0.18	14.75
13.5	24.57				24.57	0.41	16.67
14.0	36.86				36.86	0.69	18.76
14.5	196.58				196.58	4.13	21.03
15.0	159.72				159.72	3.75	23.48
15.5	270.30				270.30	7.06	26.12
16.0	184.29				184.29	5.34	28.96
16.5	110.58				110.58	3.54	32.02
17.0	24.57				24.57	0.87	35.28
17.5	12.29				12.29	0.48	38.78
18.0					12.29	0.52	42.50
18.5					12.29	0.57	46.47
19.5		24.57			24.57	1.36	55.17
20.0		12.29			12.29	0.74	59.92
20.5		49.14			49.15	3.19	64.95
21.0		36.86			36.86	2.59	70.26
21.5		61.43			61.43	4.66	75.87
22.0		98.29			98.29	8.04	81.79
22.5		61.43			61.43	5.41	88.01
23.0			49.14		49.15	4.65	94.56
23.5			61.43		61.43	6.23	101.44
24.0			393.16		393.16	42.72	108.67
24.5		20.90	974.28		995.18	115.68	116.24
25.0			896.89		896.89	111.37	124.18
25.5			700.31		700.31	92.78	132.48
26.0			307.15		307.15	43.36	141.16
26.5			103.20	68.80	172.01	25.84	150.23
27.0			122.86		122.86	19.62	159.70
33.0				24.57	24.57	7.57	307.97
33.5				24.57	24.57	7.95	323.52
34.0				49.14	49.15	16.69	339.60
34.5				86.00	86.00	30.64	356.24
35.0				73.72	73.72	27.53	373.43
35.5				49.14	49.15	19.23	391.19
36.0				61.43	61.43	25.16	409.53
36.5				24.57	24.57	10.53	428.46
37.0				49.14	49.15	22.02	448.00
TSN(10^6)	2580.34	376.95	3608.44	511.11	7101.41		
TSB(10^3 t)	40.24	28.53	449.49	177.64		696.99	
Mean length (cm)	12.78	21.28	25.00	33.94	20.98		
Mean weight (g)	15.60	75.68	124.57	347.55			98.15

TS=20.0* log(L) - 71.9

Table 5.2.2.2. Norwegian spring spawning herring. Acoustic estimates by age in autumn 1999-2014. TSN and TSB are total stock numbers (10^6) and total stock biomass (10^3 t)

Age	1		2		3		4+		Sum	
Year	TSN	TSB	TSN	TSB	TSN	TSB	TSN	TSB	TSN	TSB
1999	48758.6	715.9	985.9	31.0	50.7	2.0			49795.2	748.9
2000	14731.0	382.6	11499.0	560.3					26230.0	942.9
2001	524.5	12.0	10544.1	604.3	1714.4	160.0			12783.0	776.3
2002	-	-	-	-	-	-	-	-	-	-
2003	99785.7	3090.3	4335.7	220.1	2475.6	325.5			106596.9	3636.4
2004	14265.0	406.4	36495.0	2725.3	901.0	106.6	45.0	56.0	51717.0	3251.9
2005	46380.0	983.7	16167.0	1054.5	6973.0	795.2			69520.0	2833.4
2006	1618.0	34.2	5535.0	398.4	1250.0	152.3	370.0	58.2	8773.0	643.0
2007	3941.0	147.5	2595.0	217.5	6378.0	810.1	250.0	45.7	13164.0	1220.9
2008**	29.6	0.6	1626.4	76.9	3987.0	287.3	4.1164	523.9	9.7594	888.7
2009	1538.0	48.4	433.0	51.8	1807.0	287.3	1799.0	427.4	5577.00	814.80
2010	1047.0	34.5	315.0	33.7	234.0	37.0	429.0	102.2	2025.0	207.3
2011	95.0	2.9	1504.0	105.5	6.0	0.8			1605.0	109.2
2012	2031.0	36.1	1078.0	65.6	1285.0	194.6			4394.0	296.4
2013	7657.0	202.1	5027.0	321.6	91.0	12.5	57.0	8.9	12832.0	545.2
2014	2580.3	40.24	377.0	28.53	3608.4	449.5	511.11	177.64	7101.41	697.0
1999-2014	16332.1	409.2	6567.8	433.0	2197.2	258.6	433.2	175.0	24808.2	1174.2

*- the primary data has been checked and revised in November 2014

** - including several Kanin herring (mix concentration in south-east area)

Number of 1-year olds decreased by 75% to 2.5 billion individuals from 2013, and remained well below the long-term averages (16.3 billion individuals). In addition, the average weight and length of 1-year olds (15.6 g and 12.8 cm) was lower than last year (26.4 g and 15.8 cm). Historically, the minimum length of 1-year olds in August and September has been set to 12.5 cm, this year it was set to 9.5 cm. This low length is consistent with the data of the International ecosystem survey in the Nordic Seas (IESNS), obtained in May-June 2014 (Figure 5.2.2.2).

The were an estimated 0.37 billion 2-year olds. It is lower than last year (5.0 billion individuals), and accordingly, the estimated biomass of this group in 2014 (29 000 tonnes) was lower than in 2013 (322 000 tonnes). The average length of 2-year group (21.3 cm) was similar as previous year (20.7 cm), but average weight of fish was higher (75.7 g in 2014 and 64.0 g in 2013).

The 3-year olds dominated both in biomass (257 000 tonnes) and numbers (3.6 billion individuals). The average weight and length of the 3-year olds (126 g and 25.0 cm) were lower than in 2013 (138.1 g and 26.4 cm).

In 2014 herring age group spanning from 4 to 13 years were found, mainly in western areas. The estimated number of all group 4+ herring amounted to 511000 individuals, and biomass to 178000 tonnes (in 2013 – 57 000 individuals and 8 900 tonnes).

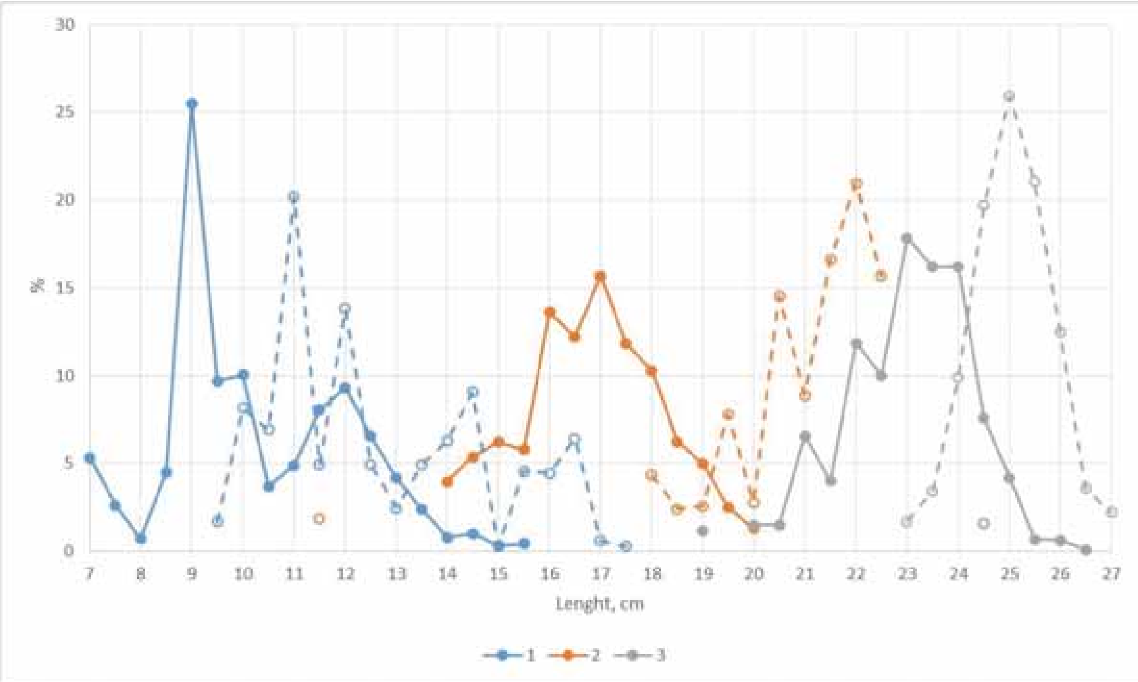


Figure 5.2.2.2. The length of herring in the age of 1-3 years, caught in the Barents Sea in May-June (IESNS, solid line) and in August-September (BESS, dashed line) 2014

5.2.3 Blue whiting (*Micromesistius poutassou*)

The old target strength (TS) used for blue whiting during the BESS differ from the new TS value now used in the main blue whiting surveys west of the British Isles and in the Norwegian Sea. The time series in the Barents Sea needs to be recalculated using the new TS in the future. Consequently, the estimates should, to a greater extent than the other estimates, be considered as relative estimates.

Blue whiting is an important component of the Barents Sea ecosystem. Changes in the status of the stock of blue whiting in the Norwegian Sea are also observed in the Barents Sea.

Distribution

As in previous years, blue whiting was observed in the western part of the Barents Sea. In comparison with 2013, the distribution was a little further to the north along the western coast of Svalbard/Spitsbergen and to east in the central part of Barents Sea (Figure 5.2.3.1).

In 2004-2005 estimated biomass of blue whiting in the Barents Sea was higher than 1 million tonnes (Table 5.2.3.1). In 2008, the estimated biomass of blue whiting showed an abrupt reduction to less than 13% of the previous year and has later been variable, but lower than the 2004-2014 average. Since 2012, there has been a decrease in the estimated abundance of blue whiting in the Barents Sea (Figure 5.2.3.2).

The number of 1-year olds (2013 yearclass) increased by more than 100 times from previous year to reach an estimated 639 million individuals. The 2011 yearclass (age 3) still dominated in number, while the number of age 4+ remained similar as last year (Table 5.2.3.1).

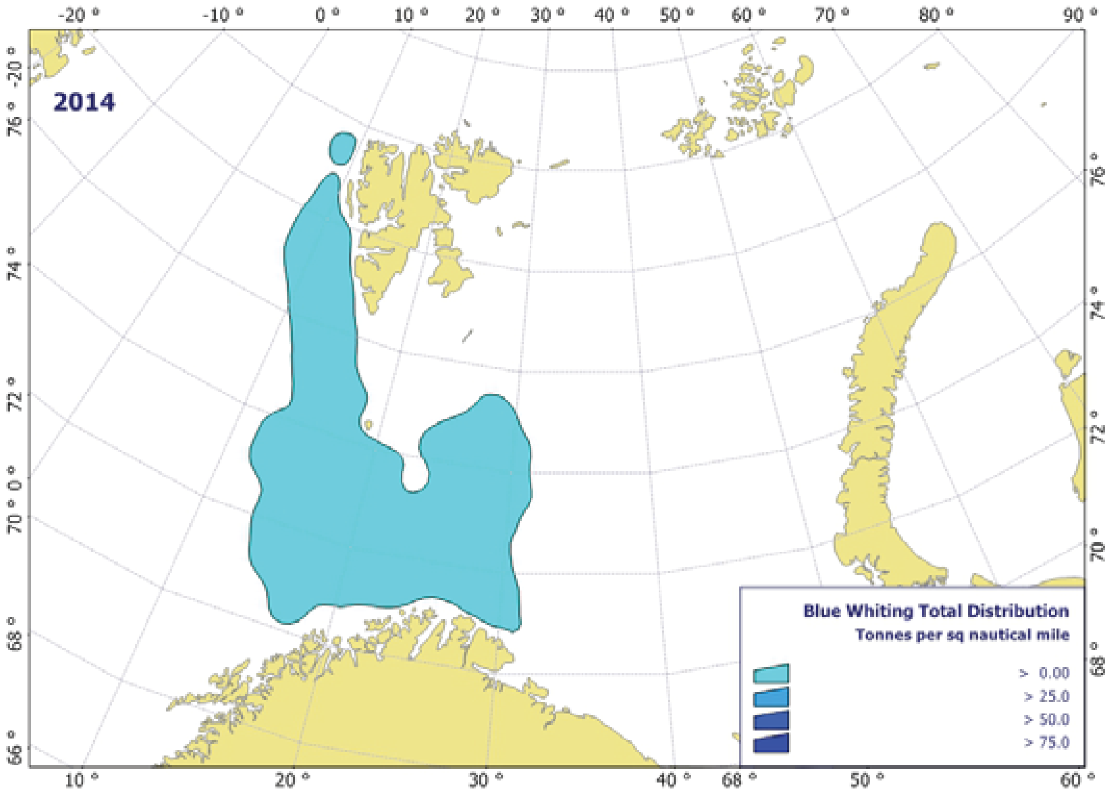
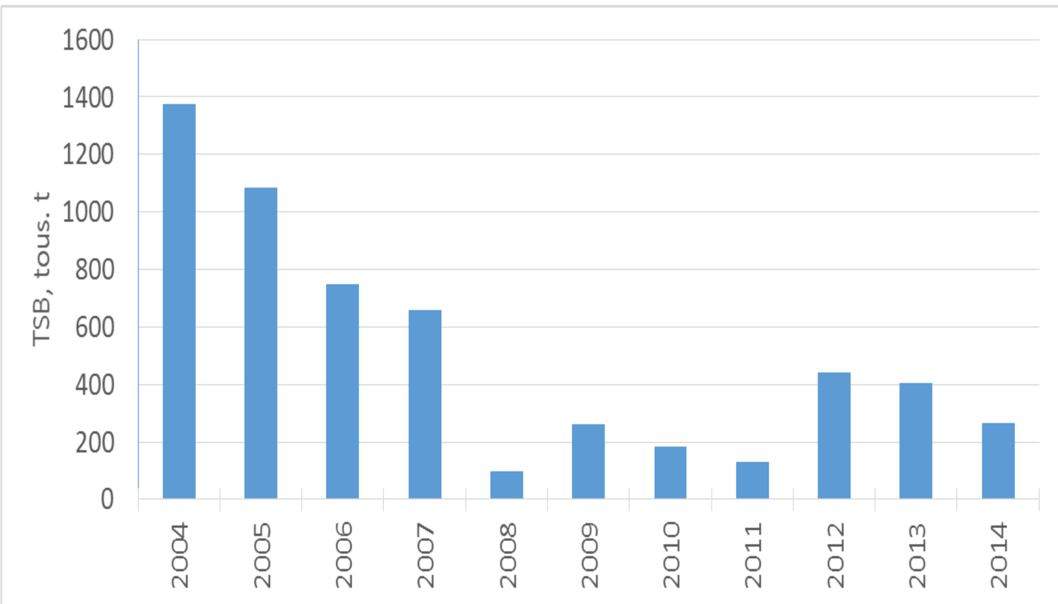


Figure 5.2.3.1.Estimated distribution of blue whiting (t/nautical mile^2) based on acoustic recordings, August-October 2014



5.2.3.2. Total biomass of blue whiting in the Barents sea (BESS data)

Table 5.2.3.1. Blue whiting. Acoustic estimate in the Barents Sea in August-October 2014.

Length (cm)	Age/Yearclass												Sum (10^6)	Biomass (10^3 t)	Mean weigt (g)
	1	2	3	4	5	6	7	8	9	10	11	12			
	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002			
15.0 - 15.5	1												1		17
16.5 - 17.0	2												2		24.5
17.0 - 17.5	11												11	0.3	26.7
17.5 - 18.0	5												5	0.2	30.1
18.0 - 18.5	73												73	2.3	32
18.5 - 19.0	36												36	1.3	34.5
19.0 - 19.5	152												152	5.7	37.3
19.5 - 20.0	78												78	3.2	41.8
20.0 - 20.5	128												128	6.6	51.6
20.5 - 21.0	47												47	2.4	51
21.0 - 21.5	58												58	3.4	58.6
21.5 - 22.0	33												33	2	61.5
22.0 - 22.5	16		6										22	1.2	55.6
22.5 - 23.0		6											6	0.4	67.9
23.0 - 23.5			17	8									25	1.7	70.6
23.5 - 24.0			17	1									19	1.4	72.6
24.0 - 24.5		31	40	16									87	7.1	81.2
24.5 - 25.0		4	60	6									70	5.9	84
25.0 - 25.5		9	148										157	14.7	93.7
25.5 - 26.0			88										88	8.7	98.7
26.0 - 26.5			107	6									113	12	105.9
26.5 - 27.0		33	81	16									129	14.9	114.9
27.0 - 27.5			143	2									145	17.6	121.8
27.5 - 28.0			78										78	10	127.6
28.0 - 28.5			61	15									77	10.8	140.8
28.5 - 29.0			32	8									40	5.8	147.5
29.0 - 29.5				46									46	7.3	160.8
29.5 - 30.0			17	1				6					25	4	160.9
30.0 - 30.5			17	14	13			3					47	8.5	179.9

Table 5.2.3.1 cont.

Length (cm)	Age/Yearclass												Sum	Biomass	Mean
	1	2	3	4	5	6	7	8	9	10	11	12	(10^6)	(10^3 t)	weigt (g)
	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002			
31.0 - 31.5					33								33	6.3	188.9
31.5 - 32.0								12					12	2.3	199.9
32.0 - 32.5							9	4		4			17	3.4	204.6
32.5 - 33.0							2	12	11				26	5.3	204.3
33.0 - 33.5						16	3	9	4				34	7.1	212.6
33.5 - 34.0									18				18	4	222.8
34.0 - 34.5							29		5				34	7.8	230.2
34.5 - 35.0					1		1	10	10	10			31	7.7	247.8
35.0 - 35.5								2	15	15		1	33	8.6	257.4
35.5 - 36.0						16	4	14	19				54	14.3	265
36.0 - 36.5								4	31				35	9.8	279.6
36.5 - 37.0									3	11		16	31	8.8	285.4
37.0 - 37.5									18	1			19	6.1	320.2
37.5 - 38.0									10	5	1		15	4.7	310.1
38.0 - 38.5						7			1		1		9	3.2	369.1
38.5 - 39.0										7	2		9	3.1	345.8
39.5 - 40.0											1		1	0.4	383
40.0 - 40.5										2			2	0.7	400.6
TSN (10^6)	639	83	932	139	47	40	49	78	145	55	4	18	2229		
TSB (10^3 t)	28.3	7.9	104.1	18.5	8.8	10.4	11	17.3	38.5	15.4	1.5	5		266.8	
Mean length (cm)	19.8	25.3	26.5	27.6	31	35.2	33.9	33.3	35.5	36.1	38.7	36.7			26.2
Mean weight (g)	44.3	95.3	111.7	132.9	187.2	261.6	226.7	221	264.4	278.9	353.1	286.4			119.7

Table 5.2.3.2. Blue whiting. Acoustic estimates by age in autumn 2004-2014. TSN and TSB are total stock numbers (10^6) and total stock biomass (10^3)

Age/year	1		2		3		4+		Sum	
	N	B	N	B	N	B	N	B	N	B
2004	5787	219.1	3801	285.5	2878	264.8	4780	606.5	17268	1376.8
2005	4871	132.0	2770	180.0	4205	363.0	3213	409.8	15058	1084.1
2006	371	21.2	2227	158.8	2665	238.1	2491	330.6	7754	748.8
2007	3	0.1	245	23.2	2934	292.2	2221	315.1	5666	657.6
2008	3	0.1	2	0.1	11	1.1	604	95.4	620	96.9
2009	2	0.1	2	0.2	2	0.2	1513	260.8	1519	261.4
2010	0	0	0	0	13	2.8	884	179.3	897	182.6
2011	31	2.0	15	1.7	80	15.6	466	110.4	592	129.7
2012	2686	124.7	354	42.9	157	25.7	1046	248.1	4242	441.3
2013	5	0.4	610	61.9	83	12.5	595	143.1	3658	406.5
2014	639	28.3	83	7.9	932	104.1	575	126.4	2229	266.8
Mean 2004-2014	1309	48.0	919	69.3	1269	120.0	1672	256.9	5409	513.9

5.2.4 Polar cod (Boreogadus saida)

Distribution

Low abundances of polar cod were found in the traditional distribution area in the northern and the eastern Barents Sea, more specifically along the south coast of Novaya Zemlya and south of Franz Josef Land The polar cod distribution area was also smaller compared to previous years, and hardly any polar cod were found to the west of 40 degrees east. No high density regions were recorded. The total geographical density distribution of polar cod inside the survey area is shown in Figure 5.2.4.1.

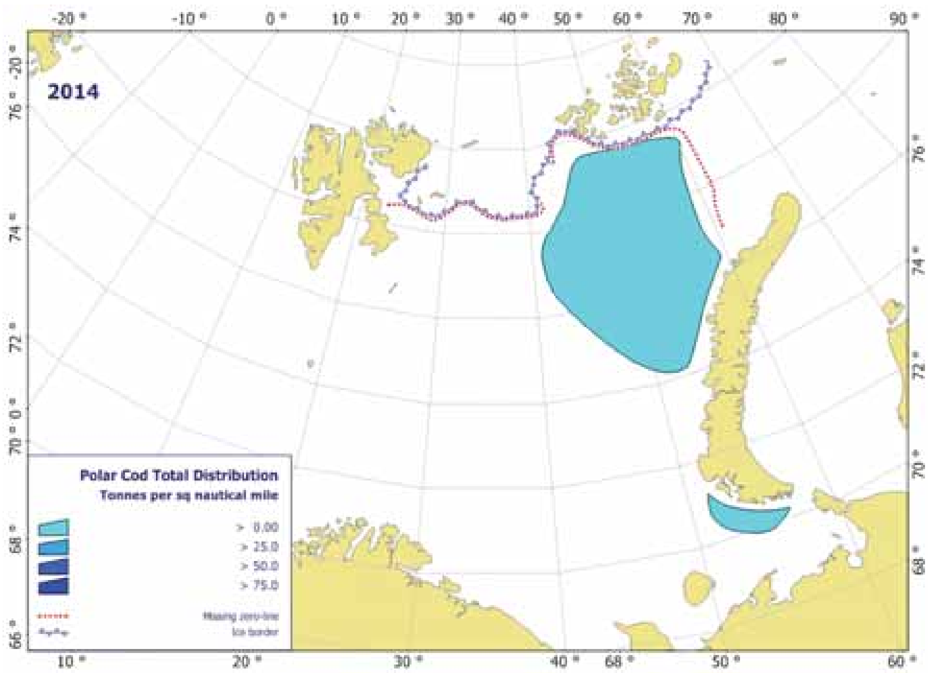


Figure 5.2.4.1 Estimated total density distribution of polar cod (t/sq nautical mile), August-October 2014.

Abundance estimation

The stock abundance estimate by age, number, and weight was calculated using the same methods as for capelin. A detailed estimate is given in Table 5.2.4.1, and the time series of abundance estimates is summarized in Table 5.2.4.2. The main results of the abundance in 2014 are summarized in table 5.2.4.3.

The following summarizes the results from the Barents Sea component: The estimated number of individuals in the 2013 year-class (the one-year-olds) is only 31% of the 2012 year-class measured as one-year-olds in 2013. The mean weight on the other hand, is a little higher, so the biomass of one-year-olds is ca. 36% of that estimated for the one-group in 2013. The abundance of the 2012 year class (the two-year-olds) is 4.4 billions, similar as corresponding age groups found in the two preceding years, and the mean weight was also similar. The biomass of two year-olds has therefore been stable the last three years. The abundance of three-years-old fish (2011 year class) decreased by ca. 39% from last year. The mean weight is also a little lower, so the biomass was reduced by ca. 42%, compared to the corresponding age group during the 2013 survey. The four-year-olds (2010 year class) were scarce, but had a higher mean weight than for the four-year-olds in 2013. No fish of age 5 or higher were found. The total size of the part of the stock covered, estimated at 0.24 million tonnes, is a ca. 30% reduction from last year.

After the decrease of the polar cod stock size in 2012, it has stabilized on a lower level. Age groups 2+ were obviously underestimated in 2012, but in any case significant increase in natural mortality and stock size reduction in recent years have been observed.

Total mortality calculated from surveys

Table 5.2.4.4 shows the “survey-mortality rates” of polar cod in the period 1985 to 2014. The mortality estimates are unstable during the whole period. Although unstable mortalities may indicate errors in the stock size estimation from year to year due to incomplete coverage and other reasons, the impression remains that there is a considerable total mortality on young polar cod. Prior to 1993, these mortality estimates represented natural mortality only, as practically no fishing took place. In the period 1993 to 2006 catches were at a level between 1 and 50 000 tonnes. Since there has been a minimum landing size of 13 cm in that fishery, a considerable amount of this could consist of two- and even one-year-olds, and this may explain some, but only a small part of the high total mortality. Negative survey mortalities were registered for age groups 1-2 from 2003-2004, 2006-2007 and 2009-2010 and also now from 2013-2014. This same was seen for age group 2-3 in 1998-1999, 2003-2004 and 2012-2013, confirming the previously expressed impression that, for some years and for various reasons, population numbers might have been underestimated.

Table 5.2.4.1 Barents Sea polar cod. Acoustic estimate in August-October 2014

	Age/Yearclass						
	1	2	3	4	Sum	Biomass	
Length (cm)	2013	2012	2011	2010	(10^9)	(10^3 t)	Mean weight (g)
6.5-7						0	2.7
7-7.5						0	3
7.5-8	1				1	0	2.8
8-8.5	2				2	0	4.5
8.5-9	13				13	0.1	4.6
9-9.5	30				30	0.2	5.6
9.5-10	52	1			53	0.3	6.5
10-10.5	59	1			60	0.4	7.4
10.5-11	138	3	2		143	1.2	8.3
11-11.5	116	3	1		120	1.1	9.6
11.5-12	122	11	2		135	1.4	10.2
12-12.5	75	18	12		105	1.3	12.6
12.5-13	79	77	2		158	2	12.8
13-13.5		77	1		79	1.1	14.4
13.5-14		189	4		193	3.5	18.1
14-14.5		247	1		248	4.5	18.1
14.5-15		608	2		610	12.2	20
15-15.5		744	4		748	17.2	23
15.5-16		862	2		863	22.2	25.7
16-16.5		643	7		650	19	29.3
16.5-17		319	416		736	20.9	28.4
17-17.5		522	133		655	20.8	31.8
17.5-18		1	590		591	21.2	35.9
18-18.5		1	537		538	18.3	34.1
18.5-19		110	331		441	15.8	35.8
19-19.5			334		334	13.6	40.7
19.5-20			237		237	10.1	42.8
20-20.5			267		267	12.5	46.8
20.5-21			112		112	6.4	57
21-21.5			93		93	5	53.7
21.5-22			107		107	5.6	52.1
22-22.5				44	44	2.6	59
22.5-23				3	3	0.2	64.1
23-23.5				18	18	1.2	65.3
24-24.5				1	1	0.1	75.3
25-25.5				14	14	1.2	87
26.5-27						0	109
TSN(10^6)	687	4439	3196	80	8402	.	.
TSB(10^3 t)	6.5	110	121	5.3	.	243.2	.
Mean length (cm)	11.2	15.6	18.6	23	.	.	.
Mean weight (g)	9.4	24.8	37.9	65.7	.	.	28.9

Table 5.2.4.2. Barents Sea polar cod. Acoustic estimates by age in August-October. TSN and TSB is total stock numbers (10^6) and total stock biomass (10^3 tonnes) respectively

Year	Age 1		Age 2		Age 3		Age 4+		Total	
	TSN	TSB	TSN	TSB	TSN	TSB	TSN	TSB	TSN	TSB
1986	24038	169.6	6263	104.3	1058	31.5	82	3.4	31441	308.8
1987	15041	125.1	10142	184.2	3111	72.2	39	1.2	28333	382.8
1988	4314	37.1	1469	27.1	727	20.1	52	1.7	6562	86.0
1989	13540	154.9	1777	41.7	236	8.6	60	2.6	15613	207.8
1990	3834	39.3	2221	56.8	650	25.3	94	6.9	6799	127.3
1991	23670	214.2	4159	93.8	1922	67.0	152	6.4	29903	381.5
1992	22902	194.4	13992	376.5	832	20.9	64	2.9	37790	594.9
1993	16269	131.6	18919	367.1	2965	103.3	147	7.7	38300	609.7
1994	27466	189.7	9297	161.0	5044	154.0	790	35.8	42597	540.5
1995	30697	249.6	6493	127.8	1610	41.0	175	7.9	38975	426.2
1996	19438	144.9	10056	230.6	3287	103.1	212	8.0	33012	487.4
1997	15848	136.7	7755	124.5	3139	86.4	992	39.3	28012	400.7
1998	89947	505.5	7634	174.5	3965	119.3	598	23.0	102435	839.5
1999	59434	399.6	22760	426.0	8803	286.8	435	25.9	91463	1141.9
2000	33825	269.4	19999	432.4	14598	597.6	840	48.4	69262	1347.8
2001	77144	709.0	15694	434.5	12499	589.3	2271	132.1	107713	1869.6
2002	8431	56.8	34824	875.9	6350	282.2	2322	143.2	52218	1377.2
2003	15434	114.1	2057	37.9	2038	63.9	1545	64.4	21074	280.2
2004	99404	627.1	22777	404.9	2627	82.2	510	32.7	125319	1143.8
2005	71675	626.6	57053	1028.2	3703	120.2	407	28.3	132859	1803.3
2006	16190	180.8	45063	1277.4	12083	445.9	698	37.2	74033	1941.2
2007	29483	321.2	25778	743.4	3230	145.8	315	19.8	58807	1230.1
2008	41693	421.8	18114	522.0	5905	247.8	415	27.8	66127	1219.4
2009	13276	100.2	22213	492.5	8265	280.0	336	16.6	44090	889.3
2010	27285	234.2	18257	543.1	12982	594.6	1253	58.6	59777	1430.5
2011	34460	282.3	14455	304.4	4728	237.1	514	36.7	54158	860.5
2012	13521	113.6	4696	104.3	2121	93.0	119	8.0	20457	318.9
2013	2216	18.1	4317	102.2	5243	210.3	180	9.9	11956	340.5
2014	687	6.5	4439	110	3196	121	80	5.3	8402	243.2
Average	29350	234	14920	342	4721	181	541	29	49569	787

Based on TSvalue = 21.8 Log L - 72.7 dB

Table 5.2.4.3. Summary of stock size estimates for polar cod.

Year class		Age	Number (10^9)		Mean weight (g)		Biomass (10^3 t)	
2013	2012	1	0.7	2.2	9.4	8.2	6.5	18.1
2012	2011	2	4.4	4.3	24.8	23.7	110	102.2
2011	2010	3	3.2	5.2	37.9	40.1	121	210.3
2010	2009	4	0.1	0.2	65.7	54.9	5.3	9.9
Total stock in								
2014	2013	1-4	8.4	12.0	28.9	28.5	243.2	340.5

Based on TS value: 21.8 log L – 72.7, corresponding to $\sigma = 6.7 \cdot 10^7 \cdot L^{2.18}$

Table 5.2.4.4. Barents Sea polar cod. Survey mortalities for age transitions 1-2 (top) and 2-3 (bottom).

Year	Year class	Age 1 (10^9)	Age 2 (10^9)	Total mort. %	Total mort Z
1986-1987	1985	24.0	10.1	58	0.87
1987-1988	1986	15.0	1.5	90	2.30
1988-1989	1987	4.3	1.8	58	0.87
1989-1990	1988	13.5	2.2	84	1.81
1990-1991	1989	3.8	4.2	-11	-0.10
1991-1992	1990	23.7	14.0	41	0.53
1992-1993	1991	22.9	18.9	17	0.19
1993-1994	1992	16.3	9.3	43	0.56
1994-1995	1993	27.5	6.5	76	1.44
1995-1996	1994	30.7	10.1	67	1.11
1996-1997	1995	19.4	7.8	60	0.91
1997-1998	1996	15.8	7.6	52	0.73
1998-1999	1997	89.9	22.8	75	1.37
1999-2000	1998	59.4	20.0	66	1.09
2000-2001	1999	33.8	15.7	54	0.77
2001-2002	2000	77.1	34.8	55	0.80
2002-2003	2001	8.4	2.1	75	1.39
2003-2004	2002	15.4	22.7	-47	-0.39
2004-2005	2003	99.4	57.1	43	0.55
2005-2006	2004	71.7	45.1	37	0.46
2006-2007	2005	16.2	25.8	-59	-0.47
2007-2008	2006	29.5	18.1	39	0.49
2008-2009	2007	41.7	22.2	47	0.63
2009-2010	2008	13.2	18.3	-39	-0.33
2010-2011	2009	27.3	14.5	47	0.63
2011-2012	2010	34.4	4.6	87	2.01
2012-2013	2011	13.5	4.3	68	1.14
2013-2014	2012	2.2	4.4	-50	-0.69
Year	Year class	Age 2 (10^9)	Age 3 (10^9)	Total mort. %	Total mort Z
1986-1987	1984	6.3	3.1	51	0.71
1987-1988	1985	10.1	0.7	93	2.67
1988-1989	1986	1.5	0.2	87	2.01
1989-1990	1987	1.8	0.7	61	0.94
1990-1991	1988	2.2	1.9	14	0.15
1991-1992	1989	4.2	0.8	81	1.66
1992-1993	1990	14.0	3.0	79	1.54
1993-1994	1991	18.9	5.0	74	1.33
1994-1995	1992	9.3	1.6	83	1.76
1995-1996	1993	6.5	3.3	49	0.68
1996-1997	1994	10.1	3.1	69	1.18
1997-1998	1995	7.8	4.0	49	0.67
1998-1999	1996	7.6	8.8	-16	-0.15
1999-2000	1997	22.8	14.6	36	0.45
2000-2001	1998	20.0	12.5	38	0.47
2001-2002	1999	15.7	6.4	59	0.90
2002-2003	2000	34.8	2.0	94	2.86
2003-2004	2001	2.1	2.6	-24	-0.21
2004-2005	2002	22.8	3.7	84	1.82
2005-2006	2003	51.7	12.1	77	1.45
2006-2007	2004	45.1	3.2	93	2.65
2007-2008	2005	25.8	5.9	77	1.48
2008-2009	2006	18.1	8.3	54	0.78
2009-2010	2007	22.2	13.0	41	0.54
2010-2011	2008	18.3	4.7	74	1.36
2011-2012	2009	14.5	2.1	85	1.92
2012-2013	2010	4.7	5.2	-11	-0.10
2013-2014	2011	4.3	3.2	26	0.30

6 Monitoring the demersal community

6.1 Fish community

Text by P. Krivosheya and B. Bogstad
Figures by P. Krivosheya

In the Barents Sea bottom catches were dominated by cod, long rough dab and haddock, and Norway pout and place in the coastal areas of Norway and Russian Federation. Figures 6.1.1.1 - 6.1.11.1 show the distribution of demersal fish. The numbers of fish sampled during the survey are presented in Appendix 2.

6.1.1 Cod (*Gadus morhua*)

At this time of the year, towards the end of the feeding period, the distribution of cod is wide, and cod was found over most of the survey area. However, the distribution area of cod in the Barents Sea (Figure 6.1.1.1) was not completely covered due to ice. The largest concentrations were found north of Svalbard and in the area between 77° and 78° N and 30° and 45° E. Both of these areas with high concentrations were close to the ice border, and it is likely that the survey underestimated the total stock abundance. Thus the reduction in observed biomass of 46% from 2013 to 2014 (Table 6.2.1) does not reflect the actual stock development. The distribution of cod in the covered area was similar to that in the two previous years.

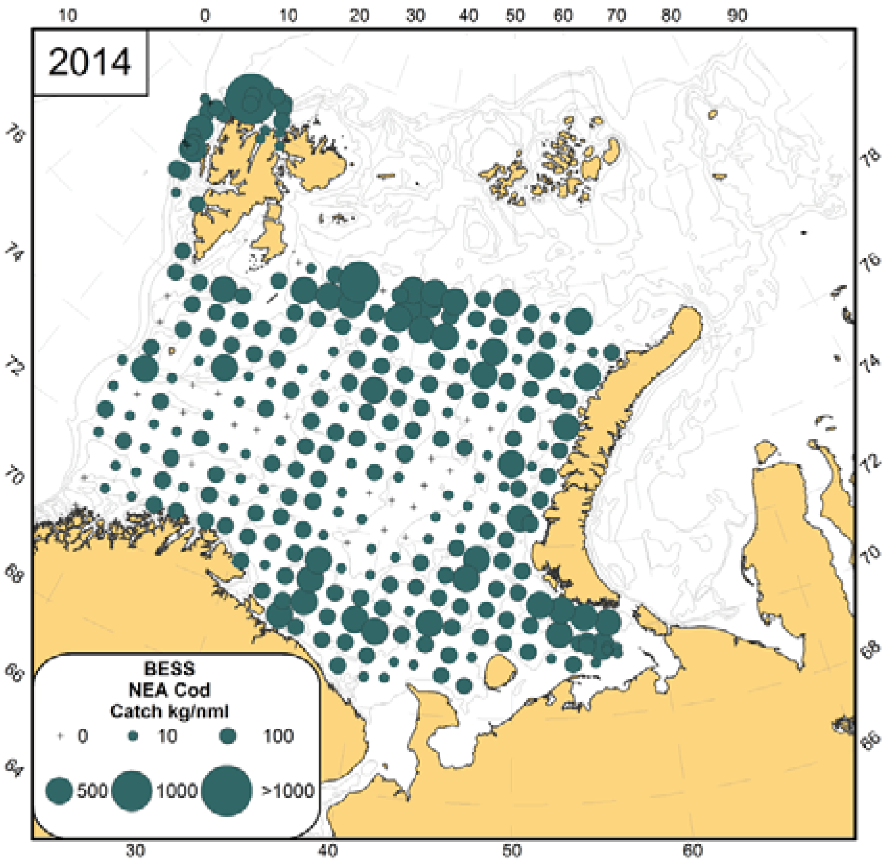


Figure 6.1.1.1. Distribution of cod (*Gadus morhua*), August-October 2014.

6.1.2 Haddock (Melanogrammus aeglefinus)

The distribution of haddock was completely covered. Haddock were widely distributed in the southern Barents Sea from the Norwegian coast to 58°E (Fig. 6.1.2.1). In the western part of the sea, haddock were observed west of Spitsbergen and between Bear Island and Hopen. In the south-eastern Barents Sea, haddock were observed in shallow areas (depths as shallow as 15m) as usual. Main concentrations of haddock were found in the southeastern Barents Sea and between Bear Island and Hopen. Compared to 2013, the occupation area of haddock distribution as well as the biomass slightly increased (Table 6.2.1).

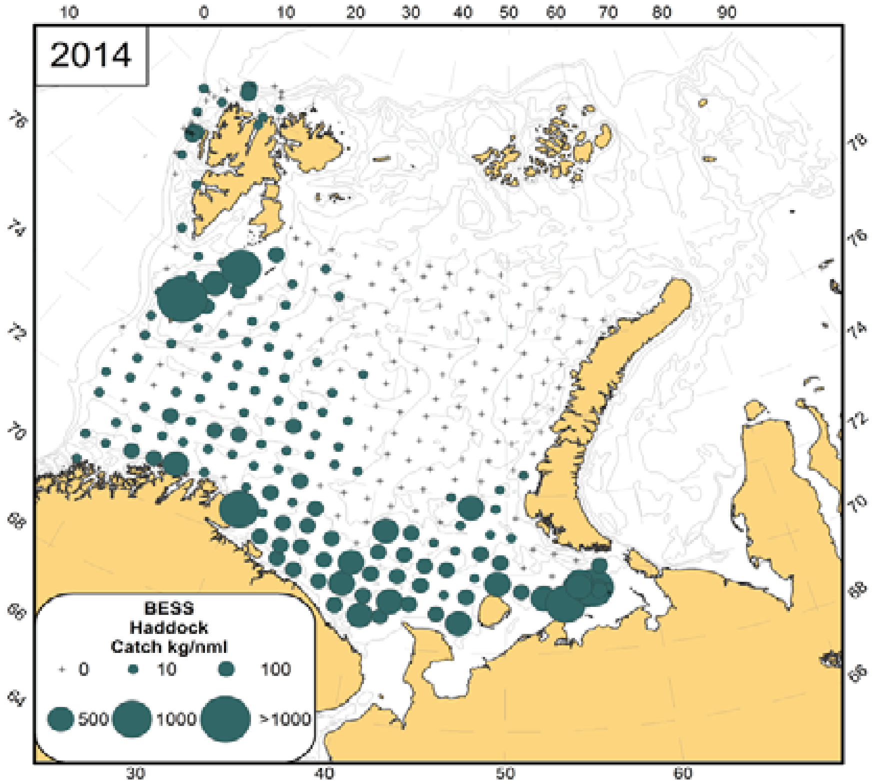


Figure 6.1.2.1. Distribution of haddock *(Melanogrammus aeglefinus)*, August-October 2014.

6.1.3 Saithe (Pollachius virens)

The survey covered only a small part of saithe distribution along the coast of Norway (Figure 6.1.3.1). Compared to the previous years, occupation area of saithe increased somewhat eastwards along the coast of Finnmark. Saithe were distributed west of 30°E only. The biomass of saithe was the lowest observed in the time series.

6.1.4 Greenland halibut (Reinhardtius hippoglossoides)

During the survey, mainly young age groups of Greenland halibut were observed. The adult part of the stock was probably distributed outside the survey area. Compared to 2013, the coverage area in the north and northeast was limited due to ice. Greenland halibut were distributed along the shelf slope in the western Barents Sea and north of Svalbard, and also in deep-water areas of the Barents Sea (Figure 6.1.4.1). The total biomass on Greenland halibut within the coverage area was the lowest since 2005, but the estimation does not reflect the stock situation because a large proportion of the Greenland halibut stock is distributed outside than coverage area.

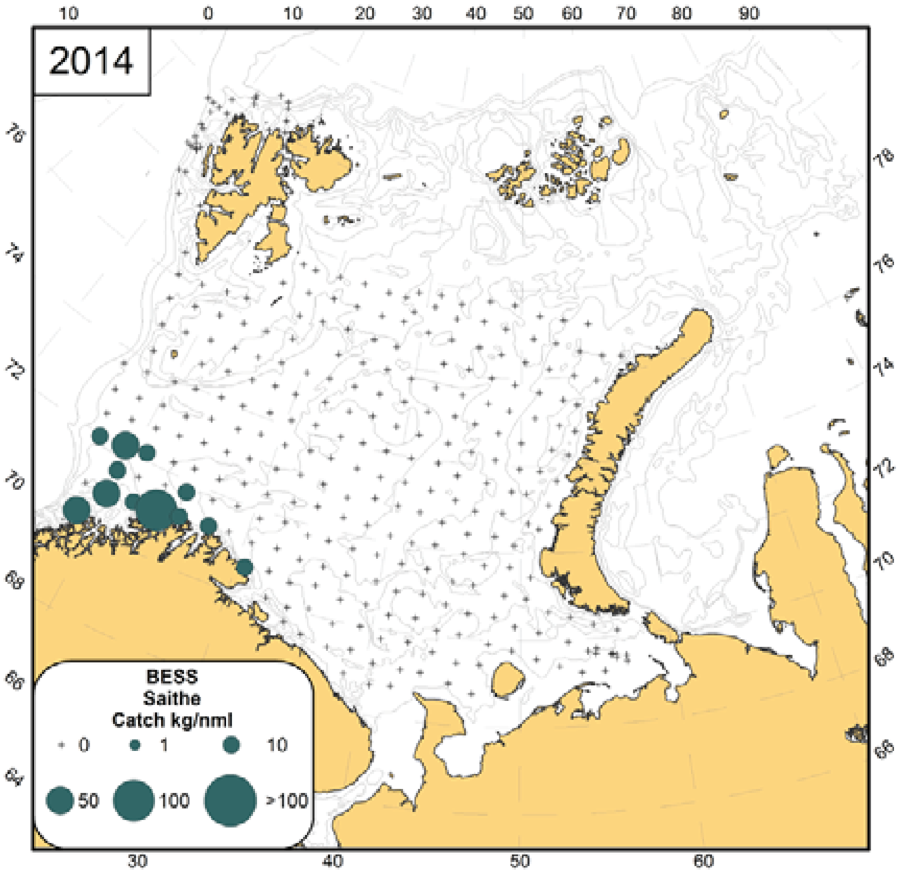


Figure 6.1.3.1. Distribution of saithe *(Pollachius virens)*, August-October 2014.

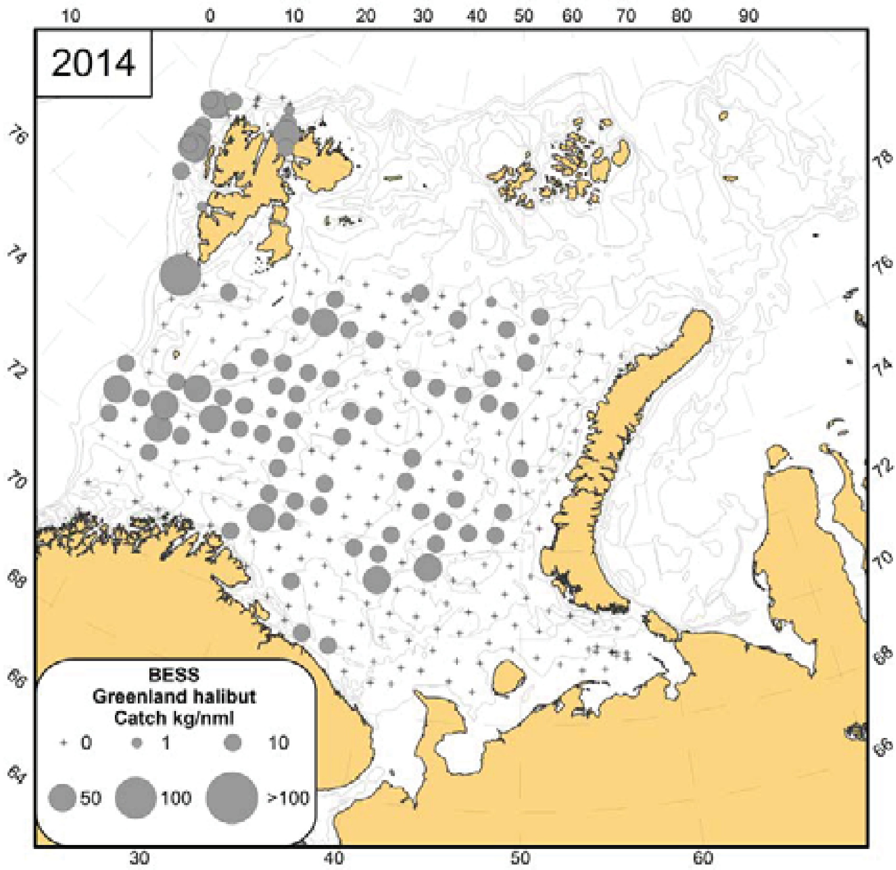


Figure 6.1.4.1. Distribution of Greenland halibut (*Reinhardtius hippoglossoides*), August-October 2014.

6.1.5 Golden redfish (*Sebastes norvegicus*)

In 2014, golden redfish was observed along the shelf slope north and west of Spitsbergen, and in deeper waters in the south-eastern Barents Sea as in 2011-2013 (Figure 6.1.5.1). However, occupation area of golden redfish increased in the southern Barents Sea in recent years during recent years. The abundance and biomass of golden redfish within the surveyed area decreased from 2013 but was still above the long-term mean (Table 6.2.1).

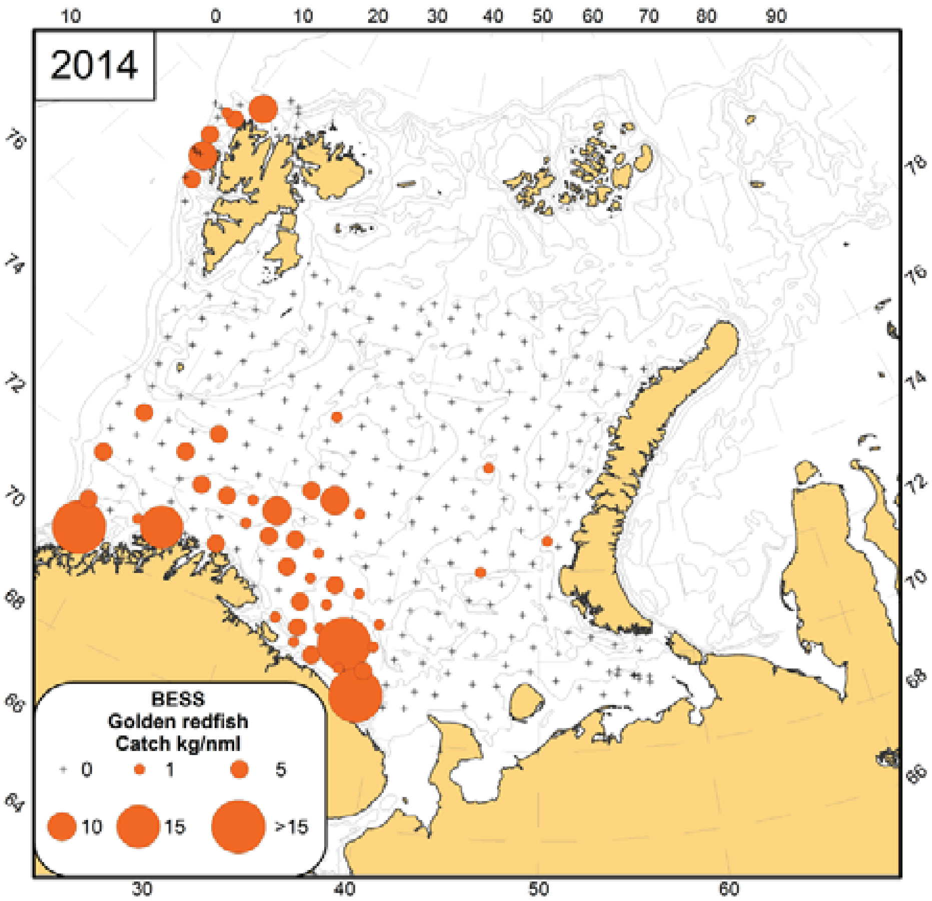


Figure 6.1.5.1. Distribution of golden redfish (*Sebastes marinus)*, August-October 2014.

6.1.6 Deep-water redfish (*Sebastes mentella*)

Deep-water redfish were widely distributed in the Barents Sea (Figure 6.1.6.1). Main concentrations of deep-water redfish were found, as usual, in the western and north-western Barents Sea, and west of Spitsbergen. The biomass of deep-water redfish in the Barents Sea decreased somewhat from 2013 to 2014 (Table 6.2.1.), but this could partly be explained by limited coverage in the northern and northeastern Barents Sea.

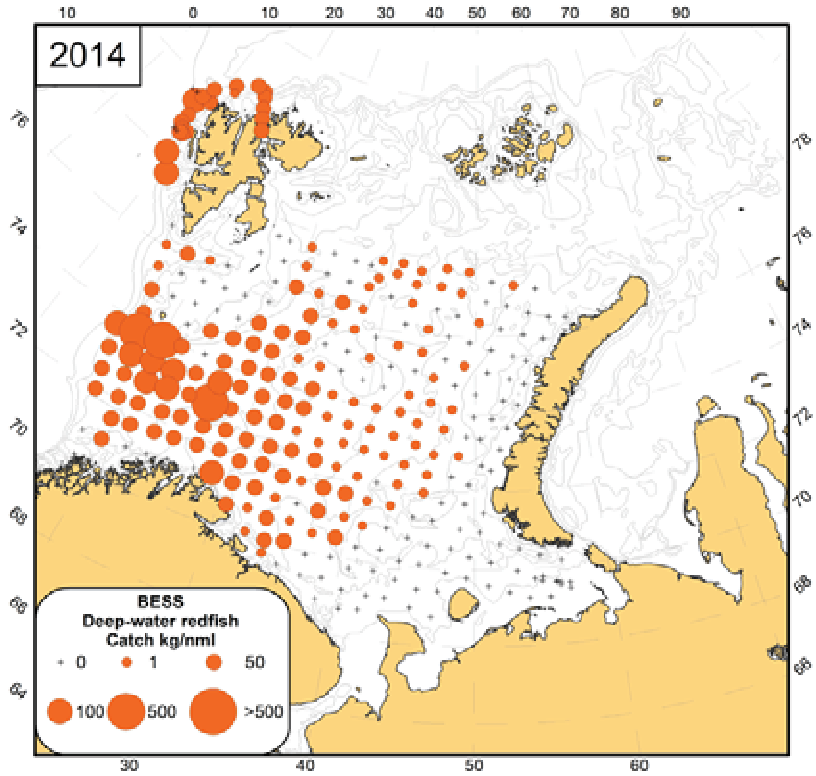


Figure 6.1.6.1. Distribution of deep-water redfish *(Sebastes mentella)*, August-October 2014.

6.1.7 Norway redfish (*Sebastes viviparus*)

Norway redfish were distributed in the southwestern Barents Sea (Figure 6.1.7.1), as in the previous years. The biomass was the lowest since 2010.

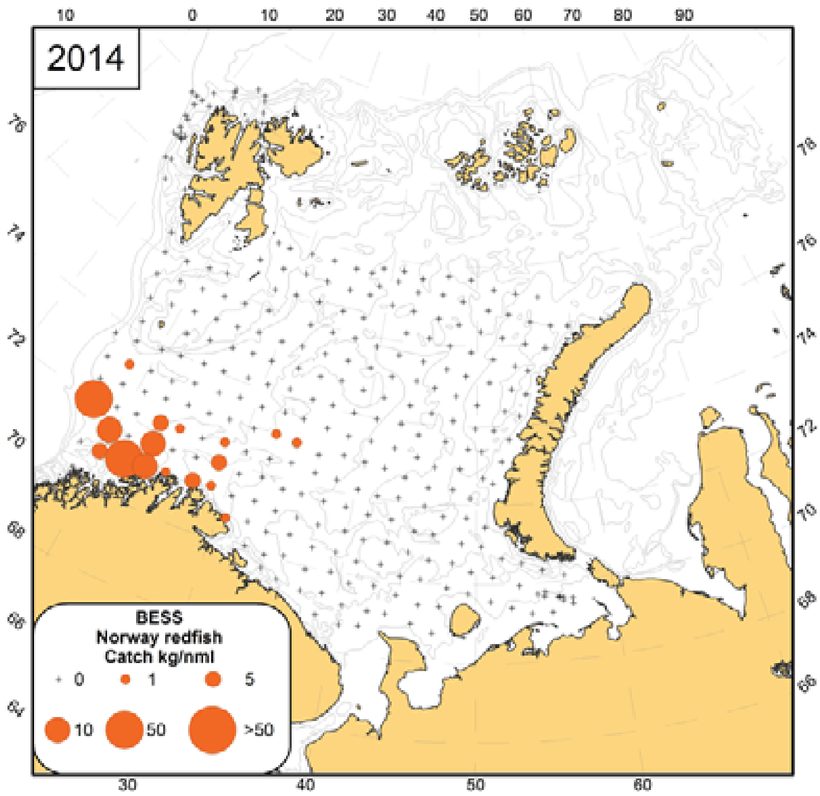


Figure 6.1.7.1. Distribution of Norway redfish *(Sebastes viviparus)*, August-October 2014.

6.1.8 Long rough dab (Hippoglossoides platessoides)

As in the previous years, long rough dab were widely distributed in the Barents Sea, and denser concentrations of long rough dab were observed in the central-northern and eastern areas (Figure 6.1.8.1). Long rough dab, as in the previous years, were dominated by numbers in bottom trawl catches with averaged catches of 6.5 kg/nm and maximum of 249 kg/nm. In 2014, long rough dab abundance was lower than previous years and were $3.0 \cdot 10^9$ individuals, which corresponding to 413 thousand tonnes (Table 6.2.1). Many small fish were observed in trawl catches especially in the eastern areas.

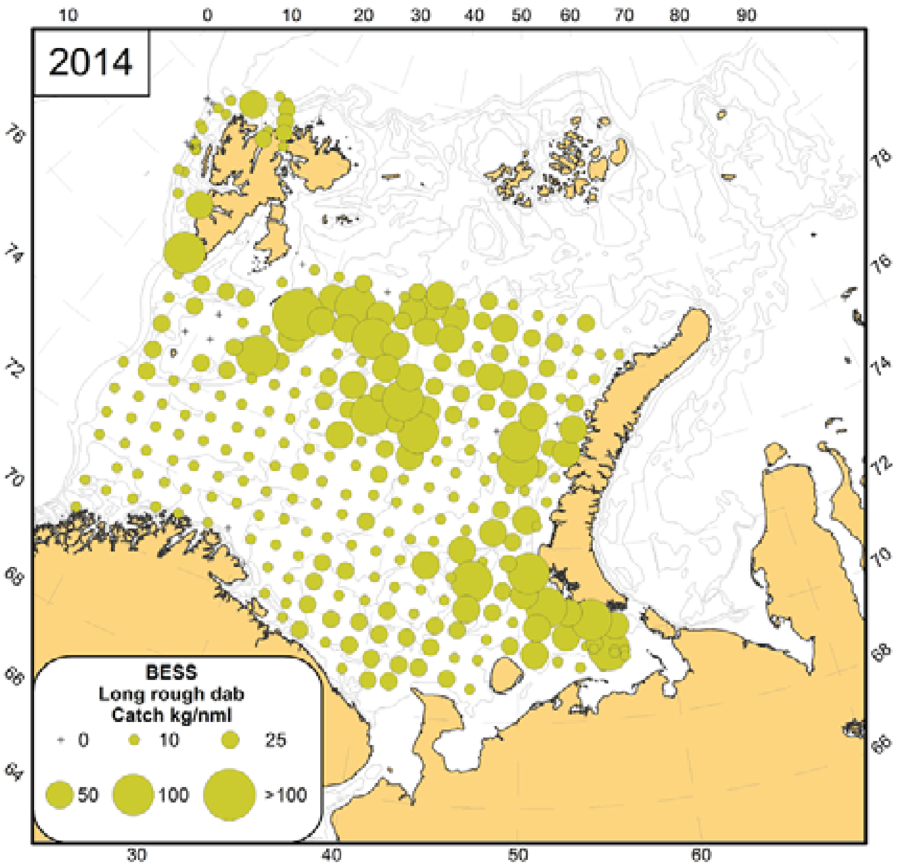


Figure 6.1.8.1. Distribution of long rough dab *(Hippoglossoides platessoides)*, August-October 2014.

6.1.9 Wolffishes (*Anarhichas* sp.)

Atlantic wolffish (*Anarhichas lupus*), Spotted wolffish (*Anarhichas minor*) and Northern wolffish (*Anarhichas denticulatus*) were observed in the Barents Sea.

The distribution of Atlantic wolffish was similar to that in 2013 except lack of Atlantic wolffish in the central area. The highest catches of Atlantic wolffish were observed in shallow southern Barents Sea, along the continental shelf, west of Spitsbergen and near Bear Island (Figure 6.1.9.1). The largest catch of 115 kg/nm was taken at 72°29 N 16° 49 E. Compared to the previous year, abundance and biomass of Atlantic wolffish decreased in 2014, and was $12 \cdot 10^9$ individuals, which corresponds to 12 thousand tonnes (Table 6.2.1).

In 2014, spotted wolffish were distributed similar to that in 2013 (Figure 6.1.9.2). Higher catches of spotted wolffish were taken in central-northern area and shallow southeastern

Barents Sea. The highest catch of 57 kg was taken in central Barents Sea. The biomass of spotted wolfish decreased, and was lower than in 2013compared to t 2013. Estimated biomass was estimated to be 51 thousand tonnes (Table 6.2.1).

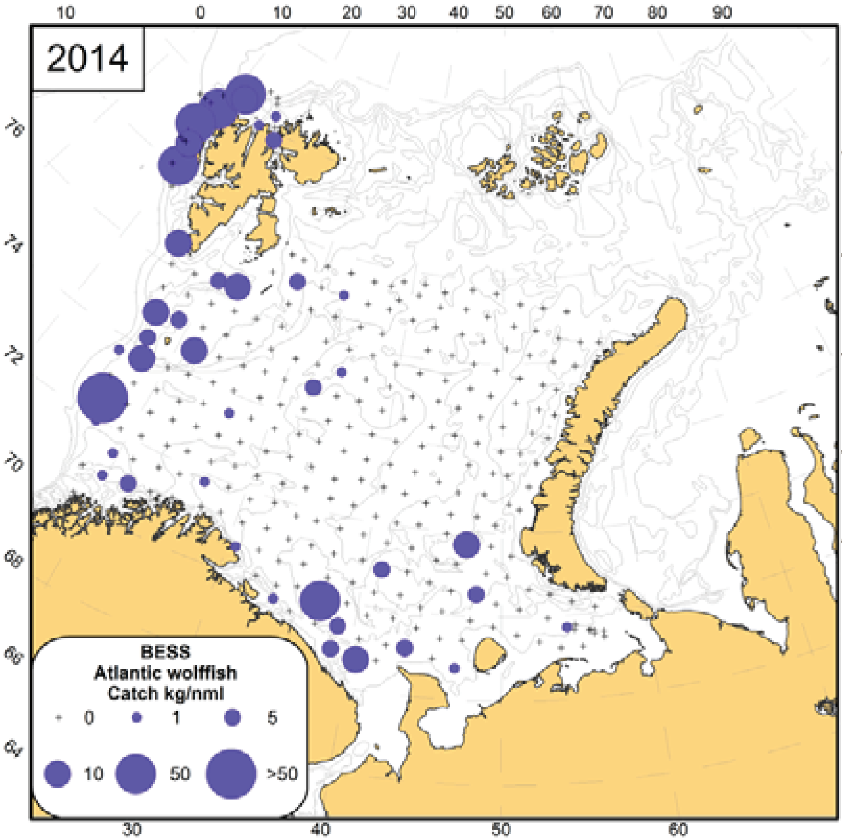


Figure 6.1.9.1. Distribution of Atlantic wolffish (*Anarhichas lupus*), August-October 2014.

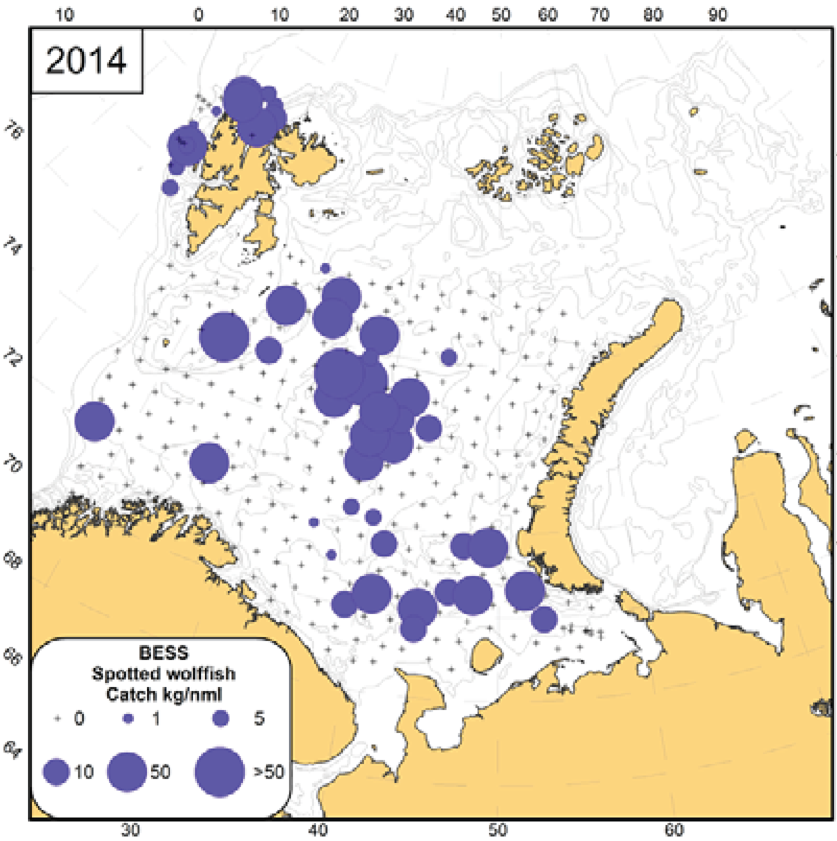


Figure 6.1.9.2. Distribution of spotted wolffish (*Anarhichas minor*), August-October 2014.

In 2014, northern wolffish were distributed similar to that in 2013 (Fig. 6.1.9.3). Higher catches (> 50 kg/nm) were northwest of Spitsbergen and in the central Barents Sea. As in previous years, there were no catches in the north-eastern areas. Abundance and biomass of northern wolffish was lower in 2014 than in 2013, and was 34 thousand tonnes (Table 6.2.1).

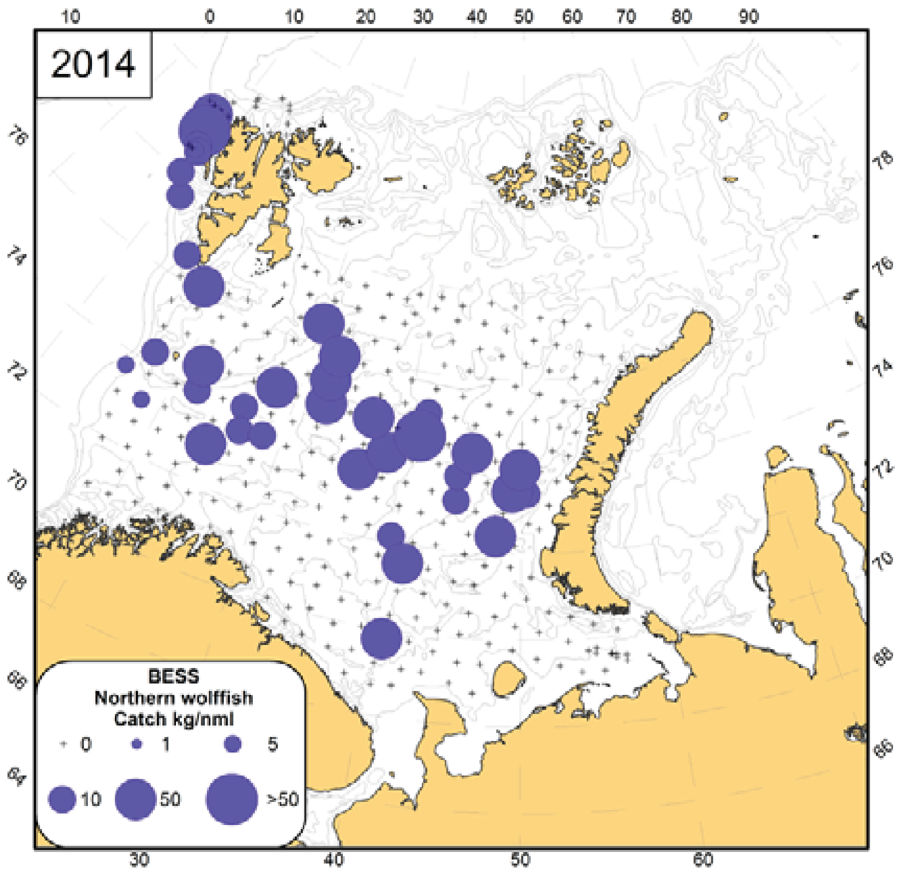


Figure 6.1.9.3. Distribution of northern wolffish (*Anarhichas denticulatus*), August-October 2014.

6.1.10 Plaice (Pleuronectes platessa)

Plaice were distributed mainly in the southern Barents Sea, between 37° and 45°E. There were only one catch north of Finnmark (Fig. 6.1.10.1). Plaice catches were generally very high (> 50 kg/nm) in 2014, and were heist recorded since 2004. The highest catch of 500 kg/nm, corresponding to 776 individuals was taken in the southern area. Thus, abundance of plaice was 4.7 times higher than in 2013 and biomass was 4.2 times higher (Table 6.2.1).

6.1.11 Norway pout (*Trisopterus esmarkii*)

The main concentrations of Norway pout were observed in the southwestern Barents Sea (Figure 6.1.11.1). A few individuals of Norway pout were found west and north of Spitsbergen, up to 80°N. Compared to 2013, distribution area of Norway pout was reduced and main concentrations were located further west along the coast of Norway. In 2014, abundance and biomass were also lower than in the previous year (Table 6.2.1).

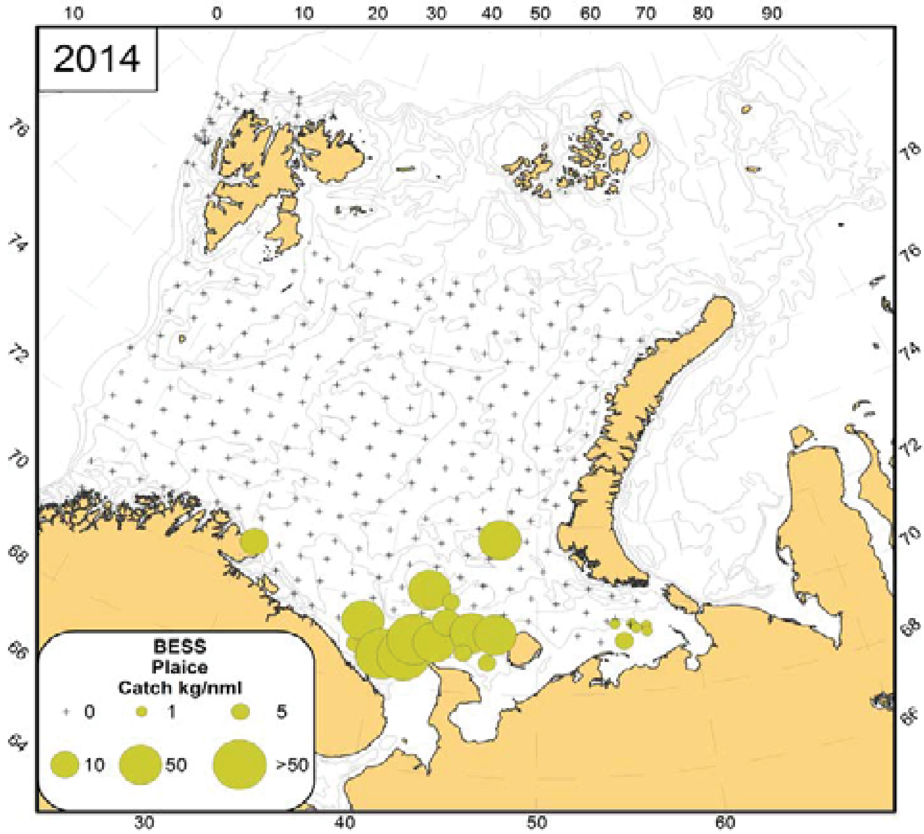


Figure 6.1.10.1. Distribution of plaice (*Pleuronectes platessa*), August-October 2014.

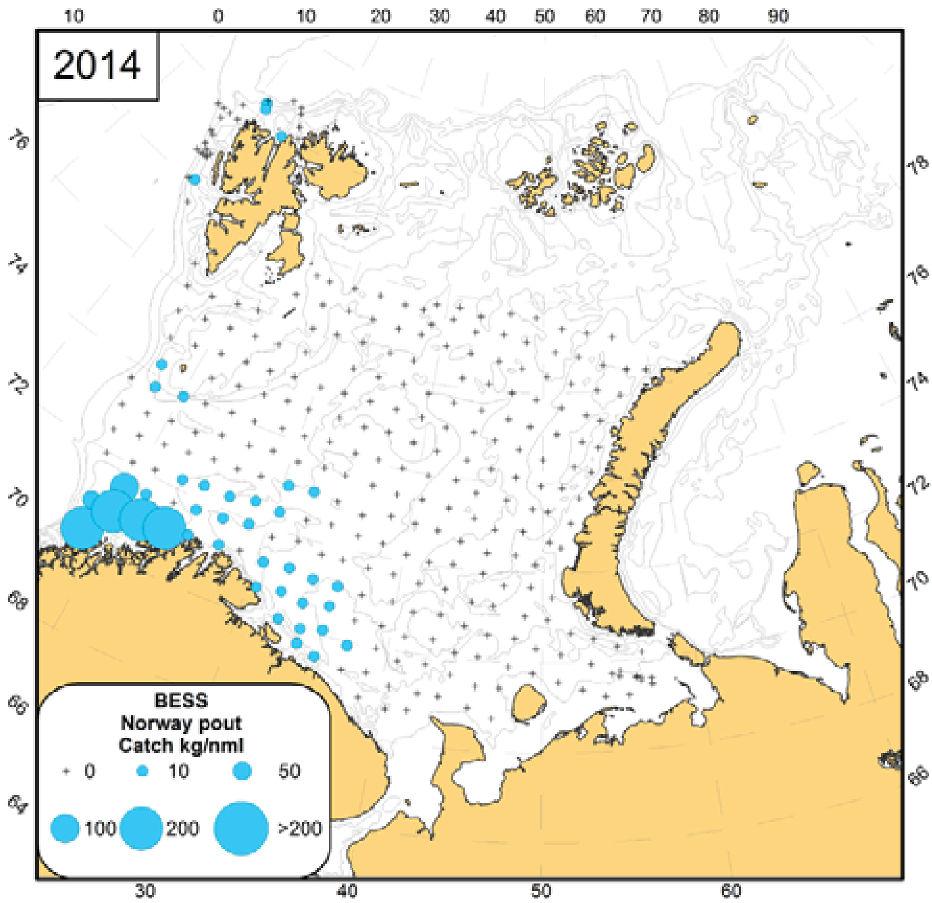


Figure 6.1.11.1. Distribution of Norway pout (*Trisopterus esmarkii*), August-October 2014.

6.1.12 Abundance and biomass estimation of demersal fish

Preliminary estimates of the abundance and biomass of demersal fish were made at the end of the survey and presented in Table 6.2.1. Final estimates by age/length group for cod, haddock, redfish and Greenland halibut will be presented in the ICES AFWG report.

Table 6.2.1. Abundance (N, million individuals) and biomass (B, thousand tonnes) of the main demersal fish species in the Barents Sea.

Year		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	**2014**	LTM
Atlantic wolffish	N	14	15	26	42	25	20	17	20	22	27	↓12	23
	B	7	6	11	11	14	8	17	13	9	30	↓12	13
Spotted wolffish	N	12	11	12	12	13	9	7	9	13	13	↓8	11
	B	31	92	46	42	51	47	37	47	83	84	↓51	56
Northern wolffish	N	3	3	2	3	3	3	3	6	8	12	↓6	5
	B	26	26	19	25	22	31	25	42	45	52	↓34	31
Long rough dab	N	2957	2910	3705	5327	3942	2600	2520	2507	4563	4932	↓3046	3596
	B	311	280	378	505	477	299	356	322	584	565	↓413	408
Plaice	N	52	19	36	120	57	21	34	36	21	36	↑170	43
	B	43	11	19	55	29	13	21	26	13	29	↑121	26
Norway redfish	N	39	110	219	64	24	17	26	83	114	233	↓105	93
	B	4	15	19	10	4	2	2	9	12	25	↓6	10
Golden redfish	N	13	23	16	20	42	12	22	14	32	75	↓45	27
	B	9	11	16	11	17	11	4	5	8	20	↓13	11
Deep-water redfish	N	263	336	526	796	864	1003	1076	1271	1587	1608	↓927	933
	B	106	143	219	183	96	213	112	105	196	256	↓208	163
Greenland halibut	N	182	358	430	296	153	191	186	175	209	160	↓43	234
	B	39	53	77	86	76	90	150	88	86	94	↓53	84
Haddock	N	757	1211	3518	4307	3263	1883	2222	1068	1193	734	↑1110	2016
	B	261	342	659	1156	1246	1075	1457	890	697	570	↑630	835
Saithe	N	36	31	28	70	3	33	5	9	14	18	↓3	25
	B	41	26	49	98	7	29	9	10	13	33	↓6	32
Cod	N	1513	1012	1539	1724	1857	1593	1651	1658	2576	2379	↓1373	1750
	B	1074	499	810	882	1536	1345	2801	2205	1837	2132	↓1146	1512
Norway pout	N	620	1026	1838	2065	3579	3841	3530	5976	3089	2267	↓1254	2783
	B	13	14	32	61	97	131	103	68	105	40	↓37	66

In 2014, the abundance and biomass of all species except haddock and plaice decreased compared to 2013. Part of the reason for this is the incomplete area coverage in 2014.

In 2014, the coverage area was limited in the north due to ice conditions. Thus coverage of some species such as, Greenland halibut, wolffishes, long rough dab, cod and haddock was limited, that influenced abundance and biomass estimates. Nevertheless, abundance indices allow for investigations of total fish quantity dynamics in the Barents Sea. Some non-commercial species can be indicators of the ecosystem state since their numbers are changing for natural reasons only (see sections 8.2.2 “Species – indicator” and 8.2.3 “Bio-geographic group”). Fluctuation in abundance numbers for different fish species indicates not only stock changes, but also changes in ecosystem conditions.

6.2 Benthos community

6.2.1 Monitoring the Northern shrimp (*Pandalus borealis*)

Text by P. Lubin, L. Lindal Jørgensen, D. Zakharov, T. Tankovskaya
Figures by D. Zakharov and P. Krivosheya

In 2014, the calculated index (based on method of squares) of the Northern shrimp stock was 303.8 thousand tonnes, which is 21 % lower than in 2013, and 13 % lower than long term mean (Figure 6.2.1.1). Denser concentrations of Northern shrimp were observed in the central and eastern areas and north of Svalbard/Spitsbergen Archipelago, while they were almost disappeared in the southern and western areas. In 2014, the decrease in stock size might be partially explained by lack of coverage in the northern area due to ice condition (see “Background” in the report).

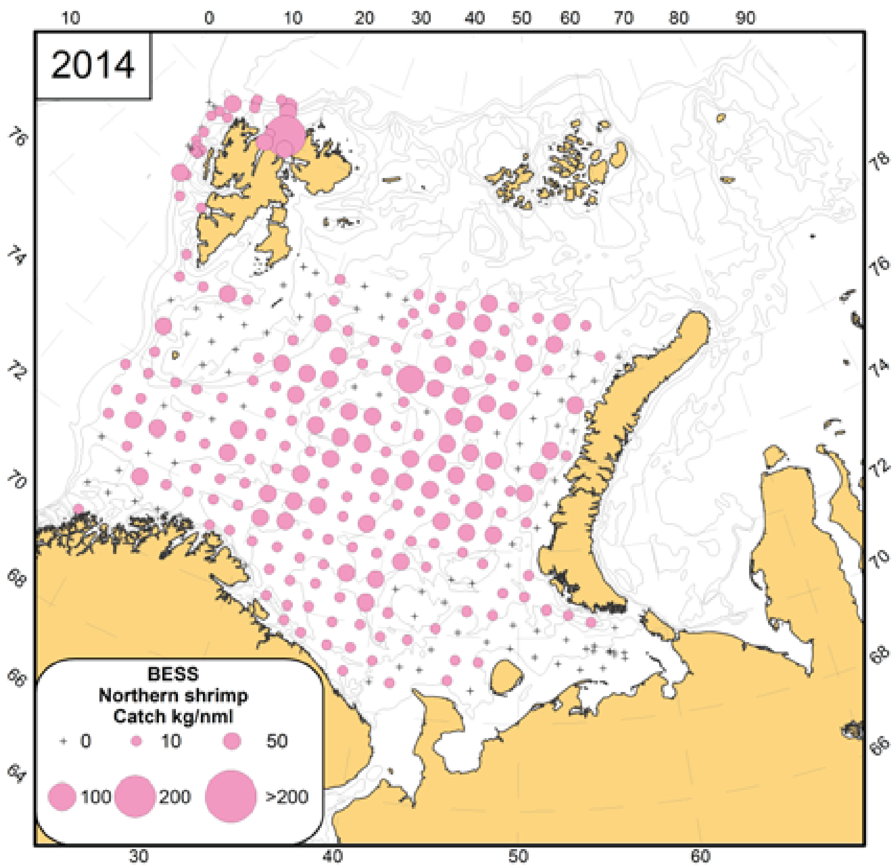


Figure 6.2.1.1. Distribution and biomass (kg/nm) of the Northern shrimp in the Barents Sea, August-October 2014.

Evaluation of the relative number of males with a length of carapace 13-17 mm, taken by bottom trawl in the Russian coverage part of ecosystem survey showed that the replenishment was at average level in 2014 and since 2006 (Figure 6.2.1.2).

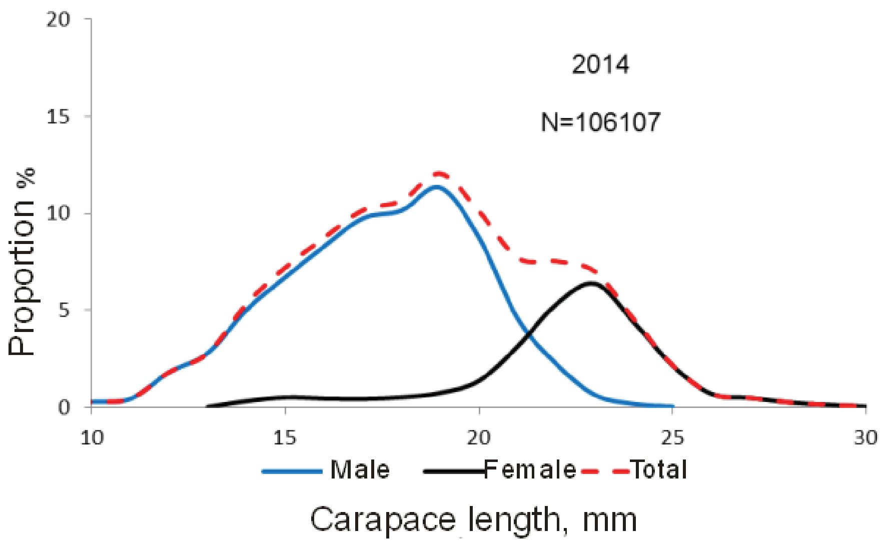


Figure 6.2.1.2. Size and sex structure of the Northern shrimp taken by bottom trawl in the area covered by Russian vessel "Vilnyus" (see Figure 1.1) in 2014 .

6.2.2 Distribution of the Red King crab (*Paralithodes camtschaticus*)

Text by P. Lubin, L. Lindal Jørgensen, D. Zakharov, T. Tankovskaya
Figures by D. Zakharov and P. Krivosheya

The Red King crab were recorded in 11 of 137 trawl catches, and were distributed in the southern area between 37 and 46°E. The denser concentration of the crab was observed along the Murman coastal area and on the Kanin banks (figure 6.2.2.1).
The catches of the crab varied between 2.470 to 139.475 kg with an average of 33.662±15.9 kg per trawl. The number of crab ranged from 1 to 60 individuals per trawl.

6.2.3 Distribution of the Snow crab (*Chionoecetes opilio*)

Text by V. Pavlov, J. Sundet
Figures by P. Krivosheya and V. Pavlov

In 2014, the snow crabs were caught at 87 bottom trawl stations (Figure 6.2.3.1). It is less than in the previous year (131 stations). The highest catches of crab were found west and south of the Novaya Zemlya Archipelago.

The surveyed area in 2014 was less than in 2013, thus a comparison of the snow crab recordings in 2013 and 2014 revealed a decrease in abundance in 2014. The catches of the snow crab varied from 1 g to 66.1 kg (the average is 8.3 kg) and it is less than in previous year (from 1 g to 189.3 kg, the average is 11.6 kg).

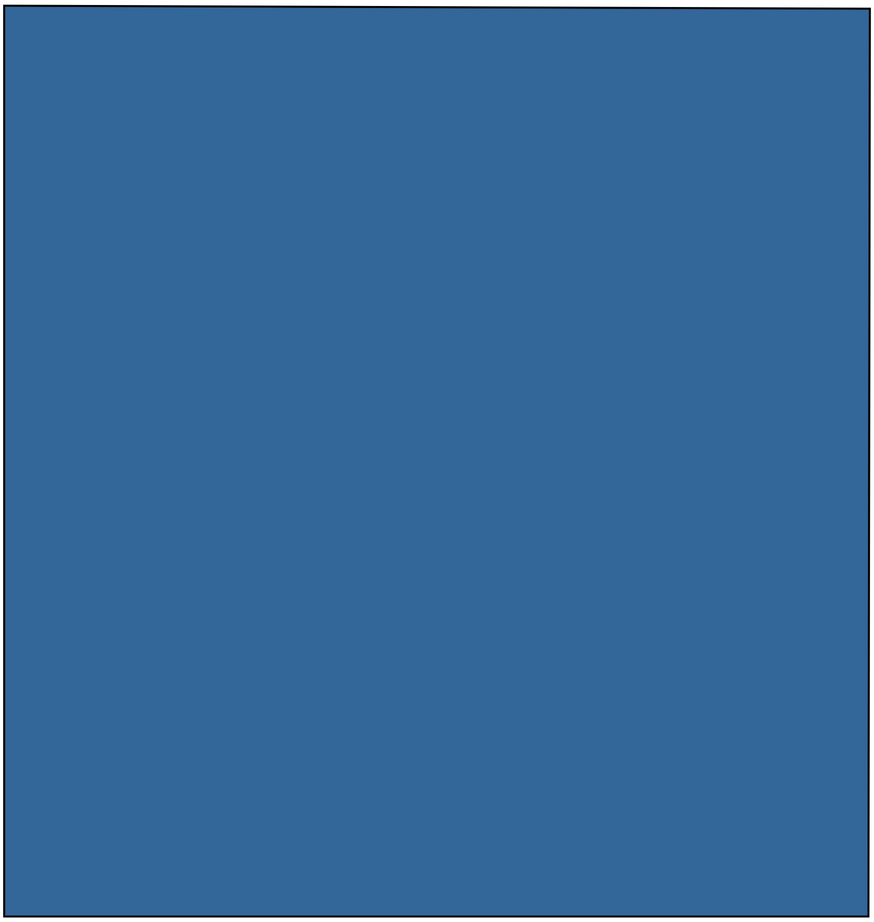


Figure 6.2.2.1. The distribution and number of individuals per nm of the Red King crab in the Barents Sea in August-October 2014.

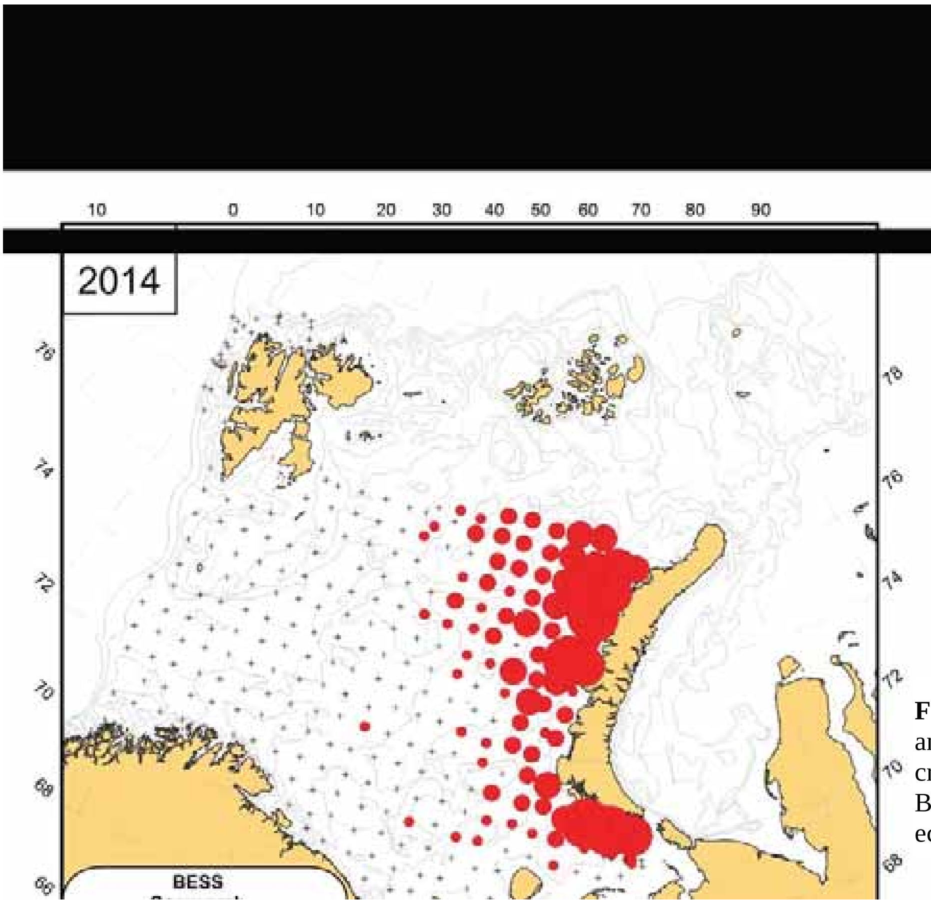


Figure 6.2.3.1. Distribution and numbers of the snow crabs per one nm in the Barents Sea during the ecosystem survey 2014.

Young individuals with a carapace width less than 75 mm prevailed among both males and females (Figure 6.2.3.2), constituting approximately 94% of all individuals.

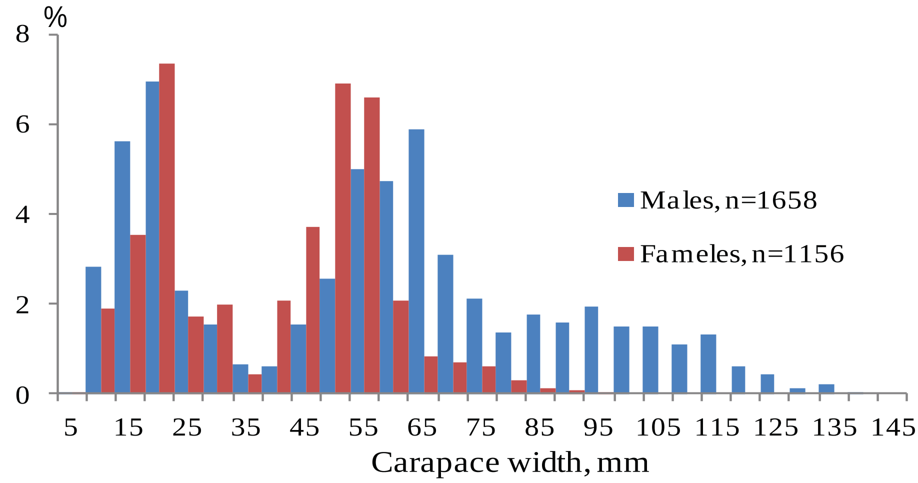


Figure 6.2.3.2. Size distribution of the Snow crab in the Barents Sea during the ecosystem survey 2014.

7 Monitoring of interactions by diet study

No results available. Take contact with responsible scientific group at IMR and PINRO.

8 Monitoring of biodiversity

8.1 Plankton biodiversity

No results available. Take contact with responsible scientific group at IMR and PINRO.

8.2 Invertebrate biodiversity

Text by P. Lubin, L. Lindal Jørgensen and D. Zakharov,
Figures by P. Lubin

8.2.1 Megabenthos bycatch in bottom trawls

In 2014, the bycatch recording of megabenthos in bottom trawls were only made on two out of four reseach vessels "Vilnyus" and "Helmer Hanssen". The two Norwegian ships "Johan Hjort" and "G. O. Sars" participated in the ecosystem survey, using bottom trawl, but did not have benthic experts onboard to identify the trawl catch due to reduced funding. A total of 181 trawl stations (137 "Vilnyus" and 44 "Helmer Hanssen") were covered. This resulted in 349 taxa of benthic invertebrates, of which 227 taxa were identified to species (Appendix 3). Some larger animal-groups included 201 genera, 174 families, 87 orders, 28 classes, and 13 phylum (Table 8.2.1.1).

Mollusca had the highest number of taxa (93 taxa) (Figure 8.2.1.1). The second highest was Arthropoda (62 taxa), the third Echinodermata (59 taxa). The lowest number of taxa was represented by a phylum Nemertini (1 taxon). The most common species and taxa in 2014 were: *Sabinea septemcarinata* (identified in 138 trawl-catches), *Strongylocentrotus pallidus* (117 catches), and *Ctenodiscus crispatus* (114 catches).

Table 8.2.1.1. Amount of benthic taxa identified during the ecosystem survey in August-October 2014.

Taxon	RV «Vilnyus»	RV «G.O. Sars»	RV "Helmer Hansen"	RV "Johan Hjort"
Phylum	12	-	9	-
Class	18	-	21	-
Order	54	-	68	-
Family	113	-	124	-
Genus	146	-	150	-
Species	211	-	203	-
Total taxons:	237	-	349	-

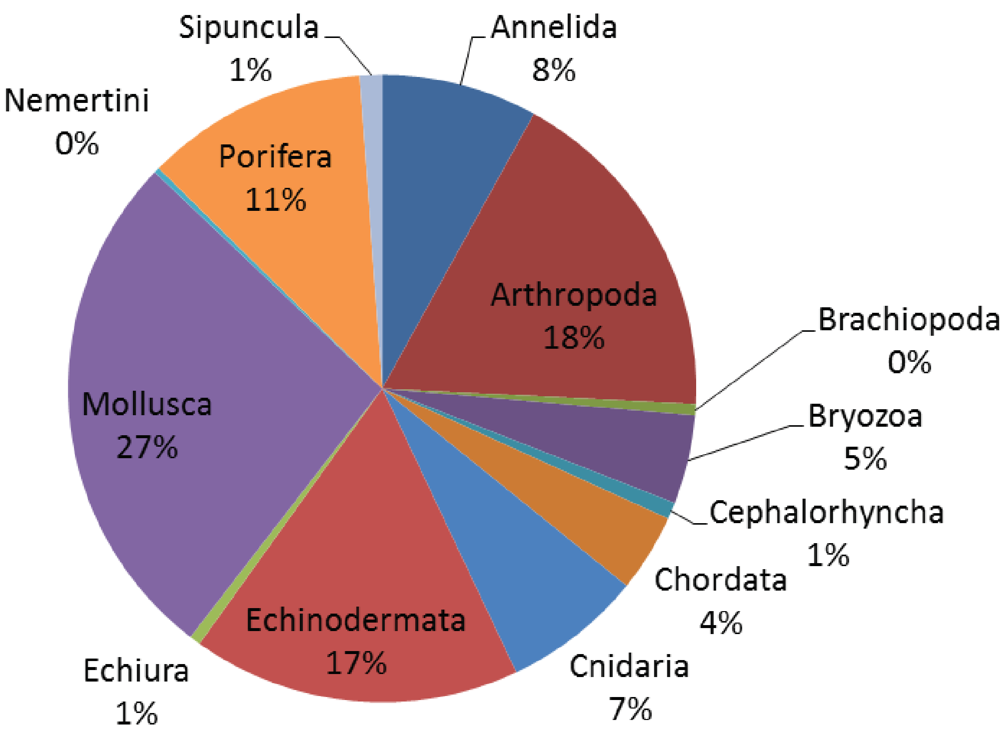


Figure 8.2.1.1. The total mean distribution of taxa per invertebrate group (%) in the bottom trawl by-catch of the ecosystem survey in August-October 2014.

8.2.2 Biodiversity (number of taxa)

The number of taxa in trawl samples ranged from 4 to 64 with an average of 24±1 taxon per trawl-catch. The maximum taxonomic diversity was observed north and west of the Spitsbergen archipelago (more than 60 taxa) (RV "Helmer Hanssen") (Figure 8.2.2.2).

In the Russian Economic Zone the taxonomic diversity ranged from 4 to 50 taxa per trawling. This resulted in a reduction of taxonomic diversity from the North to the East with the lowest values in the area of the Kanin shallow water (average number of 20±1 taxa per trawling).

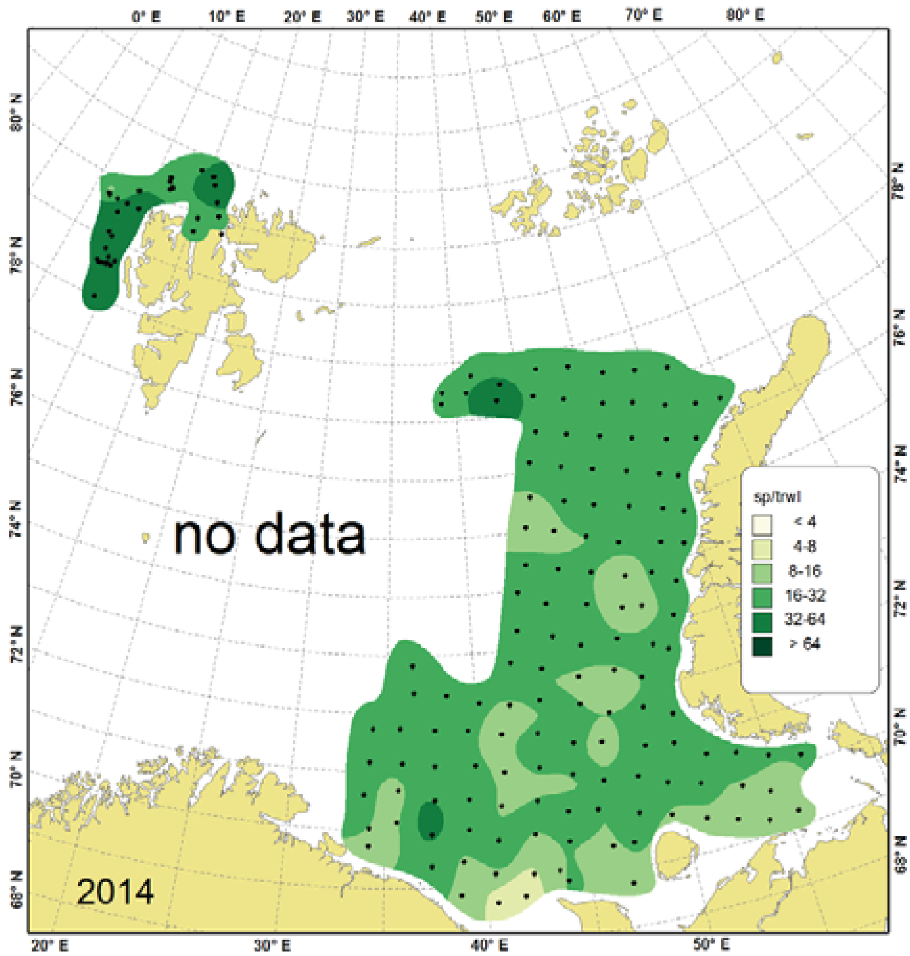


Figure 8.2.2.2. The number of taxa per trawl-catch in the Barents Sea in August-October 2014.

8.2.3 Abundance (number of individuals)

The average number of invertebrate organisms encountered in the catches was 2888±276 specimens per mile trawling (Figure 8.2.3.1). The minimum catch was recorded northwest of the Spitsbergen archipelago ("Helmer Hansen") with 17 individuals per mile trawling. The maximum number of specimens was observed in the central part of the Barents Sea with 17.6 thousand individuals ("Vilnyus") and 1/3 of the catch was represented by one species - *Ctenodiscus crispatus* (4466 individuals per mile of trawling). In the southern and southeastern regions there is a decrease in the number of benthos specimens (maximum 1000 individuals per mile of trawling).

8.2.4 Biomass

The maximum bycatch of benthos (487 kg) was observed in the southern part of the study area at a depth of 87 (Figure 8.2.4.1). The sponge *Myxilla incrustans* (317 kg) and the crab *Paralithodes camtschaticus* (171 kg) were dominating there. Lowest catch (76 g) were taken in the northwest of Spitsbergen, at a depth of 539 m. In average, the biomass of benthos was 36 ± 5 kg per mile.

Compared to the ecosystem survey in 2013, as well as the results of the previous years, there are an increasing trend of dominance of echinoderms (Echinodermata) of the total by-catch-biomass from southwest to northeast (Figure 8.2.4.2). At the same time, there has been a significant increase of crustaceans caused by the spreading and the high abundances of large *Chionoecetes opilio* specimens (snow crab). Large colonies of sponges were recorded in the southern part of the Barents Sea and in the area of the continental slope to the northwest of Spitsbergen,.

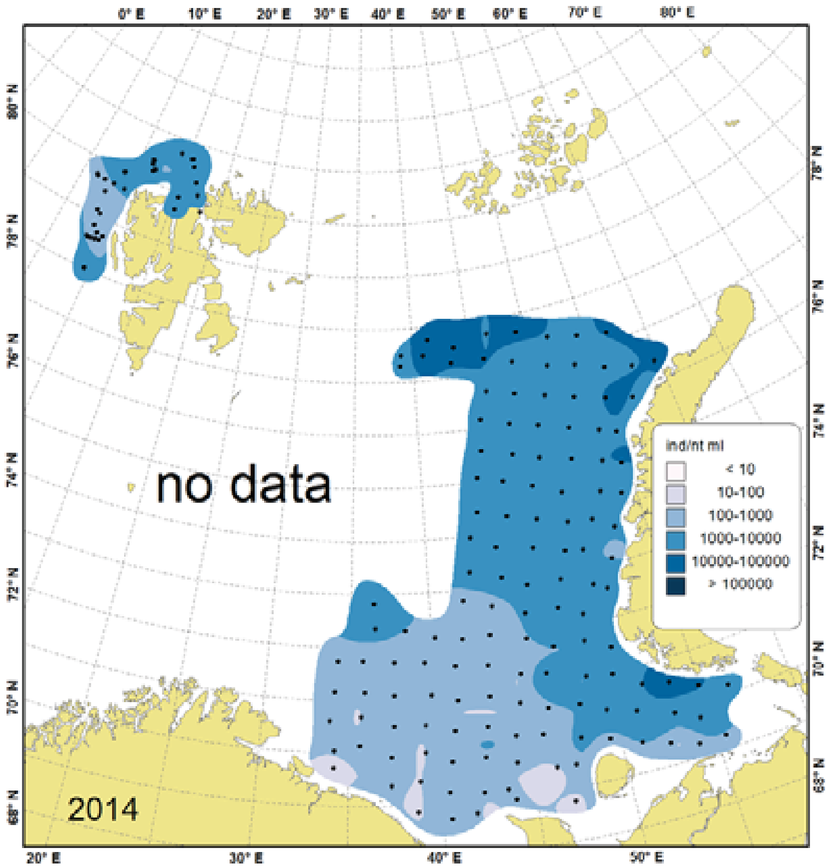


Figure 8.2.3.1. The extrapolated number of individuals of megabenthos in the Barents Sea in August-October 2014.

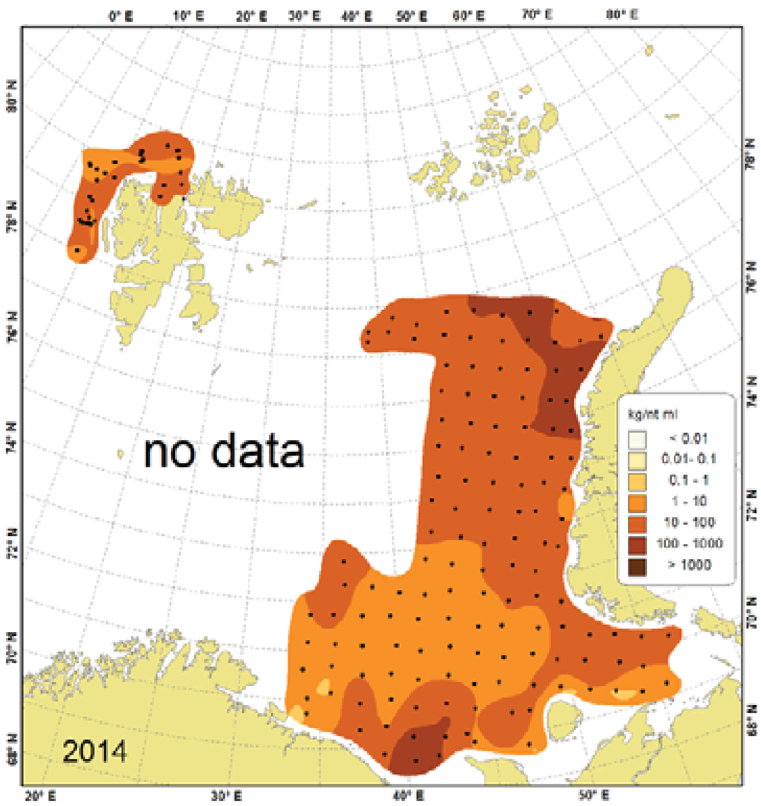


Figure 8.2.4.1. Biomass distribution of megabenthos in the Barents Sea in August-October 2014.

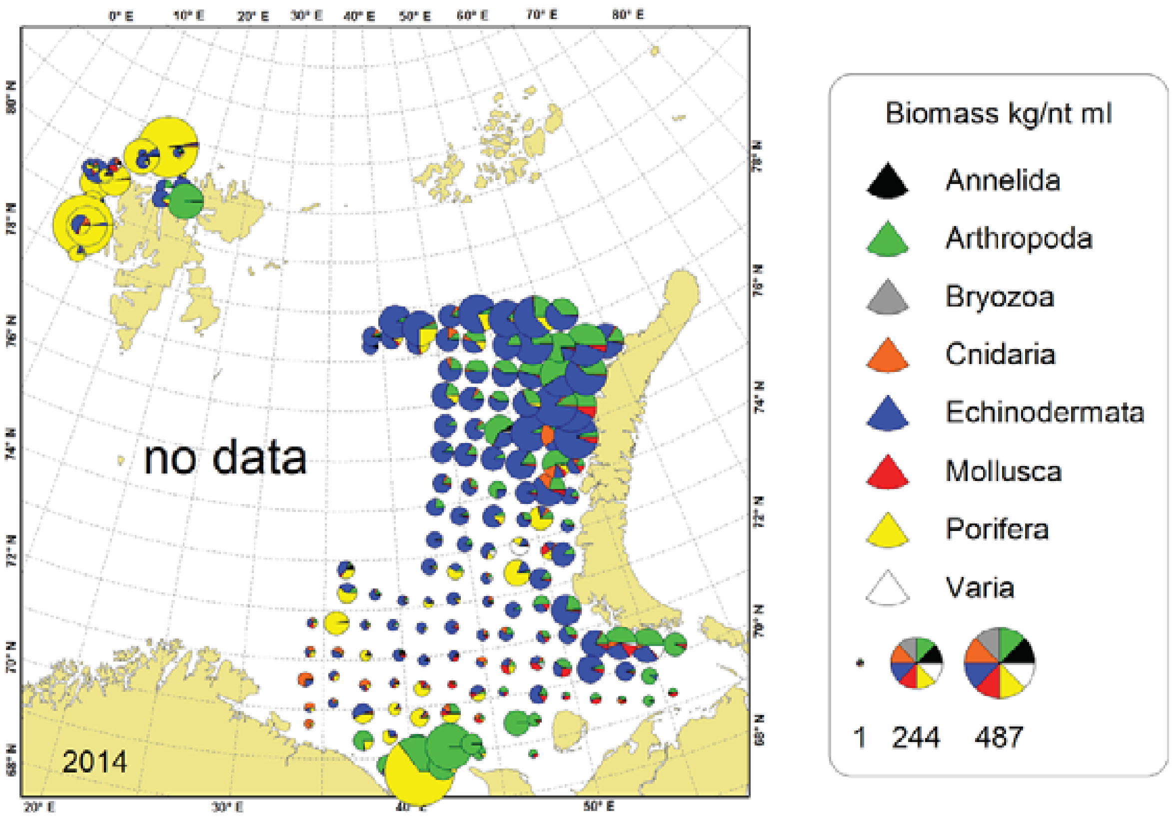


Figure 8.2.4.2, Biomass distribution of main taxonomic groups per station in the Barents Sea during in August-October 2014.

8.2.5 Distribution and amount of Gonatus fabricii

No results available. Take contact with responsible scientific group at IMR and PINRO.

8.3 Fish biodiversity

8.3.1 Small non-target fish species

No results available. Take contact with responsible scientific group at IMR and PINRO.

8.3.2 Species-indicators

by T. Prokhorova, E. Johannesen, A. Dolgov and R. Wienerroither
Figures by P. Krivosheya

Thorny skate (*Amblyraja radiata*) and Arctic skate (*Amblyraja hyperborea*) were selected as indicator species to study how fishes from different zoogeographic groups respond to changes of their environment. Thorny skate belongs to the boreal zoogeographic group and are widely distributed in the Barents Sea except the most north-eastern areas, while Arctic skate belongs to the arctic zoogeographic group and are distributed in the coldwater northern area.

In 2014 thorny skate are distributed in the wide area from the southwest to the northwest where warm Atlantic and Coastal Water have influenced (Figure 8.3.2.1, see Figure 4.1.8 in the section 4.1 "Hydrography").

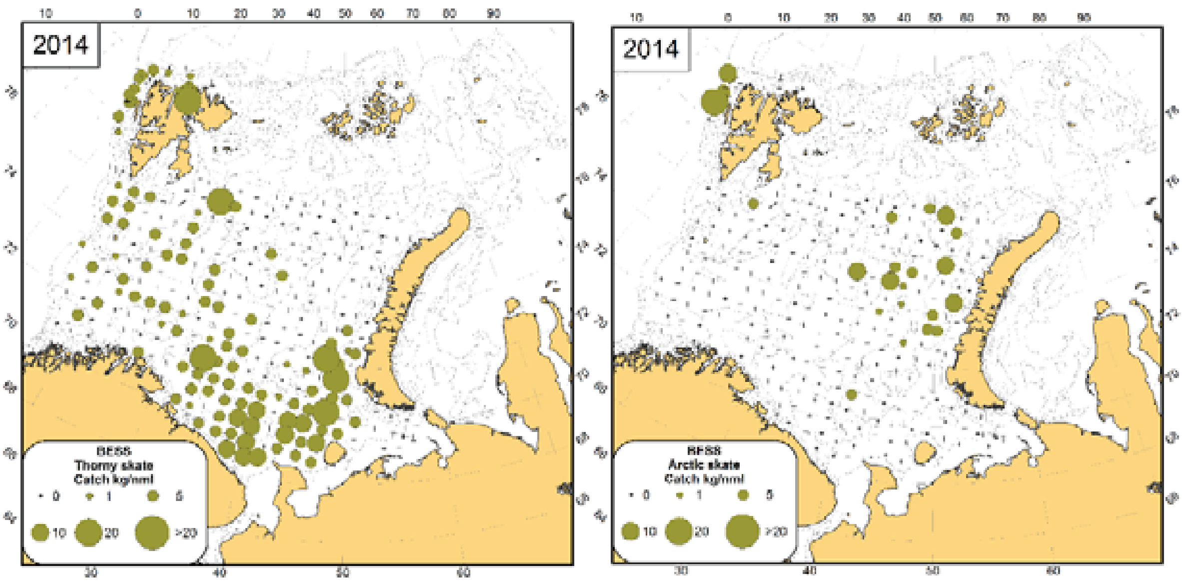


Figure 8.3.2.1. Distribution of thorny skate (*Amblyraja radiata*) and arctic skate (*Amblyraja hyperborea*), August-October 2014

Thorny skate was found at the same area as in 2013 but their biomass in the Hinlopen Strait and in the central part of the sea in 2014 was higher than in 2013. This species was observed in the 36.5 % of the bottom stations. Thorny skate are distributed within a depth of 20-813 m, but the highest biomass was observed at depth 20-150 m (43.6 % of total biomass). The mean catch (1.2 kg per nautical mile) was higher than in 2013 (0.5 kg per nautical mile), but the mean catch was approximately the same (1.4 individuals per nautical mile in 2014 and 1.3

individuals per nautical mile in 2013). The estimated total biomass and the abundance of thorny skate in 2014 (30.0 thousand tones and 34.4 million individuals) was lower than in 2013 (34.2 thousand tones and 38 million individuals). The reason for this fact is insufficient coverage of the northern area of the thorny skate distribution due to ice coverage in this region. Mean weight of this species in 2014 (0.82 kg) was little lower than in 2013 (0.84 kg).

Arctic skate was chiefly found in deep trenches at sub-zero temperatures in the northwest and central Barents Sea, as in previous year (Figure 8.3.2.1, see also Figure 4.1.8 in the section 4.1 “Hydrography”). The most biomass of this species was distributed north-west for Spitsbergen/Svalbard, unlike the 2013. Arctic skate was found in the 7.9 % of the bottom stations. This species was distributed within a depth 100-1023 m and the highest biomass was observed at 200-350 m (35.6 %) and 800-1023 m (50.9 %). The mean catch of arctic skate in 2014 (0.3 kg per nautical mile and 0.2 individuals per nautical mile) was higher than in 2013 (0.1 kg per nautical mile and 0.07 individuals per nm) and the same as in 2012. The estimated total biomass and abundance of arctic skate in 2014 (6.7 thousand tons and 3.7 million individuals) was also higher than in 2013 (4 thousand tons and 2.9 million individuals). Mean weight of this species in 2014 was higher than in 2013 (1.66 kg opposite 1.45 kg).

8.3.3 Zoogeographic groups

by T. Prokhorova, E. Johannesen, A. Dolgov and R. Wienerroither
Figures by P. Krivosheya

During the 2014 ecosystem survey 92 fish species from 29 families were recorded in the catches, and 9 species were identified up to the level higher than species (genus or family level) (Appendix 2). All recorded species belonged to the 7 zoogeographic groups: **widely distributed**, **south boreal**, **boreal**, **mainly boreal**, **arctic-boreal**, **mainly arctic** and **arctic** according to the Andriashev and Chernova (1994) and Mecklenburg et al. (2010). Table 8.2.3.1 represents average and maximum catches of species from different zoogeographic groups in the survey. Only bottom trawl data were used. Only non-commercial species were included into the analysis. Both demersal (including bentho-pelagic) and pelagic (neritopelagic, epipelagic, bethyalpelagic) species were reviewed (Andriashev and Chernova, 1994, Parin, 1968, 1988).

Widely distributed (only ribbon barracudina *Arctozenus risso* represents this group), **south boreal** (e.g. whiting silvery pout *Gadiculus argenteus*, grey gurnard *Eutrigla gurnardus*) and **boreal** (e.g. moustache sculpin *Triglops murrayi*, fourbeard rockling *Enchelyopus cimbrius*) species were mostly distributed over the south western and western part of the survey area where warm Atlantic and Coastal Water have influenced (Figure 8.2.3.1). The maximum catch of the species from these groups (479 individuals per nautical mile) was higher than in 2013 (259 individuals per nautical mile) (Table 8.3.3.1).

Mainly boreal species (e.g. lumpfish *Cyclopterus lumpus*, sandeel *Ammodytes marinus*) were widely distributed over the entire survey area in 2014 (Figure 8.3.3.1). The south boreal,

boreal and mainly boreal species were widely distributed due to positive temperature anomalies near the bottom throughout the Barents Sea in 2014 as in 2013. The average catch of species from the mainly boreal group was little less in 2014 (33.0 individuals per nautical mile) than in 2013 (38.5 individuals per nautical mile), but the maximum catch in 2014 (3841.4 individuals per nautical mile) was two times lower than in 2013 (6282.7 individuals per nautical mile) (Table 8.3.3.1). We analysed non-commercial species only but most of the Barents Sea commercial species (cod, haddock, capelin, herring, wolffishes etc.) also belong to this group. Therefore, the catch of mainly boreal group fish would greatly increase if the commercial spesies were included.

Arctic-boreal (e.g. ribbed sculpin *Triglops pingelii*, atlantic poacher *Leptagonus decagonus*), **mainly arctic** (e.g. atlantic spiny lumpsucker *Eumicrotremus spinosus*, arctic flounder *Liopsetta glacialis*, variegated snailfish Liparis bathyarcticus) and **arctic** (e.g. arctic cod *Arctogadus glacialis*, threadfin seasnail *Rhodichthys regina*, black seasnail *Paraliparis bathybius*) species were distributed west off Svalbard/ Spitsbergen, south and west off Novaya Zemlya Archipelago (Figure 8.3.3.1). They mostly occur in areas influenced by cold Arctic Water, Spitsbergen Bank Water, Novaya Zemlya Coastal Water and Pechora Coastal Water. Catches of species from these groups was in many times less than in 2013 due to lack of coverage north area during the survey in 2014 (Table 8.3.3.1).

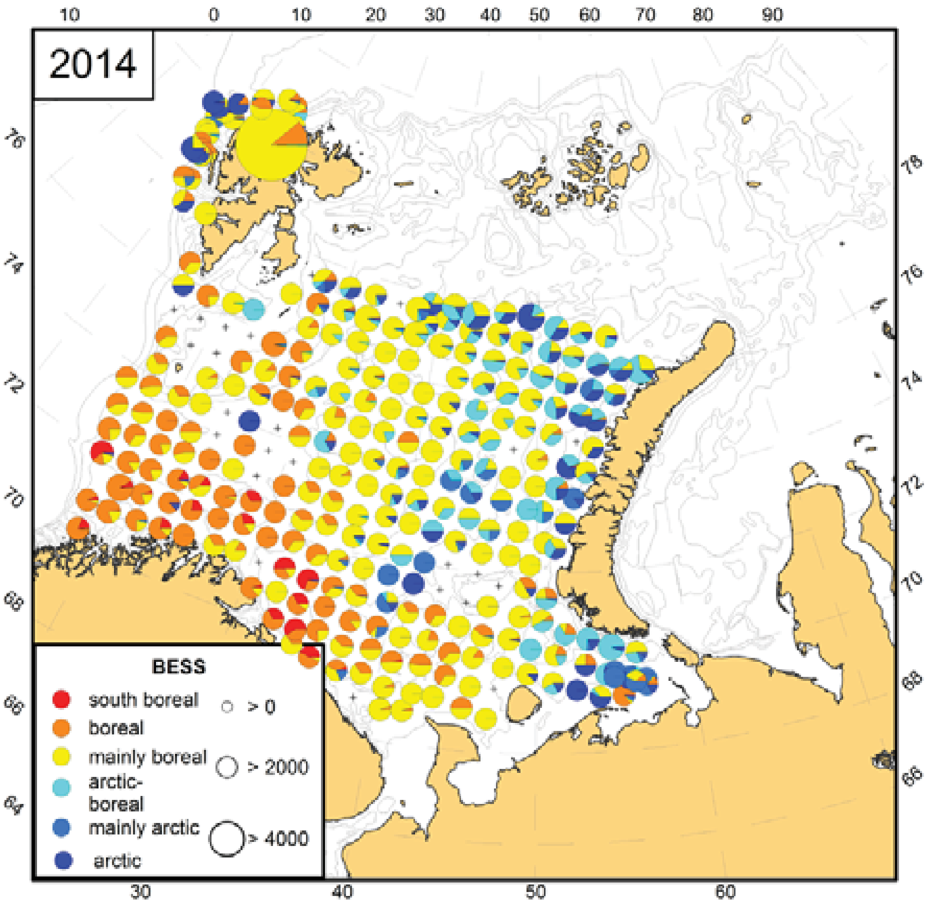


Figure 8.3.3.1. Distribution of non-commercial fish species from different zoogeographic groups during the ecosystem survey 2014. Size of circle corresponds to abundance (thousand individuals per nautical mile, only bottom trawl were used, both pelagic and demersal species are included)

Table 8.3.3.1. Average and maximum catch (individuals per nautical mile) of non-commercial fish from different zoogeographic groups (only bottom trawl data were used, both pelagic and demersal species are included).

Zoogeographic group	Average catch		Maximum catch	
	2013	2014	2013	2014
Widely distributed	0.2	0.1	45	4.3
South boreal	0.5	0.9	171.4	105.7
Boreal	5.95	10.6	258.6	478.6
Mainly boreal	38.5	33.0	6282.7	3841.4
Arctic-boreal	14.2	8.6	3326.9	371.6
Mainly arctic	5.9	1.7	656.3	60.9
Arctic	52.2	7.2	3822.7	385.2

8.3.4 Rarely found species

by T. Prokhorova, E. Johannesen, A. Dolgov and R. Wienerroither
Figures by P. Krivosheya

Some uncommon species were observed in the Barents Sea during the ecosystem survey in 2014 (Figure 8.3.4.1). Most of these species usually occur in adjacent areas of the Barents Sea and therefore occurred mainly along the border of the surveyed area (e.g. black seasnail *Paraliparis bathybius* and threadfin seasnail *Rhodichthys regina* which are distributed in the Arctic polar basin, arctic flounder *Liopsetta glacialis* and arctic *lamprey Lethenteron camtchaticum* which are distributed eastwards from the Barents Sea).

Some species are common for the ecosystem survey area but due to lack of coverage north area were few in number in 2014 (e.g. arctic cod *Arctogadus glacialis*).

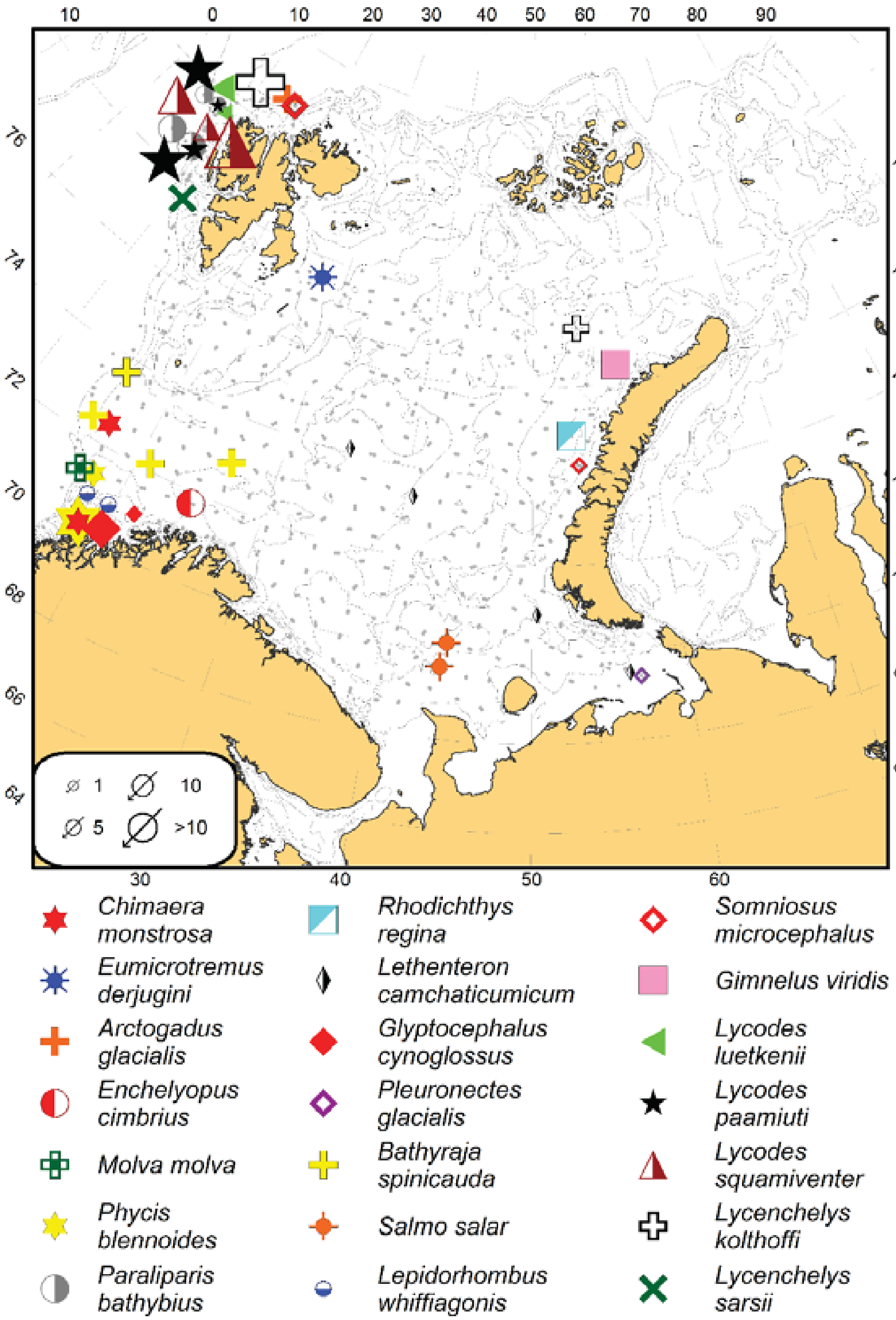


Figure 8.3.4.1. Distribution of species that are rare in the Barents that were found in the survey area in 2014. Size of circle corresponds to abundance (thousand individuals per nautical mile, both bottom and pelagic trawls were used).

9 Marine mammals and seabird monitoring

9.1 Marine mammals

Text by R. Klepikovsky
Figures by R. Klepikovsky

In 2014, standard observations of marine mammals were carried out only on Russian R/V “Vilnyus”. IMR changed the survey plan due to budget cut in June 2014, and no marine mammal observers participated on the Norwegian vessels (see “Background”, this report). However, during 15-27 September sea birds observers (onboard the Norwegian R/V "G.O.Sars") also observed and recorded some marine mammals.

During the survey 9 marine mammal species and a total of 499 individuals were recorded on board R/V "Vilnyus" and R/V "G.O.Sars". Collected data are presented in Table 9.1.1 and Figures 9.1.1-9.1.3.

As in previous years, white-beaked dolphins (67.8% of all individuals observed) were common and widely distributed in the Barents Sea. Most observations of white-beaked dolphins were recorded in the eastern area, between 70º-76º N, as the western area was not covered by marine mammal observers this year. In this eastern area, also capelin and cod of different densities were observed. However, the seabird observers also observed some dolphins in the area south and east off Spitsbergen archipelago, covered by “G.O.Sars”

Table 9.1.1. Number of marine mammal individuals observed during the survey in 2014, based on records were taken on board R/V “Vilnyus” and R/V“G.O. Sars”

Order /suborder	Name of species (in English)	“Vilnyus”	“G.O.Sars”	Total	%
Cetacea/ Baleen whales	Fin whale	3	17	20	4,0
	Humpback whale	11	52	63	12,6
	Minke whale	18	4	22	4,4
	Unidentified whale	1	6	7	1,4
Cetacea/ Toothed whales	Sperm whale	-	1	1	0,2
	White-beaked dolphin	277	61	338	67,8
	Harbour porpoise	16	-	16	3,2
	Killer whale	1	1	2	0,4
Pinnipedia	Harp seal	24	-	24	4,8
Other	Polar bear	6	-	6	1,2
Total sum		357	142	499	100

Other toothed whales observed included harbour porpoise, killer whale and sperm whales. Small groups of harbour porpoise were observed in southern regions up to 72º18' N. Harbour porpoise overlapped with young herring, capelin and 0-group of capelin and cod aggregations. Two individuals of killer whales were observed in the Great Bank area. A single sperm whale was observed in the western deeper (> 1000 meter) part of the survey area.

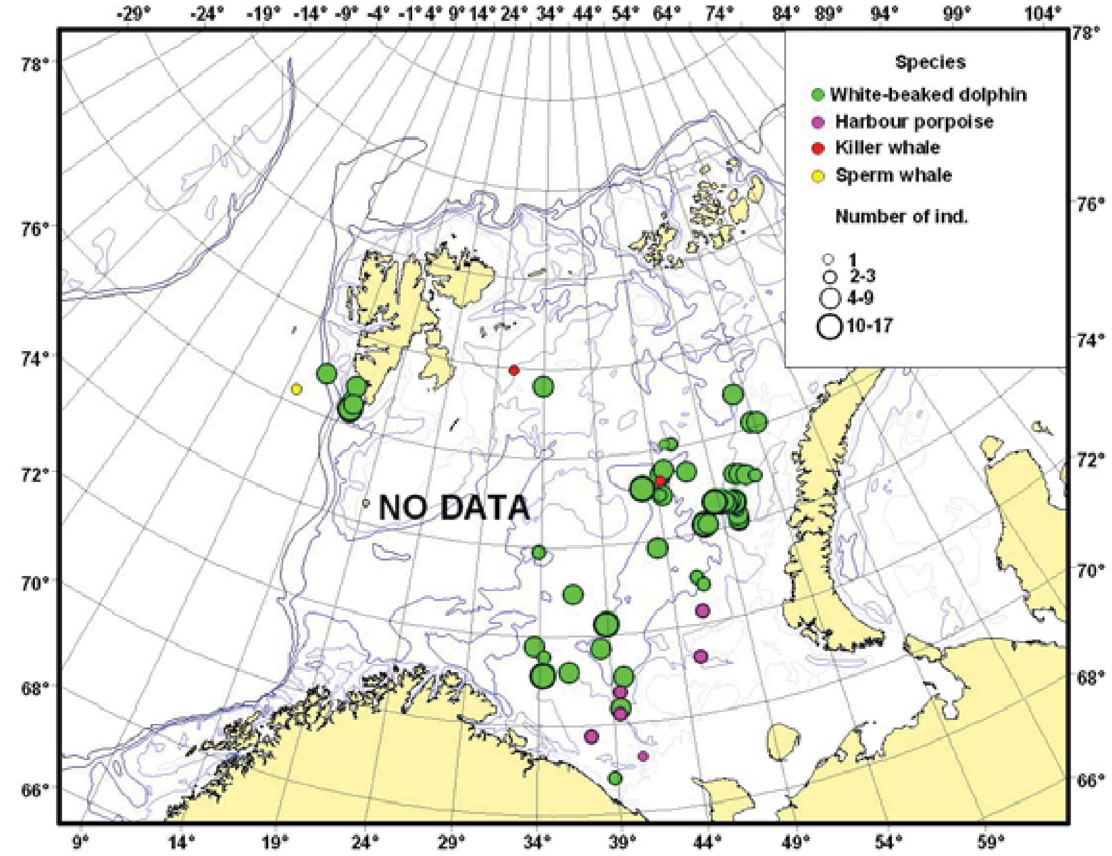


Figure 9.1.1. Distribution of toothed whales in August - October 2014.

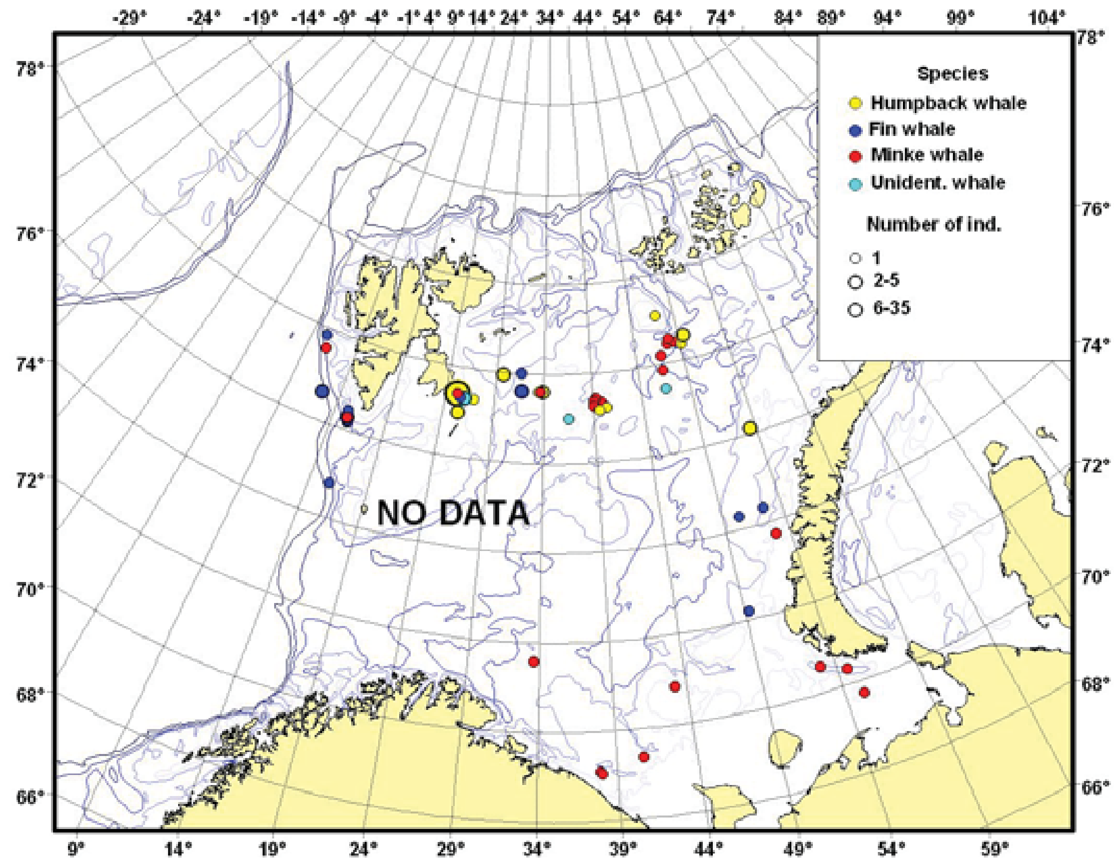


Figure 9.1.2. Distribution of baleen whales in August - October 2014.

Among the baleen whales minke whales and humpback whales were most frequently observed. Minke whales were widely distributed in northern, southern and south-eastern parts of Russian covered area, and most of the minke whales were observed north of 76° N and close to capelin aggregations. Number of observations decreased comparing with 2013, and only 45% of that was observed due to lack of marine mammal observers on the Norwegian vessels. In the south eastern Barents Sea minke whales were close to polar cod aggregations. Some minke whales were recorded by Norwegian Sea bird observers near Spitsbergen. Large aggregations of humpback whales were Observed, while few fin whales were recorded. Fin whales were observed along the continental shelf north of 74 'N, where dense aggregations of 0-group fish were found.

In 2014, low numbers of humpback whales were observed by R/V "Vilnyus", only 25% of the numbers observed in 2013 in same area. Humpback whales were observed manly as single individuals, but also in small groups (2-5 individuals) in northern areas between 76º N and 79º05 'N, close to the area of capelin aggregations.

Among the pinnipeds harp seal only was observed in the covered area of R/V "Vilnyus". This species were observed as single individuals or in small groups of up to 4 individuals in the Great Bank north of 77°N. Animals were typically in areas with 50% ice concentration. Lack of dense summer-autumn concentrations of harp seals was recorded in 2014 as in previous years. Six polar bears were observed north-east of the harp seal area (beyond 78°N). It was in a region with 90% ice concentration with small floes of white ice. Polar bears were not observed by Norwegian seabird observers.

9.2 Seabird observations

Text by P. Fauchald and R. Klepikovsky
Figures by P. Fauchald

Seabird observations were carried out by standardized strip transect methodology. Birds were counted from the vessel’s bridge while the ship was steaming at a constant speed of ca. 10 knots. All birds seen within an arc of 300 m from directly ahead to 90° to one side of the ship were counted. On the vessels Helmer Hansen, GO Sars and Johan Hjort, birds following the ship i.e. “ship-followers”, were counted as point observations within the sector every ten minutes. Ship-followers included the most common gull species and Northern fulmar. Total transect length covered by the Norwegian vessels (Helmer Hansen, GO Sars and Johan Hjort) was 5281 km. Total transect length covered by Vilnyus was 5704 km.

A total of 113 279 birds belonging to 32 different species were counted (Table 9.2.1). Similar to previous surveys, the highest density of seabirds was found north of the polar front. These areas were dominated by Brünnich’s guillemots (*Uria lomvia*), little auk (*Alle alle*), kittiwake (*Rissa tridactyla*) and Northern fulmar (*Fulmarus glacialis*).

The distribution of the different species was similar to the distribution in previous surveys (Figure 9.2.1). Alcids were observed throughout the study area but the abundance and species distribution varied geographically. Little auks were found in the northern area, Brünnich's guillemots were found in the central and northern area, Atlantic puffins (*Fratercula arctica*) were found in the western area and common guillemots (*Uria aalge*) were found in the south-eastern area. Among the ship-followers, black-backed gulls (*Larus marinus*) and herring gull (*Larus argentatus*) were found in the south, close to the coast. Glaucous gull (*Larus hyperboreus*) was found in small numbers in the central western area, kittiwakes were found in high density in the north-east, while Northern fulmars were encountered in highest numbers in the west and south.

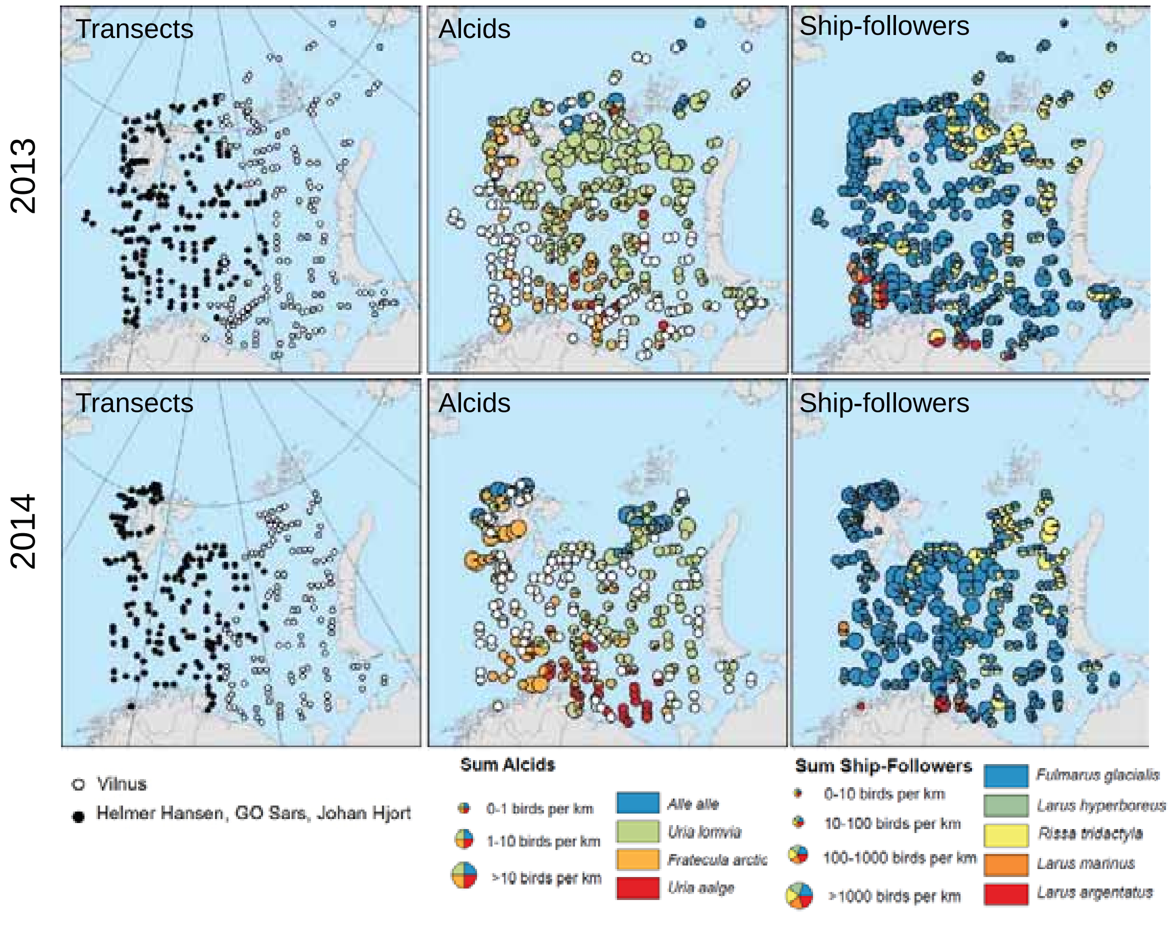


Figure 9.2.1. Seabird observations in 2013 (top) and 2014 (bottom). Left panel; positions of transects, middle panel; distribution of auks, right panel; distribution of ship-followers (gulls and fulmar).

Table 9.2.1. List of species encountered during the survey in 2014. Note that ship-followers were counted differently on the Norwegian and Russian vessels.

English name	Scientific name	Norwegian vessels	Russian vessel
Razorbill	*Alca torda*	41	1
Little auk	*Alle alle*	570	1223
Ruddy turnstone	*Arenaria interpres*	3	0
Purple sandpiper	*Calidris maritima*	5	7
Black guillemot	*Cephus grylle*	190	25
Ringed plover	*Charadrius hiaticula*	0	1
Gyrfalcon	*Falco rusticolus*	0	1
Atlantic puffin	*Fratercula arctica*	1012	18
Northern fulmar*	*Fulmarus glacialis*	92152	2027
Black-throated loon	*Gavia arctica*	0	6
Red-throated diver	*Gavia stellata*	1	0
Herring gull*	*Larus argentatus*	802	38
Heuglin's gull*	*Larus heuglini*	0	59
Glaucous gull*	*Larus hyperboreus*	1873	69
Great black-backed gull*	*Larus marinus*	371	61
Northern gannet	*Morus bassanus*	9	7
Ivory gull	*Pagophila eburnea*	110	6
Red-necked phalarope	*Phalaropus lobatus*	1	0
Snow bunting	*Plectrophenax nivalis*	0	1
Sooty shearwater	*Puffinus griseus*	9	1
Manx Shearwater	*Puffinus puffinus*	7	0
Black-legged kittiwake	*Rissa tridactyla*	4576	2661
Ross's gull	*Rhodostethia rosea*	1	0
Common eider	*Somateria mollissima*	1	10
Long-tailed skua	*Stercorarius longicaudus*	17	0
Arctic skua	*Stercorarius parasiticus*	86	100
Pomarine skua	*Stercorarius pomarinus*	230	315
Great skua	*Stercorarius skua*	12	1
Unident. Skua	*Stercorarius sp.*	11	0
Arctic tern	*Sterna paradisaea*	57	10
Redwing	*Turdus iliacus*	0	1
Common guillemot	*Uria aalge*	166	120
Brünnich's guillemot	*Uria lomvia*	3090	1080
Unspec. guillemot	*Uria* spp.	18	9
Total		105421	7858

*Ship-followers

10 Special investigations

10.1 Standardization of survey equipment and testing of experimental pelagic trawl

No results available. Take contact with responsible scientific group at IMR and PINRO.

10.2 Krill sampling by plankton net attched to the bottom trawl

by A. Benzik and A.Dolgov

10.2.1 Background and aim of investigations

Euphausiids are an abundant group of planktonic invertebrates, which play important role in trophic chains in the Barents Sea ecosystem (Drobysheva, 1994; Anon., 1996).
Since 1950s PINRO have conducted annual survey of euphausiids in the Barents Sea during Russian autumn-winter survey in October-December. Distribution, abundance, species and length compositions of euphausiids are annually estimated by PINRO. Based on these data, a review of their populations state and a forecast for the next year are conducted to evaluate feeding conditions for commercially important fishes in the Barents Sea.

To evaluate the possibility to estimate euphausiids stocks in different seasons, at the March meeting 2014 PINRO and IMR have agreed to conduct the joint investigations of euphausiids in the ecosystem survey (August-September 2014), Russian autumn-winter survey (October-December 2014) and in the Joint Norwegian-Russian winter survey (February-March 2015) onboard Russian and Norwegian vessels by standard sampling gear (the plankton net attached to the bottom trawl net).

10.2.2 Methods

According these agreements, euphausiids sampling were conducted in the ecosystem survey 2014. PINRO scientists Aleksander Benzik and Tatiana Prokhorova provided methodical help in using of the trawl net and collection of samples onboard Norwegian research vessels (G.O.Sars and J.Hjort).

Euphausiid (macro plankton) sampling was conducted according traditional methods used in PINRO (Anon., 2004). The trawl net (net size № 40, diameter of net opening - 50 cm) was used as sampling gear. The plankton net was attached to mid of the head line of bottom or pelagic trawl (Figure 10.2.1, 10.2.2 and 10.2.3).

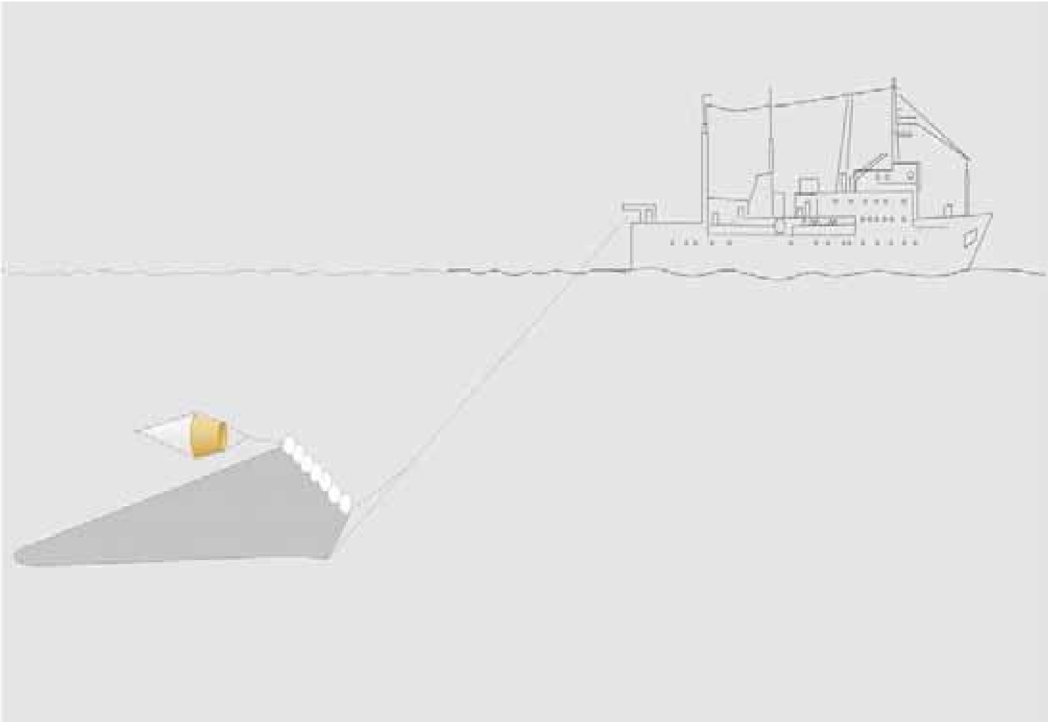


Figure 10.2.1. The plankton net attached to the bottom trawl.

Figure 10.2.2. Plankton net attached to the bottom trawl.

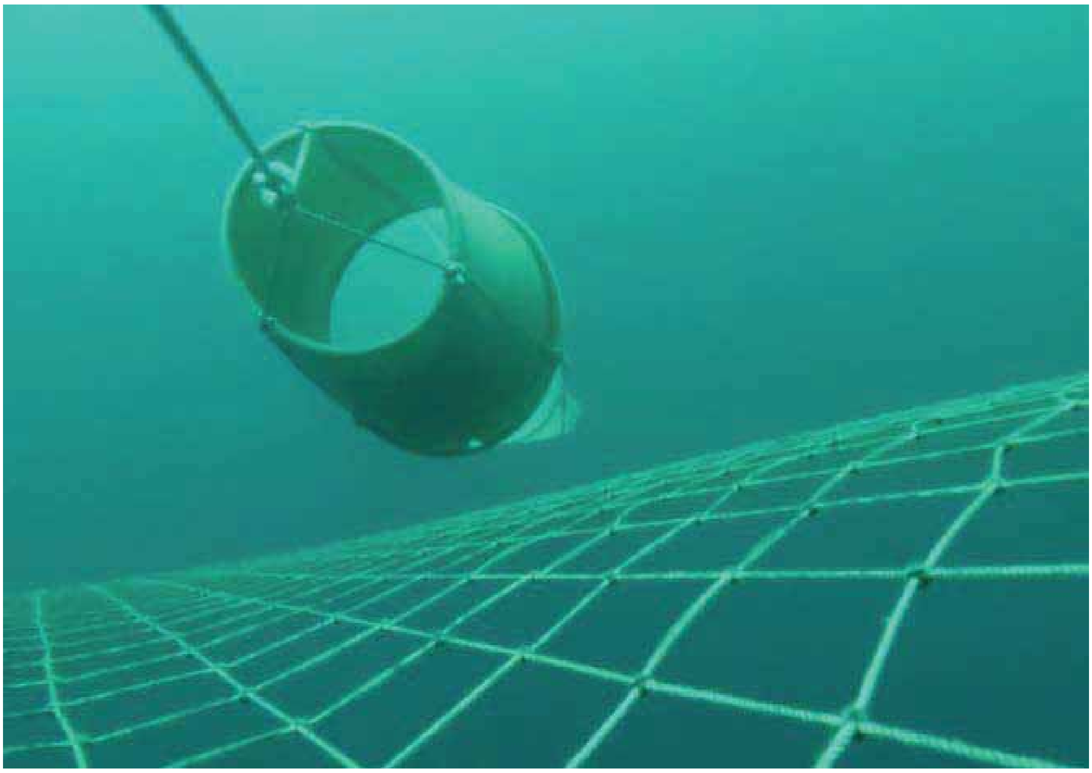


Figure 10.2.3. Underwater picture of plankton net attached to the pelagic trawl

During work on R/V G.O.Sars underwater video observations were conducted to evaluate possible effect of pelagic trawl geometry. Underwater records have shown that plankton net attached to the pelagic trawl not affected trawl geometry.

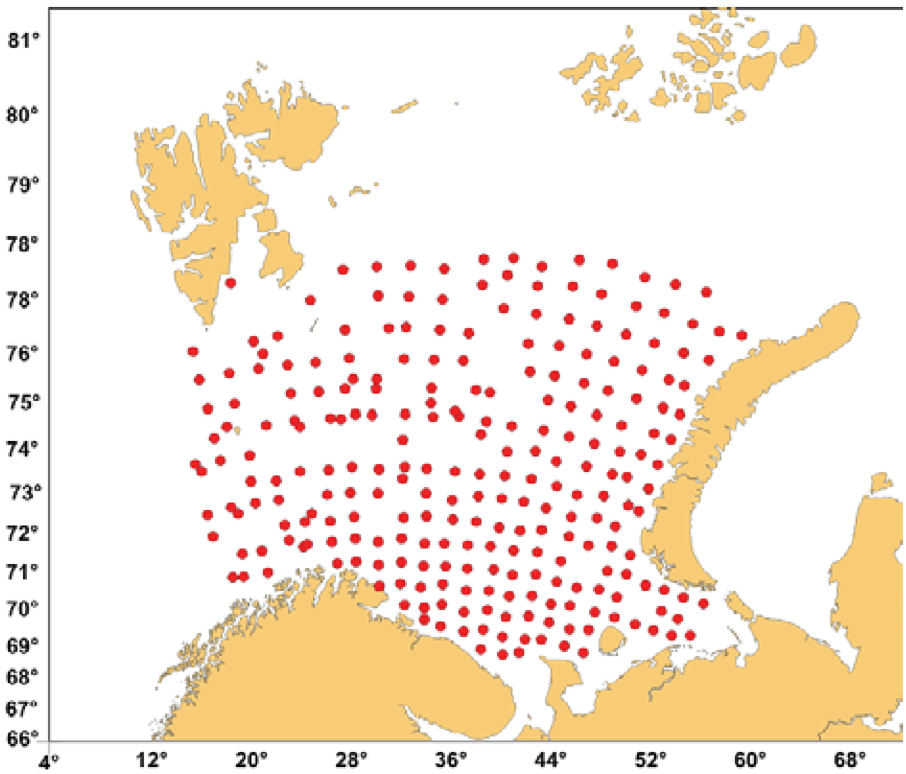


Figure 10.2.4. Macro plankton samples collected by plankton net attached to the bottom trawl.

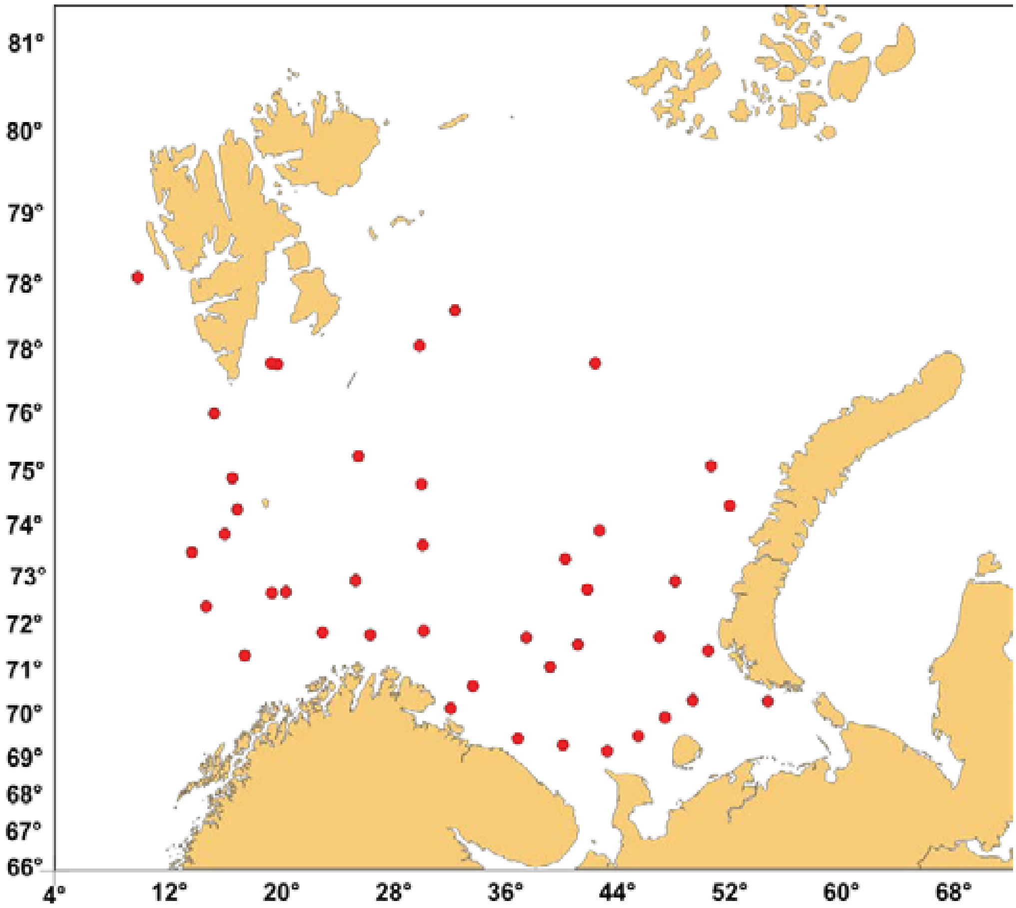


Figure 10.2.5. Macro plankton samples collected by plankton net attached to the pelagic trawl.

10.2.3 References

Anon. 1996. Annual distribution of euphausiid crustaceans – prey of commercially important fishes of the Barents Sea (1981-1995) (reference materials). Murmansk, PINRO Press. 27 pp. (in Russian).

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11 Instruments and fishing gear used

11.1 Instruments

The Simrad ER-60/18, 38, 120, 200 and 330 kHz scientific sounder was run during the survey for fish observation and bottom detection.

The details of the settings of the 38 kHz echo sounder where as follows:

Reference Target:

TS	-33.60 dB	Min. Distance	21.00 m
TS Deviation	5.0 dB	Max. Distance	27.00 m

Transducer: ES38B Serial No.

Frequency	38000 Hz	Beamtype	Split
Gain	25.51 dB	Two Way Beam Angle	-20.8 dB
Athw. Angle Sens.	21.90	Along. Angle Sens.	21.90
Athw. Beam Angle	6.85 deg	Along. Beam Angle	6.84 deg
Athw. Offset Angle	-0.08 deg	Along. Offset Angl	0.15 deg
SaCorrection	-0.65 dB	Depth	6.00 m

Transceiver: GPT 38 kHz 009072034687 2-1 ES38B

Pulse Duration	1.024 ms	Sample Interval	0.190 m
Power	2000 W	Receiver Bandwidth	2.43 kHz

Sounder Type:
EK60 Version 2.4.2

TS Detection:

Min. Value	-50.0 dB	Min. Spacing	100 %
Max. Beam Comp.	6.0 dB	Min. Echolength	80 %
Max. Phase Dev.	8.0	Max. Echolength	180 %

Environment:

Absorption Coeff.	9.4 dB/km	Sound Velocity	1485.0 m/s

Beam Model results:

Transducer Gain =	25.37 dB	SaCorrection =	-0.60 dB
Athw. Beam Angle =	7.18 deg	Along. Beam Angle =	7.17 deg
Athw. Offset Angle =	-0.08 deg	Along. Offset Angle=	-0.13 deg

Data deviation from beam model:
RMS = 0.16 dB
Max = 1.56 dB No. = 221 Athw. = 4.5 deg Along = -1.1 deg
Min = -0.54 dB No. = 44 Athw. = -4.9 deg Along = -0.2 deg

Data deviation from polynomial model:
RMS = 0.13 dB
Max = 1.65 dB No. = 221 Athw. = 4.5 deg Along = -1.1 deg
Min = -0.38 dB No. = 275 Athw. = 4.5 deg Along = -1.9 deg

Standard sphere calibrations were carried out in Malangen fjord, Spilderbukta (79°25’N and 18°31’E) 05-06.09.2014 by using a 60 mm diameter copper sphere for 38kHz. Due to high fish densities only 38kHz was calibrated. Other frequencies were examinated by running the appropriate calibration sphere through the echosounder beam in order to manually check that signal levels were normal. Thus eliminating the possibility of a faulty echo sounder.

11.2 Fishing gear

All vessels have pelagic”Harstad” and bottom ”Campelen” trawls. Additionally, the Norwegian vessels equipped with mactoplankton trawl. Trawls were used for monitoring of pelagic and demersal community and identification of acoustic targets.

The bottom trawl has a headline of 31 m, footrope 47 m and 20 mm mesh size in the cod end with an inner net of 10 mm mesh size. The trawl height was about 4.5 m and distance between wings during towing about 21 m. The sweeps are 40 m long. The trawl is equipped with a 12" rubber bobbins gear. New doors are 'Thyborøn' combi type, 7.41 m2, 1720 kg.

The SCANMAR system was used on all trawl hauls. This equipment consists of sensors, a hydrophone, a receiver, a display unit and a battery charger. Communication between sensors and ship is based on acoustic transmission. The doors are fitted with sensors to provide information on their distance, and the trawl was equipped with a trawl eye that provides information about the trawl opening. A catch sensor on the cod-end indicated the size of the catch.

11.3 Sonar recordings on board the RV “G.O. Sars”

by R.Korneliussen and G. Skaret

11.3.1 Background and objectives

Active sonars transmit and receive sound pulses. By custom, the term “echo sounder” is sonar that is essentially vertically oriented sonar, and the term “sonar” is used within fisheries acoustics if the beams are essentially horizontally oriented. Here, we use the term “echo sounder” if the beams are within ±30° from vertical, and sonar if the beams are 30° - 90° from vertical (i.e. 90° is horizontal). Echo sounders are typically used for abundance estimation during monitoring surveys for pelagic fish, also for Barents Sea capelin. With developing technology, sonars must be evaluated as supplements or even in some cases alternatives to conventional echo sounders. Sonars have the advantage over echo sounders that they sample a considerably larger volume of water including volumes usually inaccessible to echo sounders like surface waters.

The RV “G.O. Sars” is equipped with echosounder and two sonars, all manufactured by Simrad (Kongsberg). For both the echo sounder and the sonars there is now opportunity to log data and post-processing software available.

The main objective of applying the EK60 echo sounder is abundance estimation.

The main objective of applying the MS70 sonar was to find out whether it can be used as a supplement or even an alternative to conventional echosounders to quantify capelin biomass, in particular in cases where capelin are distributed close to the surface.

The main objective of running the SX90 sonar was to quantify swimming direction and speed of the capelin to evaluate whether there was systematic migration during the survey potentially biasing the survey estimate.

11.3.2 Application and methods

EK60 recordings

The scientific echosounder EK60 is modular by means of one GPT (General Purpose Transceiver) and one transducer for each frequency controlled by a common PC using MS operating system. The EK60 onboard RV "G.O. Sars" are connected to transducers at the frequencies 18-, 38-, 70-, 120-, 200- and 333-kHz in a tightly packed configuration for optimal spatial overlap with the purpose of reliable species identification.

EK60 was used during all of the survey. The data were processed by means of LSSS to remove noise and do automatic species detection. The EK60 data were scrutinized daily during two sessions. The official capelin abundance is based on the EK60 results. Capelin was also automatically identified from multi-frequency and pre-processed EK60 data by means of LSSS.

The EK60 data were processed in sequence the following way prior to scrutinizing: (A) Remove spike noise, e.g. due to unsynchronized instruments; (B) Correct for transducer geometry; (C) Detect bottom; (D) Remove ambient noise; (E) Remove unnecessary data; (F) Detect school-candidates; (G) Suggest acoustic categories (i.e. do "species identification"). See Appendix A for details.

MS70 recordings

The Simrad MS70 is the first quantitative, high resolution multibeam sonar (Korneliussen et al. 2009). It is designed to provide output which can be used to quantify echo backscattering and hence estimate fish biomass. The MS70 uses 500 beams distributed equally over 20 fans to insonify a volume corresponding to 60 degrees horizontally and 45 degrees vertically in each ping (Figure 10.4.1). The sonar transmits in the frequency range of 75 to 112 kHz with a gradually increasing frequency with depth for each of the 20 fans; 75 kHz in the fan parallel with the surface, and 112 kHz in the lowest fan (pointing 45 degrees downwards). Although MS70 covers the frequencies 75 – 112 kHz, the frequency span is not very wide, so the sonar is considered to be essentially single frequency. The frequency span is a technical solution used to avoid interference between the vertical fans.

The sonar was operated with port-oriented beams, and pulse duration of 2 ms. Sonar transmission was synchronized with the echosounder, but due to the slower processing speed of the sonar ping-rate was usually one half or one third of the echo sounder, i.e. pinging every second or every third time the echo sounder transmitted. The sonar was calibrated in Norwegian waters following Ona *et al.* (2007), using 75- and 84-mm diameter spheres made from tungsten carbide (WC) and 6% cobalt binder. The sonar data were processed using the PROMUS module of the Large Scale Survey System (LSSS) (Korneliussen et al., 2006, www.marec.no, Bergen, Norway)

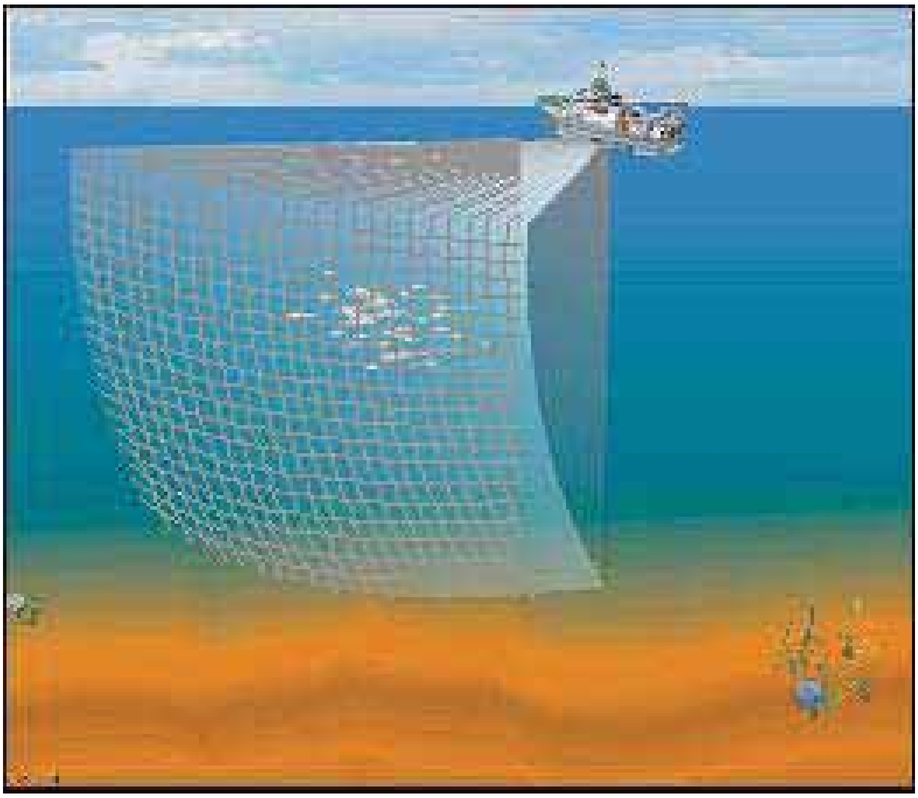

Figure 11.4.1. Illustration of MS70 (courtesy of Hans Petter Knudsen).

Application of MS70 during the survey

MS70 was used during all of the survey. The data were processed by means of the LSSS module PROMUS to remove noise and to make semi-automatic school-detection easier. The MS70 data were scrutinized daily simultaneously with the EK60 data during two sessions, i.e. the scrutinizing of pre-processed MS70 data and pre-processed EK60 data was done during the same operation. The results of the MS70 data were intended to make an abundance estimate of capelin independent of the EK60 data.

During the first 2/3 of the cruise, the MS70 data were scrutinized simultaneously with the EK60 data. However, some of the necessary processes to scrutinize the MS70 data were increasing the time needed to scrutinize all data to well beyond the 2 hour goal for 24 hours of collected acoustic data. It was especially the time needed to read the raw-data and store the scrutinized MS70-data into the database that were time-consuming. Therefore it was decided to postpone the scrutinizing of the MS70 data. After the survey, effort was put into removing those bottlenecks, and they are now removed. In fact, the reading and storing of processed MS70 data are now faster than EK60.

Further, it was decided that only a subset of the cruise-tracks should be used to compare the abundances based on MS70 data and EK60 data. A nearby area where significant amounts of capelin were found during an earlier period of the cruise was selected. Cruise-tracks were designed for a mini-survey (see below), and those cruise tracks should be covered during 30 hours to account for diel variations. Several trawl-hauls and other biological samples were intended together with CTD-samples. Unfortunately, RV “G.O. Sars” had to return to shore after 17 hours, from January 21 19:00 UTC to January 22 12:00 UTC. Although a full diurnal coverage was not done, the survey-tracks were covered 3 times, and two trawl-stations were carried out in the survey area, one pelagic and one bottom. The survey-grid is shown in Figure 10.4.2.

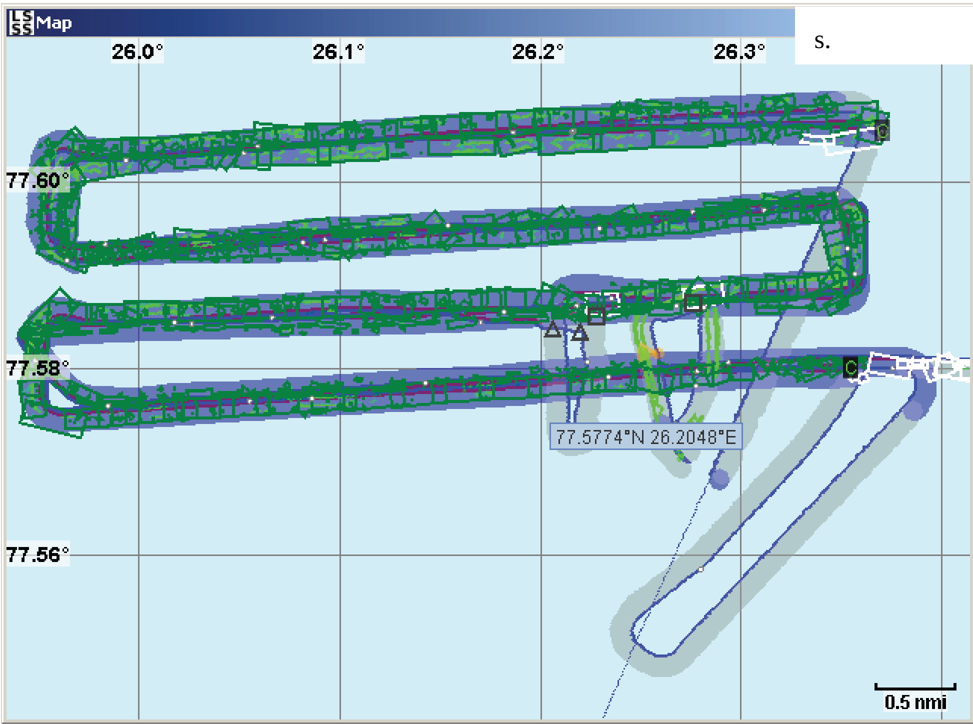

Figure 11.4. 2. Survey-grid covered three times. The grey proportions are excluded, e.g. due to trawling. The thin dark blue show cruise-lines covered by EK60, the thick lighter blue lines show what MS70 covered (and to which side of the cruise-line), the small black triangles mark start and stop of pelagic trawl, the black squares mark start and stop of bottom trawl. The green “blobs” are school-candidates detected by the K-means algorithm. The green boxes are accepted and scrutinized school

MS70 processing prior to school-detection and scrutinizing

The MS70 quantitative 4-dimensional sonar suffer from both spike-noise and ambient noise, so massive pre-processing to improve the data is necessary. Further, the MS70 generates so much data, that there had to be a selection of filters to keep the processing time down. The processing modules were used in sequence prior to scrutinizing. The processing modules do the following: (A) Remove spike noise, e.g. due to nearby fishing vessels, unsynchronized instruments, or problems in the MS70; (B) Remove ambient noise; (C) Remove unnecessary data, i.e. reduce the amount of data; (D) Do school-candidate detections for visualisation in a map; and (E) Compress data. In addition, the data after (C) are branched, and (F) phantom echograms (i.e. echograms generated from MS70 data) were generated better semi-automatic detection of schools. See Appendix B for details.

Scrutinizing EK60 and MS70 data

Figure 10.4.3 shows the interpretation interface for scrutinizing both MS70 and EK60 data. The echogram windows show approximately the same depth range. Figure 10.4.4 shows automatically detected acoustic categories. In this case, essentially all schools were identified as capelin, which is in accordance with the manual scrutiny. Thus, the scrutiny was in this case simple.

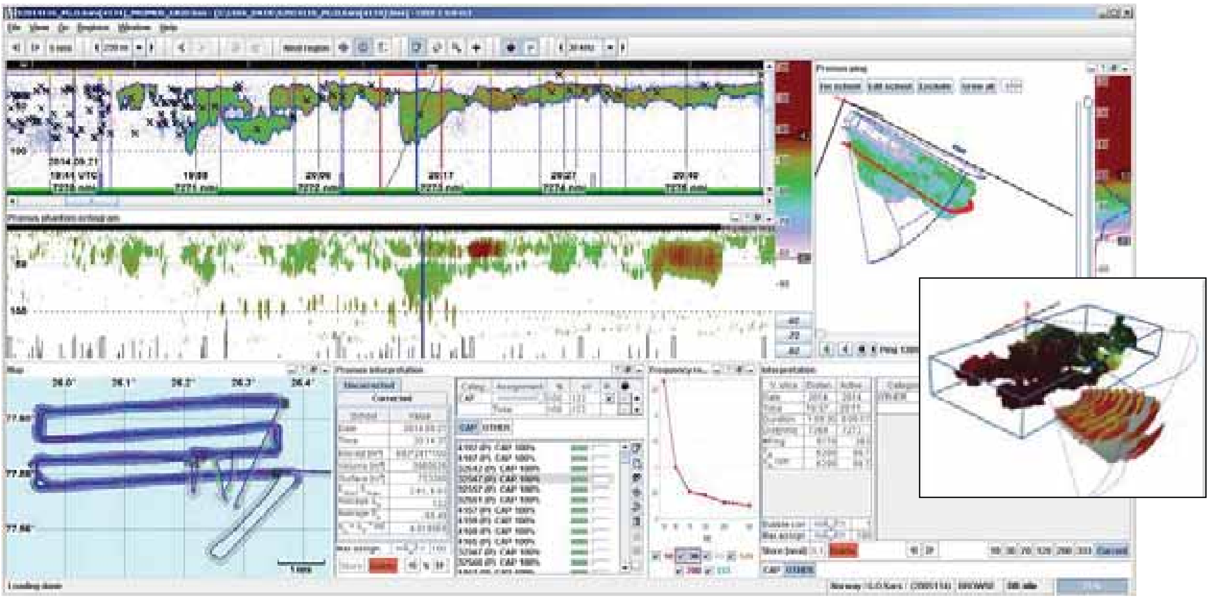

Figure 11.4.3. Example of echosounder and multibeam sonar (MS70) capelin recordings. Upper left: echogram displaying capelin recordings. Middle left: the same section with capelin as above, here as recorded with the multibeam sonar and visualized as a phantom echogram. Lower left: map showing the transect which was covered three times. Upper right: three dimensional representation of a single capelin school as observed with the MS70 (250 m range), with the bottom is seen in the lower part. Middle right: capelin shoal also showing the bottom (400 m range). The lower middle to right windows show: MS70 interpretation windows, frequency response of capelin recordings, EK60 interpretation window.

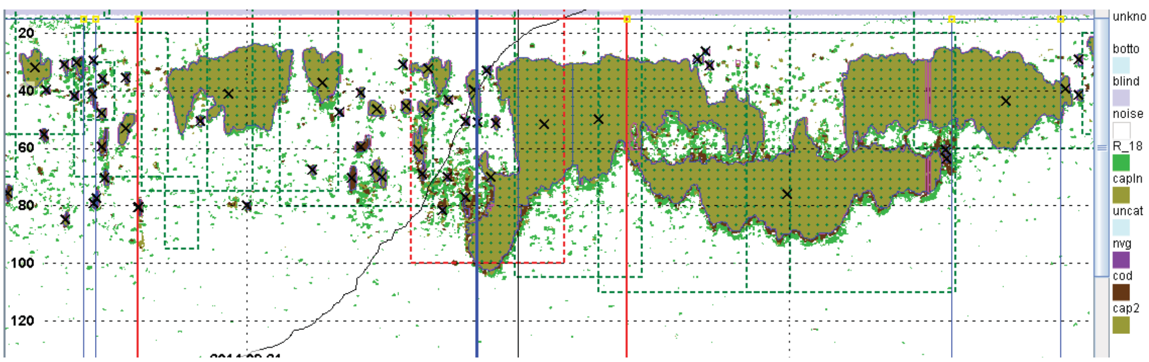

Figure 11.4.4. Automatic detection of species from multifrequency EK60 data show almost pure capelin for the schools (brownish spotted regions). The most relevant of the tested acoustic categories were in addition to capelin, also herring (Norwegian Spring Spawning herring) and cod (Norwegian Arctic cod).The stippled lines show the extent of schools detected from MS70 data. Those are schools accepted by the scrutinizer to really be schools, e.g. not only school-candidates.

The dorsal TS, i.e. the TS to be used with echo-sounder data, is well known, but the target strength (TS) for sonar data is in principle unknown. Dorsal side, capelin is expected to have tilt 0°±13°, while side aspect is more likely to be 0°±90°. Thus, the side aspect TS is smaller than dorsal side TS at the same frequency provided there is no reaction from capelin to the ship.

SX90 recordings

The Simrad SX90 is an omnidirectional fisheries sonar which operates at 20-30 kHz. The sonar can be operated in different modes deciding which volume is sampled. Here, we operated in ’Bow up/vertical’ mode which alternates every second ping between transmitting a 360 degrees horizontal fan (64 beams), and a vertical fan (See Figure 10.4.5).

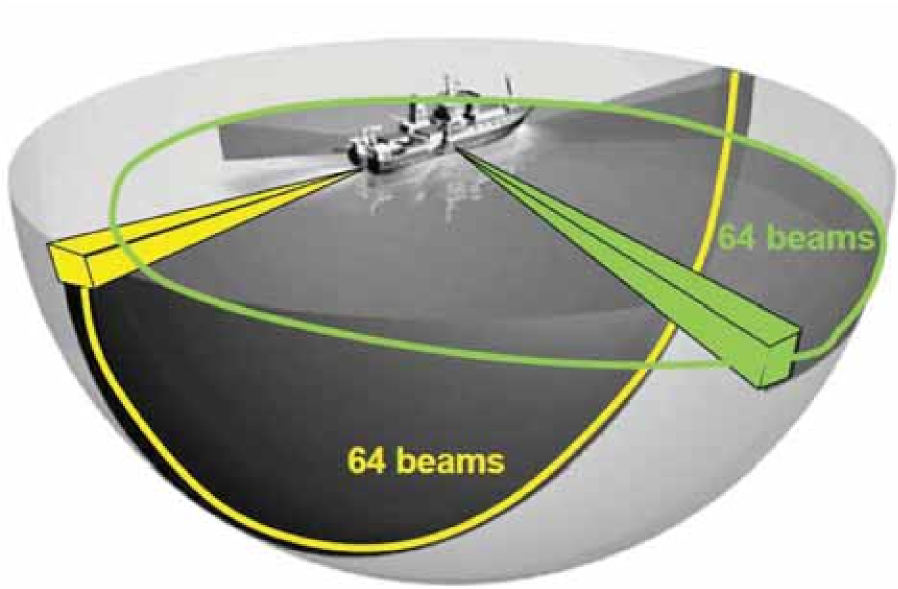

Figure 10.4.5. Example of a Simrad SX90 omni directional sonar modified from Simmonds and MacLennan (2005). The two transmitted beams forming conical shells are in this case pointing forwards and tilted slightly downwards (green) and vertically in the fore-aft plane (yellow). Tilting and rolling the sonar head can modify the sampling volume.

We used a pulse repetition rate of 1 Hz, recorded to 600 m range with a tilt of 4 degrees, targeting schools at depths of 0–50 m. Unprocessed data were stored for each ping from the sonar-control computer to an external hard drive. Sonar data were post-processed using the software “Processing system for omnidirectional fisheries sonar” (PROFOS), which is a module of the Large Scale Survey System (Korneliussen et al., 2006, www.marec.no, Bergen, Norway). The sonar data were displayed as a circular image with the vessel at the centre and a diameter equal to the sonar operational range (i.e. 400 m).When a school was visually detected, a mouse click on top of the centre of each school (“to seed a school”) told the software to automatically find the adjacent cells, where uncalibrated volume backscattering strength (S_v) ranged from -10 to -50 (dB re m^{-1}), and group them into one school (“growing a school”). This growing procedure was repeated for the ping where the school was seeded and for consecutive pings (i.e. 5 to 10 pings before and after the seed) until the school was no longer detected in the sonar (Pena et al. 2013). For each detected school, the geographic position, date, time, mean SV, and school area (m^2) were computed.

ADCP recordings

Data from both the 75 kHz and 150 kHz Acoustic Doppler Current Profiler (ADCP) on board were logged. They provide information about the vertical current pattern which is important when interpreting migration speed and direction. These data have not yet been processed.

11.3.3 Preliminary results

MS70 abundance estimation

The data were stored at a resolution of 0.1 nmi horizontally. The official TS-relation for capelin at 38 kHz does not consider compression of the swimbladder with depth:

Dorsal TS at frequency f: TS(f) = TS(38) + 10 Log(r(f))
The r(f) of capelin-schools in library: r(38)=1; r(70)=0.55; r(120)=0.42; r(200)=0.44;

Dorsal TS at 38 kHz:	TS = 19.1 Log L -74.0 [dB];
Dorsal TS at 70 kHz:	TS = 19.1 Log L -76.6 [dB];
Dorsal TS at 94.2 kHz:	*TS_{94}≈19.1 Log L -77.2 [dB] (suggested), 3.2 dB from 38 kHz*
Dorsal TS at 120 kHz:	TS = 19.1 Log L -77.8 [dB];
Dorsal TS at 200 kHz:	TS = 19.1 Log L -77.6 [dB];

	Date	Hour	Log		Date	Hour	Log
Coverage 1:	2014.09.21	19:33	7269.1	-	2014.09.22	1:05	7294.2
Coverage 2:	2014.09.22	1:10	7294.4	-	2014.09.22	5:57	7322.4
Coverage 3:	2014.09.22	5:59	7322.4	-	2014.09.22	9:35	7346.4

	MS70	[kHz]	[DEG]	EK60_38	*EK60/MS70*
Coverage 1:	1253	93533	111.8	6525	5.2 (7.2 dB)
Coverage 2:	497	93613	112	3544	7.1 (8.5 dB)
Coverage 3:	213	95491	114.7	1055	5.0 (7.0 dB)

Due to the difference in target strength when insonified from the dorsal side or lateral side (see above), the EK60/MS70 ratio is expected to be >1. However, further work is needed to investigate whether these results are within the range of expectancy. The frequency difference (EK60 38 kHz and MS70 95 kHz) explains 3.2 dB of the difference. The difference in tilt is expected to explain 3 – 6 dB difference (although this is not clear yet.

Results from the SX90

Altogether 146 schools were detected using the SX90 (Figure 10.4.6). The main swimming direction was towards north-east, while a significant proportion also headed due north or due south (Figure 10.4.7). Only a very low proportion had a westerly swimming direction. This preliminary result indicates a non-random swimming direction of the capelin, with a main migration direction towards more northerly feeding areas, and a component heading south.

The swimming speed was generally quite low and peaked between 0.1 and 0.2 m/sec (Figure 10.4.5).

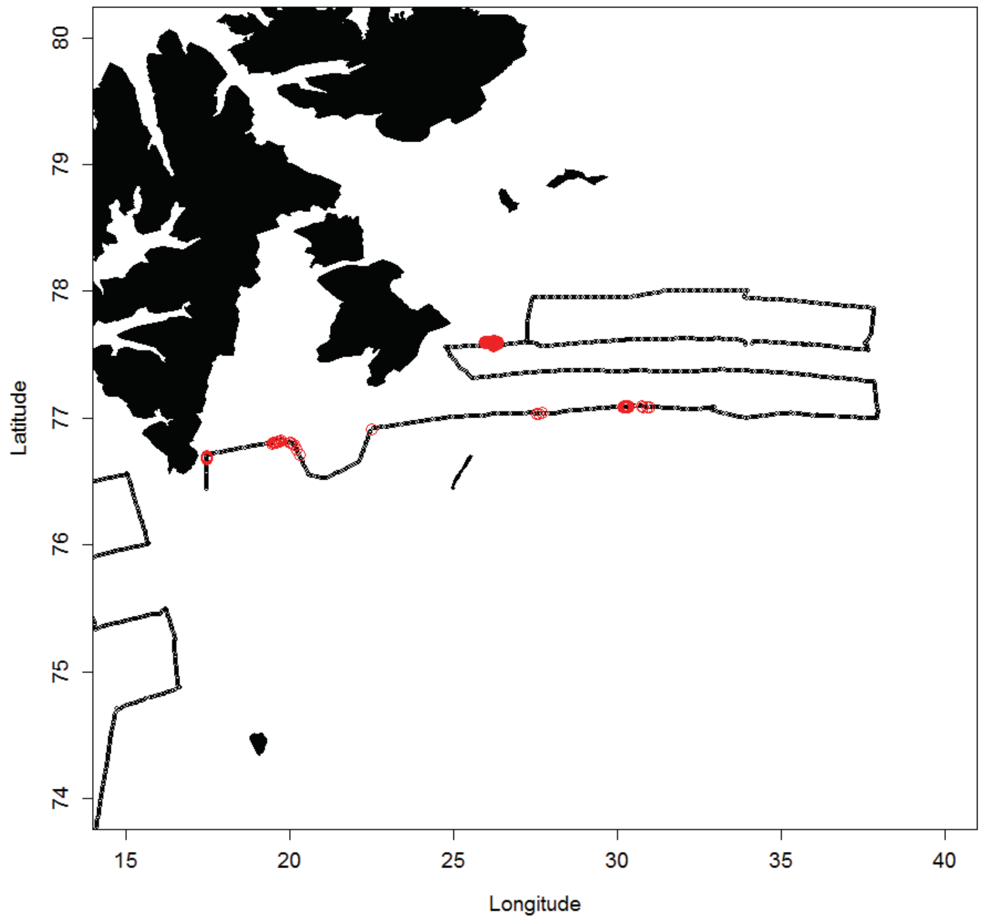

Figure 11.4.6. Positions with school observations marked in red.

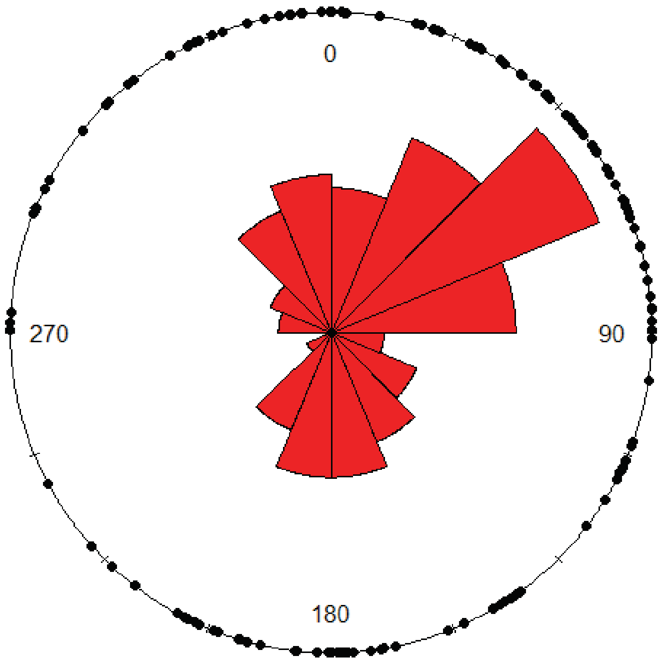

Figure 10.4.7. Rose plot indicating main swimming directions of the 146 detected schools. The range of the red sectors is proportional to the number of schools with net swimming direction indicated by the given sector. The points indicate single school detections.

The distribution of the capelin was such that the conditions for distinguishing schools with the fisheries sonar were often not ideal during the survey. Typically, when distributed close to the surface, capelin was found in layers more than distinct schools. Under such conditions, there is a risk that school detections by the sonar reflect local high-density patches in a layer, rather than distinct schools. Only schools that were clearly visible for more than 20 pings were therefore included. The distribution in layers could in itself be an indication of quite stationary behaviour, since schooling behaviour is expected during migration. This is confirmed by the generally low swimming speeds (Figure 10.4.8). On several occasions capelin were also distributed below the detection range of the sonar. These were found in more distinct schools, but swimming speed and direction could not be investigated by underway sonar monitoring.

There were some technical issues during the logging of the data. It seemed as if the data logging was corrupted when logging over the Ethernet. Even though the size of the files indicated that data were logged appropriately, only echo from two beams had actually been logged. The problem disappeared when logging to a local disc.

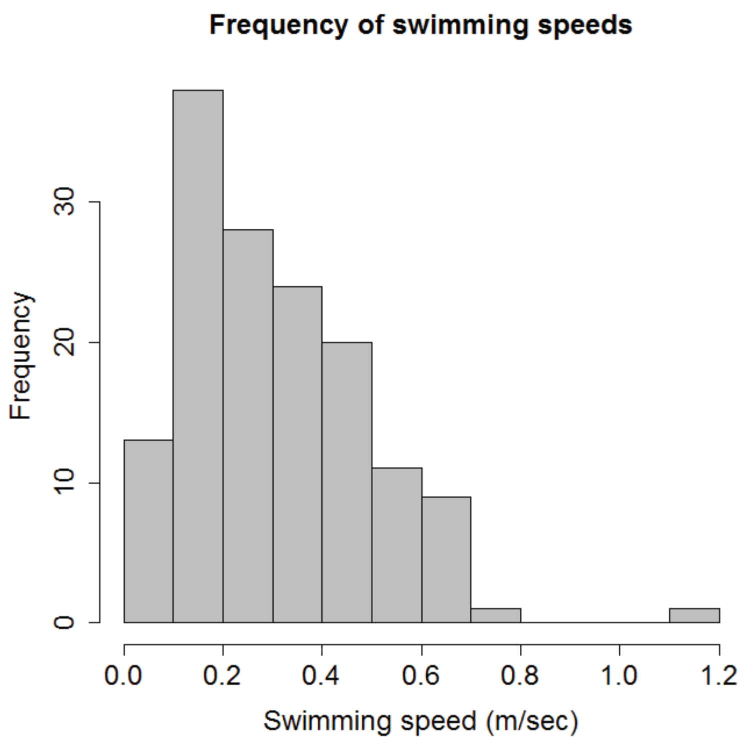

Figure 11.4.8. Frequency histogram showing swimming speed of the 146 detected schools.

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Appendix A. Processing steps of EK60 prior to scrutinizing

1) SpikeFilterModule - Remove spikes above 100 m
2) SpikeFilterModule - Remove spikes between 90 m and 250 m
3) SpikeFilterModule - Remove spikes between 240 m and 2500 m
4) FillMissingDataModule - Duplicate previous ping if a ping is not exixting for a frequency
5) SpotNoiseModule - Remove noise in a sample
6) BubbleNoiseModule - Correct for bubble-blocking of ping above 100 m
7) BubbleNoiseModule - Correct for bubble-blocking of ping between 90 m and 250 m
8) BubbleNoiseModule - Correct for bubble-blocking of ping between 240 m and 2500 m
9) HorizontalOffsetCorr.Module - Correct for horizontal transducer geometry
10) VerticalOffsetCorr.Module - Correct for vertical transducer geometry and for EK60 system delay
11) TemporaryCompBeginModule - Start of temporary computations. Discard data from until "Comp.End"
12) SmootherModule - Smooth horizontally with a Gaussian 50 m diameter kernal
13) DepthModule - Detect bottom on the smoothed data
14) *TemporaryComp.EndModule* - End of temporary computations: discard smoothing, but keep bottom.
15) SmootherModule - Smooth <u>above</u> detected bottom. Gaussian kernel: 8 m x 0.5 m.
16) SmootherModule - Smooth <u>below</u> detected bottom. Gaussian kernel: 8 m x 0.5 m.
17) NoiseQuantificationModule - Quantify noise parameters by using primarily data below bottom.
18) DataReductionModule - Remove data beyond useful range (e.g. beyond 300 m at 200 kHz)
19) NoiseRemoverModule - Correct data for noise (quantified abovs)
20) *TemporaryComp.BeginModule* - Start of temporary computations. Discard data from until "Comp.End"
21) ThresholdModule - Set data >-20 dB = -20 dB (due to weakness in RegionModule)
22) ThresholdModule - Set data <-120 dB = -120 dB (due to weakness in RegionModule)
23) SmootherModule - Smooth <u>above</u> detected bottom. Gaussian kernel: 35 m x 0.5 m.
24) ExpressionModule - Calculate synthetic channel: average data at 18, 38, 120 and 200 kHz
25) RegionModule - Detect school-candidate extent
26) *TemporaryComp.EndModule* - End of temporary computations: keep extent of detected schools only.
27) *TemporaryComp.BeginModule* - Start of temporary computations. Discard data from until "Comp.End"
28) SmootherModule - Smooth <u>inside</u> school-candidates. Gaussian kernel: 10 m x 1 m.
29) CategorizationModule - Calculate acoustic-category candidates of pixels (volume-segments)
30) SchoolCategorizationModule - Calculate acoustic-category candidates of school-candidates
31) *TemporaryComp.EndModule* - End of temporary computations: keep categorization only.
32) PlanktonInversionModule - Calculate zooplankton-model candidate

Appendix B. Processing steps of MS70 prior to scrutinizing

The processing modules do the following: (A) Remove spike noise, e.g. due to nearby fishing vessels, unsynchronized instruments, or problems in the MS70; (B) Remove ambient noise; (C) Remove unnecessary data, i.e. reduce the amount of data; (D) Do school-candidate detections for visualisation in a map; and (E) Compress data. In addition, the data after (C) are branched, and (F) phantom echograms (i.e. echograms generated from MS70 data) were generated better semi-automatic detection of schools.

I. 4-dimensional data:

1) TransducerDepthModule - Set transducer depth to 7.5 m (erroneously not set prior to operation)

2) MedianSpikeFilterModule (1) - Detect and remove spikes across beams, i.e. “walls” commonly generated by sonars from nearby ships of unsynchronized instruments on own ship. Require: sample >-45 dB and >10 dB of search window. The sample is replaced by the median of the search window.

3) MedianSpikeFilterModule (2) - Detect and remove spikes along beams. This may be caused by MS70-instrument problems. Require: sample >-45 dB and >10 dB of search window. The sample is replaced by the median of the search window.

4) SpotNoiseModule - Detect and remove noise in a single sample. This may be caused by MS70-instrument problems. Reqiure: sample >15 dB of search surrounding samples, and replace it by the median of the surroundings.

5) NoiseQuantificationModule - Ambient noise quantification. For each of the 500 beams: use samples the 175 m outermost data of 3 consecutive pings to calculate histograms of power-samples, and extract noise-parameters. The results of the noise calculations are estimated for (A) Moving average values of the noise-parameters for 3 running pings; (B) Minimum values of the noise-parameters for each file (that is commonly approximately 150 pings; (C) Minimum values for the noise-parameters for each day (here: January 21 and 22); (D) Minimum values of the noise-parameters for the whole survey.

6) BeamSmootherModule - For each of the 500 beams: smooth the samples by means of a 8 m diameter Gaussian kernel. The smoothing reduces the sample variance. The “mean noise” of smoothed data remain unchanged while “high noise” will be reduced. The BeamSmootherModule is placed after NoiseQuantificationModule to keep a slightly high estimate of “high-noise”.

7) DataReductionPromus - Remove all samples at shorter range than 20 m and greater range than 250 m from the transducer, and vertical fans at the edges of the beam. The inner data are removed to avoid the transmission pulse, near-field effects and near-ship reactions of the fish. The removal of the data outside 250 m is somewhat arbitrary: it could have been 350 m based on the highest frequency (112 kHz), but horizontal beams bends due to hydrography and 250 m is thought to be a “safe” range to avoid problems like beams hitting the surface or large deviations of calculated depth and real dept of each beam.

   -There are 25 vertical fans, and the 4 leftmost and 3 rightmost fans are removed. The leftmost and rightmost vertical fans are removed due to visual impression of noise in the data combined with the fact that the average values are used to calculate abundance. Removing 7 vertical fans means that the averages are based on 18 vertical fans instead of 25.

   -The DataReductionModule is placed after the NoiseQuantification

Module to allow for calculation of file, day and survey values even if the calculations for all beams are not used. Further, the 8-m smoothing diameter extends slightly outside the range-extents (by 4 m on each side).

8) NoiseAcceptanceModule - Decides which of the calculated noise-parameters that should be used ((A) running; (B) file; (C) day; or (D) survey). Due to massive amounts of capelin in the complete measured horizontal extent, the noise-parameters are extracted from the day-files (B). The noise parameters based on running values may be too high, and possibly also the al-file-minimum noise-parameter values, therefore the noise-parameters for the day-values (C) are used.

9) NoiseRemoverModule - Remove ambient noise based on the calculated noise-parameters selected in the NoiseAcceptanceModule. Noise is removed according to Korneliussen, 2000: power-samples smaller than “high-noise” is set to zero, power-samples larger than “high-noise” is reduced by the value “mean-noise”.

10) DataReductionPromus - Remove the uppermost fan that is always noisy. Keep other fans for optimal spike removal (MedianSpikeFilterModule (3) - point 11 below).

11) MedianSpikeFilterModule (3) - Detect and remove spikes in horizontal fans. This may be caused by MS70-instrument problems. Require: sample >-70 dB and >20 dB of search window. The sample is replaced by the median of the search window.

12) MedianSpikeFilterModule (4) - Detect and remove spikes along beams, similar as MedianSpikeFilterModule (2), but testing smaller values after smoothing and ambient noise removal, and requiring spikes to be 20 dB stronger than the surrounding signals. Require: sample >-70 dB and >20 dB of search window. The sample is replaced by the median of the search window.

13) MedianSpikeFilterModule (5) - Detect and remove spikes in small 4D surrounding each sample (3x3x3x3). Require: sample >-70 dB and >20 dB of search window. The sample is replaced by the median of the search window.

14) DataReductionPromus - Remove the two uppermost fans, i.e. one in addition to those previously removed. Also remove data more than 200 m below the sea surface.

15) MedianSpikeFilterModule (6) - Detect and remove spikes from ping to ping (“time-spikes”). This may be caused by MS70-instrument problems. Require: sample >-120 dB and >50 dB of search window. The sample is replaced by the median of the search window.

16) ThresholdModule - Set all samples weaker than -70 dB to -120 dB. This is done to make data compression (see below) better. Capelin-schools are expected to be stronger than -70 dB.

17) ThresholdModule - Set all samples stronger than -25 dB to -120 dB. This is done to make data compression (see below) better. Values stronger than -25 dB is expected to be wrong.

18) *Temporary branch calculations - Used to calculate phantom echograms for school detection. Not relevant here – see below.*

19) SchoolClusterModule - Detect school-candidates to be visualised in map.

20) EchoLineExtractor - Compress data.

21) DepthModulePromus - Detect bottom. First candidate is at same depth as detected by the echo-sounder.

22) Phantom echograms: This was done in under point 18 above:

1-17)	...	- The data processed under points 1 – 17 above were.
18-A)	TemporaryComp.Begin	- Start temporary calculations that will be disregarded when ended
18-B)	DataReductionPromus	- Remove all but the vertical fan number 16
18-C)	WriterModule	- Write results to sub-dir. “TMP” under the MS70Processed directory.
18-D)	TemporaryComp.End	- Stop temporary calculations and disregard all calculations since the TemporaryComputationsBeginModule, but keep all telegrams. Here the important piece is the data reduction and followed by saving for further processing.
22)	PhantomModule	- Generate synthetic echograms based on MS70 data. The data are taken from vertical fan 16 that points 277 degrees (7 degrees forward) where 0 degrees is the cruise directions.
23)	ThresholdModule	- Set all samples stronger than -57 dB to -200 dB. This is done to only show strong schools.
24)	SpikeFilterModule	- Remove spikes in phantom echograms: use median of surrounding samples instead.
24)	SpotNoiseModule	- Remove noise in single samples: use median of surrounding samples instead.

Technical report

From 2003, the survey has been part of a joint Barents Sea autumn ecosystem survey (BESS), designed and carried out in cooperation between the Institute of Marine Research (IMR), Norway and the Knipovich Polar Research Institute of Marine Fisheries and Oceanography (PINRO). Most aspects of the ecosystem are covered, from physical and chemical oceanography, pollution, garbage, phytoplankton and zooplankton to fish (both young and adults), sea mammals, benthic invertebrates and birds.

The 11th joint Barents Sea autumn ecosystem survey (BESS) was carried out during the period from 12th August to 3st October 2014. In 2014 all research vessels spent fewer days on the survey than in 2013 (129 vs 178), and the effective days at sea were less than 129 due to different reason (see above “H.Hanssen” and “Vilnyus”). The surveyed area in 2014 was smaller in the Svalbard (Spitsbergen) region due to ice coverage. Adjustment water in northern Kara Sea and Arctic basin were not observed also due to reduced Russian vessel days.

“Technical Report” presentes of all types of deviations from the standards presented in the “Sampling Manual”:
http://www.imr.no/tokt/okosystemtokt_i_barentshavet/sampling_ manual /nb-no).

In addition to the standard monitoring of the Barents Sea, several studies and experiments are carried out.

Deviations from the standards presented in the “Sampling Manual”

Text by E. Eriksen and P. Krivosheya

Equipment:

Pelagic sampling trawl- Harstad Trawl

Inspections of Harstad trawls used by IMR in 2013 showed that both the total length of the codends and the length of inside blinders (8 mm mesh size) used during the survey were different. It was found difficult to identify when these different lengths were implemented in the survey. A new codend was designed and used by G.O.Sars and J.Hjort during the 2014 survey (H.Hansen used one of the old codends). The new codend is tapered, 20 m long and made of 8 mm mesh size. A fish lock, made of similar twine and mesh size as the codend, was mounted in the front part of the codend. The codend and its fish lock were observed with an underwater camera and found to work as intended during towing and haulback.

Demersal sampling trawl – Campelen 1800

Extra floats on the groundgear and lower belly (called Tromsø rigging) on the Campelen 1800 used by IMR to prevent digging in to the bottom in areas with soft bottom, has been extended from an limited area to the whole Norwegian survey area. In 2014, recommendation was not to use the Tromsø rigging, except in areas with very soft bottom.

Acknowlegements

Preparing and conducting of ecosystem survey requires an enormous effort and knowledge. Every year in survey large number of people involved.

Special thanks to crew of research vessels “Helmer Hanssen”, “Johan Hjort”, “G.O.Sars” and “Vilnyus” for ensuring the investigation and good work.

We are thankful to the scientific staffs both in Norway and Russia that have organized and participated in the surveys and those in Institutes who have analysed the samples.

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Appendix 1. Vessels and participants of the Ecosystem survey 2013

Prepared by P. Krivosheya and E.Eriksen

Research vessel	Participants
"Vilnyus" (09.08- 03.10)	D. Prozorkevich (cruise leader), A. Amelkin, V. Barakov (16.09-03.10), A. Benzik, N. Ibragimova, S. Ivanov (09.08-13.09), Y. Kalashnikov, S. Kharlin, R. Klepikovsky, P. Krivosheya, I. Malkov, A. Mashnin (16.09-03.10), M. Nosov, A. Trofimov, V. Vyaznikova (09.08-13.09).
"G.O. Sars" (23.08 – 19.09)	Part 1 (23.08 – 11.09) S. Mehl (cruise leader), I. Beck, O. Didenko, J. Ford, G. Franze, P. Fossum, A. Golikov, T. Haugland, I. Henriksen, Y. Hunt, K. Kvile, B. Kvinge, A. Rey, J. Røttingen, T. Sivertsen, J. Skadal, I. Slipko, T. Thangstad, A. Staby. Part 2 (11.09 – 19.09) P. Fossum (cruise leader), B. Axelsen, G. Bakke, J. Ford, A. Golikov, T. Haugland, K. Kvile, B. Kvinge, J. Lange, A. Rey, H. Senneset, J. Skadal, Ø. Sørensen, E. Strand.
"Johan Hjort" (14.08 – 01.10)	Part 1 (14.08 – 21.08) J. Rønning (cruise leader), L. Drivenes, J. Erices, M. Mjanger, S. Murray, I. Prokopchuk. Part 2 (21.08 – 11.09) E. Johannesen (cruise leader), A. Aasen, R. Degree, L. Drivenes, O. Dyping, J. Erices, E. Hermansen, A. Kristiansen, C. Landa, G. McCallum, M. Mjanger, S. Murray, T. Prokhorova, J. Rønning, B. Røttingen, A. Storaker, O. Zimina. Part 3 (11.09 – 27.09) J. Alvarez (cruise leader), E. Holm, A. Johnsen, S. Karlson, S. Kolbeinson, B. Krafft, M. Martinussen, G. McCallum, F. Midtøy, S. Murray, M. Nilsen, J. Nygaard, T. Prokhorova, B. Røttingen, J. Vedholm, A. Voronkov, J. Wilhelmsen, O. Zimina. Part 4 (27.09 – 01.10) E. Eriksen (cruise leader), A. Aasen, A. Engås, E. Holm, J. Nygaard, J. Øvredal, A. Pavlenko, T. Prokhorova, J. Rønning, J. Wilhelmsen.
"Helmer Hanssen" (19.08 – 01.09)	Part 1 (19.08 – 01.09) T. Wenneck (cruise leader), A. Abrahamsen, I. Ahlquist, A. Golikov, E. Grønningsæter, C. Irgens, A. Johnsen, T. Klevjer, A. Knag, E. Langhelle, G. Langhelle, G. Richardsen, S. Seim, K. Sunnanå, A. Sveistrup.

Appendix 2. Sampling of fish in ecosystem survey 2014

Prepared by I. Malkov and T. Prokhorova

Species are divided into **boreal (includes widely distributed, south boreal, boreal and mainly boreal zoogeographic groups)**, **arctic (includes arctic and mainly arctic zoogeographic groups)** and **arctic-boreal**. Black genus name (Genus sp.) means that fish was identified only to the genus level and species of this genus belong to different zoogeographic groups. Length measurements present samples from bottom and pelagic trawl catches.

Family	Latin name/ English name	Norwegian vessels	Russian vessel	Total	Length, cm mean (min-max)
Agonidae	**Leptagonus decagonus/ Atlantic poacher**				11.9 (2-20)
	No of stations with samples	65	73	138	
	Nos. length measured	306	989	1295	
	Nos. aged	-	-	-	
Agonidae	**Ulcina olrikii/ Arctic alligatorfish**				6.7 (5-8)
	No of stations with samples	-	33	33	
	Nos. length measured	-	393	393	
	Nos. aged	-	-	-	
Ammodytidae	**Ammodytes marinus/ Lesser sandeel**				6.0 (3-20)
	No of stations with samples	22	33	55	
	Nos. length measured	156	433	589	
	Nos. aged	-	-	-	
Ammodytidae	**Ammodytes sp./Sandeel**				7.7 (7-8)
	No of stations with samples	25	-	25	
	Nos. length measured	257	-	257	
	Nos. aged	-	-	-	
Anarhichadidae	**Anarhichas denticulatus/ Northern wolffish**				69.0 (5-117)
	No of stations with samples	33	13	46	
	Nos. length measured	60	18	78	
	Nos. aged	-	-	-	
Anarhichadidae	**Anarhichas lupus/ Atlantic wolffish**				23.7 (3-115)
	No of stations with samples	52	13	65	
	Nos. length measured	247	30	277	
	Nos. aged	-	-	-	
Anarhichadidae	**Anarhichas minor/ Spotted wolffish**				37.3 (5-114)
	No of stations with samples	46	21	67	
	Nos. length measured	112	24	136	
	Nos. aged	-	-	-	
Argentinidae	**Argentina silus/ Greater argentine**				23.5(9-50)
	No of stations with samples	28	-	28	
	Nos. length measured	459	-	459	
	Nos. aged	-	-	-	
Chimaeridae	**Chimaera monstrosa/ Rabbit fish**				42.3 (20-60)
	No of stations with samples	2	-	2	
	Nos. length measured	4	-	4	
	Nos. aged	-	-	-	

Family	Latin name/ English name	Norwegian vessels	Russian vessel	Total	Length, cm mean (min-max)
Clupeidae	**Clupea harengus harengus/ Atlantic herring**				6.8 (2-37)
	No of stations with samples	110	28	138	
	Nos. length measured	1940	304	2244	
	Nos. aged	203	37	240	
Clupeidae	**Clupea pallasii suworowi/ Kanin herring**				21.5 (15-27)
	No of stations with samples	-	7	7	
	Nos. length measured	-	38	38	
	Nos. aged	-	32	32	
Cottidae	**Artediellus atlanticus/ Atlantic hookear sculpin**				7.3 (3-13)
	No of stations with samples	102	72	174	
	Nos. length measured	763	1290	2053	
	Nos. aged	-	-	-	
Cottidae	**Cottidae spp./ Sculpins**				4.0
	No of stations with samples	-	1	1	
	Nos. length measured	-	1	1	
	Nos. aged	-	-	-	
C	**Gymnocanthus tricuspis/ Arctic staghorn sculpin**ottidae				12.5 (6-20)
	No of stations with samples	-	15	15	
	Nos. length measured	-	124	124	
	Nos. aged	-	-	-	
Cottidae	**Icelus bicornis/ Twohorn sculpin**				6.3 (4-9)
	No of stations with samples	12	7	19	
	Nos. length measured	61	12	73	
	Nos. aged	-	-	-	
Cottidae	**Icelus spatula/ Spatulate sculpin**				8.4 (5-12)
	No of stations with samples	-	16	16	
	Nos. length measured	-	69	69	
	Nos. aged	-	-	-	
Cottidae	**Myoxocephalus scorpius/ Shorthorn sculpin**				5.6 (2-27)
	No of stations with samples	10	5	15	
	Nos. length measured	46	17	63	
	Nos. aged	-	-	-	
Cottidae	**Triglops murrayi/ Moustache sculpin**				9.5 (4-15)
	No of stations with samples	32	27	59	
	Nos. length measured	223	149	372	
	Nos. aged	-	-	-	
Cottidae	**Triglops nybelini/ Bigeye sculpin**				10.5 (5-13)
	No of stations with samples	2	13	15	
	Nos. length measured	11	226	237	
	Nos. aged	-	-	-	

Family	Latin name/ English name	Norwegian vessels	Russian vessel	Total	Length, cm mean (min-max)
Cottidae	**Triglops pingelii/ Ribbed sculpin**				13.0 (2-18)
	No of stations with samples	3	25	28	
	Nos. length measured	6	351	357	
	Nos. aged	-	-	-	
Cottidae	**Triglops sp./**				3.5 (3-4)
	No of stations with samples	1	2	3	
	Nos. length measured	1	17	18	
	Nos. aged	-	-	-	
Cyclopteridae	**Cyclopterus lumpus/ Lumpsucker**				24.9 (2-49)
	No of stations with samples	116	35	141	
	Nos. length measured	415	48	463	
	Nos. aged	-	-	-	
Cyclopteridae	**Eumicrotremus derjugini/ Leatherfin lumpsucker**				4.0
	No of stations with samples	1	-	1	
	Nos. length measured	1	-	1	
	Nos. aged	-	-	-	
Cyclopteridae	**Eumicrotremus spinosus/ Atlantic spiny lumpsucker**				5.7 (3-9)
	No of stations with samples	4	1	5	
	Nos. length measured	14	6	20	
	Nos. aged	-	-	-	
Gadidae	**Arctogadus glacialis/ Arctic cod**				9.0
	No of stations with samples	1	-	1	
	Nos. length measured	1	-	1	
	Nos. aged	-	-	-	
Gadidae	**Boreogadus saida/ Polar cod**				11.5 (2-26.5)
	No of stations with samples	78	112	190	
	Nos. length measured	1276	5909	7185	
	Nos. aged	430	175	605	
Gadidae	**Eleginus nawaga/ Atlantic navaga**				17.1 (12-26)
	No of stations with samples	-	7	7	
	Nos. length measured	-	1663	1663	
	Nos. aged	-	225	225	
Gadidae	**Enchelyopus cimbrius/ Fourbeard rockling**				14.5 (2-27)
	No of stations with samples	2	-	2	
	Nos. length measured	2	-	2	
	Nos. aged	-	-	-	
Gadidae	**Gadiculus argenteus/ Silvery pout**				11.4 (7-17)
	No of stations with samples	12	7	19	
	Nos. length measured	105	50	155	
	Nos. aged	-	-	-	

Family	Latin name/ English name	Norwegian vessels	Russian vessel	Total	Length, cm mean (min-max)
Gadidae	**Gaidropsarus argentatus/ Arctic threebearded rockling**				26.3 (10-36)
	No of stations with samples	6	-	6	
	Nos. length measured	23	-	23	
	Nos. aged	-	-	-	
Gadidae	**Gadus morhua/ Atlantic cod**				7.5 (1-132)
	No of stations with samples	333	238	571	
	Nos. length measured	11701	9833	21534	
	Nos. aged	1017	1211	2228	
Gadidae	**Melanogrammus aeglefinus/ Haddock**				18.2 (3-72)
	No of stations with samples	217	94	311	
	Nos. length measured	4547	5089	9636	
	Nos. aged	307	473	780	
Gadidae	**Merlangius merlangus/ Whiting**				11.3 (4-53)
	No of stations with samples	4	-	4	
	Nos. length measured	9	-	9	
	Nos. aged	-	-	-	
Gadidae	**Micromesistius poutassou/ Blue whiting**				22.3 (15-40)
	No of stations with samples	57	-	57	
	Nos. length measured	1822	-	1822	
	Nos. aged	230	-	230	
Gadidae	**Molva molva/ Ling**				111.0 (111)
	No of stations with samples	1	-	1	
	Nos. length measured	1	-	1	
	Nos. aged	-	-	-	
Gadidae	**Phycis blennoides/ Greater forkbeard**				28.1 (20-52)
	No of stations with samples	2	-	2	
	Nos. length measured	18	-	18	
	Nos. aged	-	-	-	
Gadidae	**Pollachius virens/ Saithe**				56.7 (5-90)
	No of stations with samples	16	-	16	
	Nos. length measured	67	-	67	
	Nos. aged	-	-	-	
Gadidae	**Trisopterus esmarkii/ Norway pout**				16.2 (1-23)
	No of stations with samples	33	10	43	
	Nos. length measured	772	265	1037	
	Nos. aged	-	21	21	
Gasterosteidae	**Gasterosteus aculeatus/ Threespine stickleback**				6.6 (5-8)
	No of stations with samples	3	13	16	
	Nos. length measured	3	144	147	
	Nos. aged	-	-	-	

Family	Latin name/ English name	Norwegian vessels	Russian vessel	Total	Length, cm mean (min-max)
Liparidae	**Careproctus sp./ Snailfish**				9.8 (4-19)
	No of stations with samples	13	-	13	
	Nos. length measured	26	-	26	
	Nos. aged	-	-	-	
Liparidae	**Careproctus micropus/**				7.3 (7-8)
	No of stations with samples	-	3	3	
	Nos. length measured	-	4	4	
	Nos. aged	-	-	-	
Liparidae	**Careproctus ranula/ Scotian snailfish**				8.1 (6-10)
	No of stations with samples	-	7	7	
	Nos. length measured	-	9	9	
	Nos. aged	-	-	-	
Liparidae	**Careproctus cf. reinhardti/ Sea tadpole**				9.8 (6-22)
	No of stations with samples	9	24	33	
	Nos. length measured	27	51	78	
	Nos. aged	-	-	-	
Liparidae	**Liparis fabricii/ Gelatinous snailfish**				5.3 (1-18)
	No of stations with samples	13	9	22	
	Nos. length measured	112	115	227	
	Nos. aged	-	-	-	
Liparidae	**Liparis bathyarcticus/ Variegated snailfish**				10.5 (1-23)
	No of stations with samples	1	15	16	
	Nos. length measured	7	45	52	
	Nos. aged	-	-	-	
Liparidae	**Liparis sp./ Sea snail**				2.0
	No of stations with samples	-	1	1	
	Nos. length measured	-	1	1	
	Nos. aged	-	-	-	
Liparidae	**Paraliparis bathybius/ Black seasnail**				20.3 (15-26)
	No of stations with samples	4	-	4	
	Nos. length measured	13	-	13	
	Nos. aged	-	-	-	
Liparidae	**Rhodichthys regina/ Threadfin seasnail**				9.0
	No of stations with samples	-	1	1	
	Nos. length measured	-	1	1	
	Nos. aged	-	-	-	
Lotidae	**Brosme brosme/ Cusk**				39.7 (4-68)
	No of stations with samples	18	1	19	
	Nos. length measured	40	2	42	
	Nos. aged	-	-	-	

Family	Latin name/ English name	Norwegian vessels	Russian vessel	Total	Length, cm mean (min-max)
Macrouridae	**Macrourus berglax/ Rough rat-tail**				13.3 (6-27)
	No of stations with samples	4	-	4	
	Nos. length measured	15	-	15	
	Nos. aged	-	-	-	
Myctophidae	**Benthosema glaciale / Glacier lanternfish**				4.2 (2-7)
	No of stations with samples	22	2	24	
	Nos. length measured	163	3	166	
	Nos. aged	-	-	-	
Myctophidae	**Notoscopelus sp./**				7.0 (6-8)
	No of stations with samples	2	-	2	
	Nos. length measured	2	-	2	
	Nos. aged	-	-	-	
Osmeridae	**Mallotus villosus/ Capelin**				11.4 (2-19)
	No of stations with samples	226	214	440	
	Nos. length measured	10921	17694	28615	
	Nos. aged	2408	1050	2458	
Osmeridae	**Osmerus mordax dentex/ Rainbow smelt**				16.8 (9-23)
	No of stations with samples	-	4	4	
	Nos. length measured	-	49	49	
	Nos. aged	-	-	-	
Paralepididae	**Arctozenus risso/ White barracudina**				19.0 (19)
	No of stations with samples	14	1	15	
	Nos. length measured	31	1	32	
	Nos. aged	-	-	-	
Petromyzontidae	**Lethenteron camchaticumicum/ Arctic lamprey**				36.8 (34-41)
	No of stations with samples	2	2	4	
	Nos. length measured	2	2	4	
	Nos. aged	-	-	-	
Pleuronectidae	**Glyptocephalus cynoglossus/ Witch flounder**				3.5 (3-5)
	No of stations with samples	2	-	2	
	Nos. length measured	11	-	11	
	Nos. aged	-	-	-	
Pleuronectidae	**Hippoglossoides platessoides/ Long rough dab**				19.4 (1-55)
	No of stations with samples	180	178	358	
	Nos. length measured	3619	16146	19765	
	Nos. aged	-	225	225	
Pleuronectidae	**Limanda limanda/ Dab**				23.4 (11-39)
	No of stations with samples	-	9	9	
	Nos. length measured	-	197	197	
	Nos. aged	-	-	-	

Family	Latin name/ English name	Norwegian vessels	Russian vessel	Total	Length, cm mean (min-max)
Pleuronectidae	**Microstomus kitt/ Lemon sole**				36.8 (20-49)
	No of stations with samples	5	-	5	
	Nos. length measured	25	-	25	
	Nos. aged	-	-	-	
Pleuronectidae	**Pleuronectes glacialis/ Arctic flounder**				16.0 (16)
	No of stations with samples	-	1	1	
	Nos. length measured	-	1	1	
	Nos. aged	-	-	-	
Pleuronectidae	**Pleuronectes platessa/ European plaice**				39.4 (23-60)
	No of stations with samples	1	21	22	
	Nos. length measured	6	465	471	
	Nos. aged	-	25	25	
Pleuronectidae	**Pleuronectidae spp./ Righteyed flounders**				4.0
	No of stations with samples	1	-	1	
	Nos. length measured	1	-	1	
	Nos. aged	-	-	-	
Pleuronectidae	**Reinhardtius hippoglossoides/ Greenland halibut**				38.9 (4-88)
	No of stations with samples	91	29	120	
	Nos. length measured	491	63	554	
	Nos. aged	157	62	219	
Psychrolutidae	**Cottunculus microps/ Polar sculpin**				9.6 (3-21)
	No of stations with samples	19	9	28	
	Nos. length measured	44	12	56	
	Nos. aged	-	-	-	
Rajidae	**Amblyraja hyperborea/ Arctic skate**				46.1 (14-78)
	No of stations with samples	2	17	19	
	Nos. length measured	44	20	64	
	Nos. aged	-	-	-	
Rajidae	**Amblyraja radiata/ Thorny skate**				39.4 (9-63)
	No of stations with samples	56	55	111	
	Nos. length measured	135	226	361	
	Nos. aged	-	3	3	
Rajidae	**Bathyraja spinicauda/ Spinetail ray**				123.8 (80-153)
	No of stations with samples	4	-	4	
	Nos. length measured	5	-	5	
	Nos. aged	-	-	-	
Rajidae	**Rajella fyllae/ Round ray**				24.6 (9-50)
	No of stations with samples	12	-	12	
	Nos. length measured	24	-	24	
	Nos. aged	-	-	-	
Salmonidae	**Salmo salar/ Atlantic salmon**				18.2 (17-20)
	No of stations with samples	-	2	2	
	Nos. length measured	-	5	5	
	Nos. aged	-	5	5	

Family	Latin name/ English name	Norwegian vessels	Russian vessel	Total	Length, cm mean (min-max)
Scombridae	**Scomber scombrus/ Atlantic mackerel**				11.7 (1-39)
	No of stations with samples	13	-	13	
	Nos. length measured	117	-	117	
	Nos. aged	2	-	2	
Scophthalmidae	**Lepidorhombus whiffiagonis/ Megrim**				
	No of stations with samples	2	-	2	44.3 (34-60)
	Nos. length measured	3	-	3	
	Nos. aged	-	-	-	
Scorpaenidae	**Sebastes norvegicus/ Golden redfish**				24.4 (5-61)
	No of stations with samples	29	21	50	
	Nos. length measured	148	328	476	
	Nos. aged	132	-	132	
Scorpaenidae	**Sebastes mentella/ Deepwater redfish**				22.7 (4-47)
	No of stations with samples	114	54	168	
	Nos. length measured	4167	569	4736	
	Nos. aged	350	68	418	
Scorpaenidae	**Sebastes sp./ Redfish**				4.5 (1-18)
	No of stations with samples	118	-	118	
	Nos. length measured	2540	-	2540	
	Nos. aged	-	-	-	
Scorpaenidae	**Sebastes viviparus / Norway redfish**				15.9 (5-36)
	No of stations with samples	19	-	19	
	Nos. length measured	316	-	316	
	Nos. aged	-	-	-	

Appendix 3. Invertebrate sampling in ecosystem survey 2013

Prepared by P. Lubin and A. Mashnin

Scientific vessels, which participated on the 2013 Ecosystem survey in the Barents Sea: GOS-G.O.Sars, HH-Helmer Hanssen, JH-Johan Hjort and VI-Vilnyus

Phylum	Class	Order	Family	Species	Author	GOS	HH	JH	VI	Total
Porifera				Porifera g. sp.		31	32	57	114	234
	Calcarea			Calcarea g. sp.			1			1
		Calcarea	Sycettidae	Sycon sp.			2	6		8
	Demospongiae	Astrophorida	Geodiidae	Geodia atlantica	(Stephens, 1915)	2				2
				Geodia barretti	Hentschel, 1929	16	16			32
				Geodia macandrewii	Bowerbank, 1858	15	8			23
				Geodia sp.			4		15	19
			Pachastrellidae	Thenea muricata	(Bowerbank, 1858)	15	11	8	1	35
				Thenea sp.		11	6			17
			Stellettidae	Stelletta normani	Sollas, 1880		2			2
				Stryphnus ponderosus	Bowerbank, 1866	10	12			22
			Tetillidae	Tetilla cranium	(O.F. Mueller, 1776)	7	11	1		19
				Tetilla polyura	Schmidt, 1870	7	2	4	6	19
				Tetilla sp.		1				1
		Axinellida	Axinellidae	Axinella sp.		4	1			5
				Axinella ventilabrum	(Johnston, 1842)	1				1
				Phakellia sp.		6	13	2	2	23

		Dendroceratida	Darwinellidae	Aplysilla sp.		1				1
		Hadromerida	Polymastiidae	Polymastia boletiformis	(Lamarck, 1815)	2	8			10
				Polymastia mammillaris	(Mueller, 1806)				5	5
				Polymastia sp.		4	11		40	55
				Polymastia thielei	Koltun, 1964			1	7	8
				Polymastia uberrima	(Schmidt, 1870)	8	1	7	8	24
				Quasillina brevis	(Bowerbank, 1861)	1				1
				Radiella grimaldi	(Topsent, 1913)	11	2	15	14	42
				Radiella hemisphaericum	(Sars, 1872)	16	5	2		23
				Sphaerotylus borealis	(Swarchevsky, 1906)		1			1
				Tentorium semisuberites	(Schmidt, 1870)	8	16	5	8	37
				Tentorium sp.		1				1
			Stylocordylidae	Stylocordyla borealis	(Loven, 1866)	1	1	2	2	6
			Suberitidae	Suberites ficus	(Johnston, 1842)	1	6		7	14
				Suberites sp.		1				1
			Tethyidae	Tethya aurantium	(Pallas, 1766)			1		1
				Tethya citrina	Sarà & Melone, 1965	4	10			14
		Halichondriida	Halichondriidae	Halichondria panicea	(Pallas, 1766)		1			1
				Halichondria sp.			22			22
		Haplosclerida	Haliclonidae	Haliclona sp.		3	30		7	40
				Haliclona ventilabrum	(Fristedt, 1887)				3	3
		Poecilosclerida	Cladorhizidae	Asbestopluma pennatula	(Schmidt, 1875)	2	5			7
				Asbestopluma sp.		2				2

				Chondrocladia sp.		2				2
				Cladoriza sp.			3			3
			Coelosphaeridae	Histodermella sp.		12	15			27
			Hamacanthidae	Hamacantha implicans	Lundbeck, 1902.				3	3
			Mycalidae	Mycale lingua	(Bowerbank, 1866)	1	2			3
				Mycale sp.		10	3	1		14
			Myxillidae	Forcepia sp.			2			2
				Iophon piceus	(Vosmaer, 1881)		2			2
				Myxilla brunnea	Hansen, 1885	1				1
				Myxilla incrustans	(Johnston, 1842)				6	6
				Myxilla sp.			3			3
			Tedaniidae	Tedania suctoria	Schmidt, 1870			2		2
Cnidaria	Anthozoa			Anthozoa g. sp.					7	7
		Actiniaria		Actiniaria g. sp.		1	4	2	150	157
			Actiniidae	Bolocera tuediae	(Johnston, 1832)	6	3	1		10
				Urticina sp.		11				11
			Actinostolidae	Actinostola callosa	(Verrill, 1882)	7	7			14
				Actinostola sp.		3		8	1	12
				Glandulactis spetsbergensis	(Carlgren, 1913)		2			2
				Stomphia coccinea	(O.F. Mueller, 1776)		4			4
			Edwardsiidae	Edwardsiidae g. sp.					1	1
			Hormathiidae	Hormathia digitata	(O.F. Mueller, 1776)	35	14	20	41	110

				Hormathia digitata m. josephi josephi	Zhiubicas, 1977		1			1
				Hormathia digitata m. parasitica parasitica	Danielssen, 1890	4	14	24		42
				Hormathia sp.				1	3	4
			Liponematidae	Liponema multicornis	(Verrill, 1879)	1		3	1	5
		Alcyonacea	Isididae	Isidella lofotensis	Sars, 1868		6			6
			Nephteidae	Drifa glomerata	(Verrill, 1869)	1	32	34	109	176
				Duva florida	(Rathke, 1806)	7	10	18	8	43
				Gersemia fruticosa	(M. Sars, 1860)	1		1		2
				Gersemia rubiformis	(Ehrenberg, 1834)	11	7	25	26	69
				Gersemia sp.				3	33	36
		Gorgonacea	Paragorgiidae	Paragorgia arborea	(L., 1758)		1			1
		Pennatulacea	Umbellulidae	Umbellula encrinus	(L., 1758)		11		31	42
		Scleractinida	Flabellidae	Flabellum sp.		2				2
		Zoanthacea		Zoanthacea g. sp.		5	2			7
			Epizoanthidae	Epizoanthidae g. sp.				8	1	9
				Epizoanthus incrustatus	(Dueben & Koren, 1847)			1		1
				Epizoanthus sp.		7	3	1	12	23
	Hydrozoa			Hydroidea g. sp.				7	41	48
				Hydrozoa g. sp.			3		15	18
		Athecata	Candelabridae	Candelabrum sp.				4		4
			Tubulariidae	Tubularia indivisa	L., 1758	2				2

				Tubularia sp.		2				2
		Limnomedusae	Monobrachiidae	Monobrachium parasitum	Mereschkowsky, 1877		7			7
		Thecaphora	Campanulariidae	Campanulariidae g. sp.				1		1
				Orthopyxis integra	(McGillivray, 1842)		1			1
			Campanulinidae	Lafoeina maxima	Levinsen, 1893		7			7
			Haleciidae	Halecium muricatum	(Ellis & Solander, 1786)		5	22		27
				Halecium sp.		6	1		10	17
			Lafoeidae	Grammaria abietina	(M. Sars, 1850)		9	2		11
				Grammaria sp.			2			2
				Lafoea fruticosa	(M. Sars, 1850)		3			3
				Lafoea grandis	Hincks, 1874		1			1
				Lafoea sp.		1	21	15		37
			Laodiceidae	Ptychogena lactea	A. Agassiz, 1865			3		3
			Plumulariidae	Nemertesia antennina	(L., 1758)		3			3
			Sertulariidae	Abietinaria abietina	(L., 1758)		6	30	2	38
				Abietinaria sp.			1	1		2
				Diphasia fallax	(Johnston, 1847)		1			1
				Diphasia sp.				1		1
				Hydrallmania falcata	(L., 1758)			2		2
				Sertularia mirabilis	(Verrill, 1873)			5		5
				Sertularia sp.				3		3
				Symplectoscyphus tricuspidatus	(Alder, 1856)			2		2
				Thuiaria articulata	(Pallas, 1766)			4		4

				Thuiaria carica	Levinsen, 1893			1		1
				Thuiaria lonchitis	Naumov, 1960				1	1
				Thuiaria obsoleta	(Lepechin, 1781)			5		5
	Scyphozoa	Semaeostomeae	Cyaneidae	Cyanea capillata	(L., 1758)			24		24
Plathelminthes				Plathelmintes g. sp.				5		5
	Turbellaria			Turbellaria g. sp.				5		5
Annelida	Hirudinea			Hirudinea g. sp.					1	1
	Polychaeta			Polychaeta g. sp.		3	2	29	105	139
		Amphinomida	Euphrosinidae	Euphrosine armadillo	M. Sars, 1851	6				6
				Euphrosine sp.			14	7		21
		Capitellida	Maldanidae	Maldane arctica	Detinova, 1985		4			4
				Maldane sarsi	Malmgren, 1867		1			1
				Maldanidae g. sp.			4	3	1	8
				Nicomache lumbricalis	(Fabricius, 1780)				1	1
				Nicomache sp.			2			2
				Notoproctus oculatus	Arwidsson, 1906				1	1
		Chaetopterida	Chaetopteridae	Spiochaetopterus typicus	M. Sars, 1856	7	16	18	51	92
		Eunicida	Lumbrineridae	Lumbrineris sp.		2	4		2	8
			Onuphidae	Nothria hyperborea	(Hansen, 1878)	1		12	7	20
				Nothria sp.		4	6			10
		Flabelligerida	Flabelligeridae	Brada granulata	Malmgren, 1867	17	4	10	5	36
				Brada inhabilis	(Rathke, 1843)	24	17	38	34	113
				Brada sp.				7	23	30

				Brada villosa	(Rathke, 1843)	2	3			5
				Diplocirrus hirsutus	(Hansen, 1879)		2			2
				Diplocirrus sp.					2	2
				Flabelligera affinis	M. Sars, 1829			9		9
				Pherusa plumosa	(O.F. Mueller, 1776)			4		4
				Pherusa sp.			1			1
		Opheliida	Opheliidae	Ophelina acuminata	Oersted, 1843				1	1
			Scalibregmidae	Polyphysia crassa	(Oersted, 1843)			3	1	4
				Polyphysia sp.		5				5
		Phyllodocida	Aphroditidae	Aphrodita sp.					1	1
				Laetmonice filicornis	Kinberg, 1855	4				4
			Glyceridae	Glycera sp.			1			1
			Nephtyidae	Nephtyidae g. sp.		2	1	1		4
				Nephtys sp.		1	13	13	7	34
			Nereididae	Nereis pelagica	L., 1761	1	1			2
				Nereis zonata	Malmgren, 1867	1	2			3
			Phyllodocidae	Phyllodoce groenlandica	Oersted, 1842		1			1
				Phyllodoce sp.			1			1
			Polynoidae	Harmothoe sp.		36	37		61	134
				Lepidonotus sp.					1	1
				Lepidonotus squamatus	(L., 1767)				1	1
				Polynoidae g. sp.		1	2	49	25	77
		Sabellida	Sabellidae	Branchiomma arcticum	(Ditlevsen, 1937)		4			4

				Chone sp.					2	2
				Euchone analis	(Kroeyer, 1856)				1	1
				Euchone papillosa	(M. Sars, 1851)	1	5			6
				Sabellidae g. sp.		3	5	4	7	19
			Serpulidae	Chitinopoma serrula	(Stimpson, 1854)		2			2
				Filograna implexa	Berkeley, 1827		5			5
				Placostegus tridentatus	(Fabricius, 1779)	3				3
				Protula globifera	(Theel, 1879)		2			2
				Protula tubularia	(Montagu, 1803)		5			5
			Spirorbidae	Bushiella (Jugaria) similis	(Bush, 1905)		2			2
				Circeis armoricana	Saint- Joseph, 1894		4			4
				Circeis spirillum	(L., 1758)		2			2
				Spirorbidae g. sp.			1		1	2
		Terebellida	Ampharetidae	Ampharete sp.			1		2	3
				Ampharetidae g. sp.			2	1		3
			Pectinariidae	Pectinaria auricoma	(O.F. Mueller, 1776)				4	4
				Pectinaria hyperborea	(Malmgren, 1865)	2	6		3	11
				Pectinaria sp.		2			7	9
			Terebellidae	Amphitrite cirrata	(O.F. Mueller, 1771)		1			1
				Amphitrite sp.			1			1
				Pista maculata	(Dalyell, 1853)		5	7	2	14
				Pista sp.			2			2
				Terebellidae g. sp.		11	1	2	5	19

				Thelepus cincinnatus	(Fabricius, 1780)		3			3
Sipuncula	Sipunculidea			Sipunculidea g. sp.		1	1		18	20
		Golfingiiformes	Golfingiidae	Golfingia margaritacea margaritacea	(M. Sars, 1851)		2			2
				Golfingia sp.				3	2	5
				Golfingia vulgaris vulgaris	(Blainville, 1827)		1			1
				Nephasoma diaphanes diaphanes	(Gerould, 1913)		1			1
			Phascolionidae	Phascolion strombus strombus	(Montagu, 1804)	9	13	12	3	37
Cephalorhyncha	Priapulida	Priapulomorpha	Priapulidae	Priapulidae g. sp.					18	18
				Priapulopsis bicaudatus	(Koren & Danielssen, 1868)			4	4	8
				Priapulus caudatus	Lamarck, 1816	2	2			4
Echiura	Echiurida	Echiuroinea		Echiurida g. sp.					2	2
			Bonelliidae	Hamingia arctica	Danielssen & Koren, 1881	10	3	5	8	26
			Echiuridae	Echiurus echiurus echiurus	(Pallas, 1767)				3	3
Nemertini	Enopla	Monostilifera	Emplectonematidae	Cryptonemertes actinophila	(Bürger, 1904)		2			2
		Polystilifera	Dinonemertidae	Dinonemertes alberti	(Joubin, 1906)		2			2
	Nemertini			Nemertini g. sp.			8	11	17	36
Arthropoda	Cirripedia			Cirripedia g. sp.			1			1
		Thoracica	Balanomorpha	Balanus balanus	(L., 1758)		3	14	23	40
				Balanus crenatus	Bruguiere, 1789	1	3	1	2	7
				Balanus sp.		1			10	11
			Scalpellidae	Ornatoscalpellum stroemii	(M. Sars, 1859)		5			5
				Tarasovium cornutum	(G.O. Sars, 1879)	1				1

	Malacostraca	Amphipoda		Amphipoda g. sp.				6		6
			Acanthonotozomatidae	Acanthonotozoma cristatum	(Ross, 1835)		1	1		2
			Amathillopsidae	Amathillopsis spinigera	Heller, 1875		1		6	7
			Ampeliscidae	Ampelisca eschrichti	Kroeyer, 1842		1	11		12
				Ampelisca sp.				1		1
				Ampeliscidae g. sp.				1		1
				Byblis gaimardi	(Kroeyer, 1846)			1		1
			Atylidae	Atylus smittii	(Goes, 1866)			8		8
			Calliopiidae	Cleippides quadricuspis	Heller, 1875		4		8	12
				Cleippides sp.					16	16
				Halirages fulvocinctus	(M. Sars, 1858)		1			1
			Caprellidae	Aeginina longicornis	(Kroeyer, 1843)			1		1
				Caprellidae g. sp.				1		1
			Corophiidae	Neochela monstrosa	(Boesk, 1861)		1			1
			Epimeriidae	Epimeria loricata	G.O. Sars, 1879	24	26	28	18	96
				Paramphithoe hystrix	(Ross, 1835)	4	14	29	8	55
			Eusiridae	Eusirus cuspidatus	Kroeyer, 1845	1	2	3	4	10
				Eusirus holmi	Hansen, 1887		5		2	7
				Rhachotropis aculeata	(Lepechin, 1780)		19	22	1	42
				Rhachotropis helleri	A. Boeck, 1871			1		1
				Rhachotropis sp.					3	3
			Gammaridae	Gammaridae g. sp.					3	3
				Gammarus sp.					14	14

			Hyperiidae	Hyperiidae g. sp.				2		2
				Themisto abyssorum	Boeck, 1870		4			4
				Themisto libellula	(Lichtenstein,1882)		27	5	13	45
			Lysianassidae	Anonyx bispinosus	Steele,1967		4			4
				Anonyx lilljeborgii	Boeck, 1870	4				4
				Anonyx nugax	(Phipps, 1774)		17	32	11	60
				Anonyx sarsi	Steele, Brunel, 1986		3			3
				Anonyx sp.				2	47	49
				Eurythenes gryllus	(Lichtenstein, 1822)		5			5
				Lysianassidae g. sp.		1	1	1	1	4
				Onisimus sp.		2				2
				Socarnes bidenticulatus	(Bate, 1858)			2		2
				Tmetonyx cicada	(Fabricius, 1780)	2	1	4		7
			Oedicerotidae	Acanthostepheia malmgreni	(Goes, 1866)	5	5	24	15	49
				Arrhis phyllonyx	(M. Sars, 1858)			2		2
				Paroediceros lynceus	(M. Sars, 1858)		1			1
			Stegocephalidae	Phippsiella similis	(G.O. Sars, 1891)		7			7
				Stegocephalopsis ampulla	(Phipps, 1774)		10	2		12
				Stegocephalus inflatus	Kroeyer, 1842	7	13	31	54	105
				Stegocephalus sp.					6	6
		Cumacea		Cumacea g. sp.		3			1	4
			Diastylidae	Diastylis glabra	Zimmer, 1926				1	1
				Diastylis goodsiri	Bell, 1855		3	3		6

		Decapoda		Natantia g. sp.		1				1
			Crangonidae	Crangonidae g. sp.					1	1
				Pontophilus norvegicus	M. Sars, 1861	36	16	12		64
				Sabinea sarsi	Smith, 1879	5	21	11	3	40
				Sabinea septemcarinata	(Sabine, 1821)	29	44	72	186	331
				Sabinea sp.		2				2
				Sclerocrangon boreas	(Phipps, 1774)		22	12	45	79
				Sclerocrangon ferox	(G.O. Sars, 1821)	4	19	38	97	158
			Galatheidae	Munida bamffica	(Pennant, 1777)	21				21
			Hippolitydae	Bythocaris biruli	(Kobjakova, 1964)		2		10	12
				Bythocaris irene	Retovsky, 1946		1			1
				Bythocaris payeri	(Heller, 1875)		2	1	5	8
				Bythocaris simplicirostris	G.O. Sars, 1869				3	3
				Bythocaris sp.					11	11
				Eualus gaimardi	(Milne-Edwards, 1837)			11	33	44
				Eualus gaimardi belcheri	(Bell, 1855)		3	6		9
				Eualus gaimardi gaimardi	(Milne-Edwards, 1837)		4	2		6
				Eualus sp.					4	4
				Lebbeus polaris	(Sabine, 1821)	20	37	50	59	166
				Spirontocaris lilljeborgii	(Danielssen, 1859)				1	1
				Spirontocaris sp.					6	6
				Spirontocaris spinus	(Sowerby, 1802)	10	20	34	28	92
			Hoplophoridae	Hymenodora glacialis	(Buchholz, 1874)		6			6

			Lithodidae	Lithodes maja	(L., 1758)	4		1		5
				Paralithodes camtschaticus	(Tilesius, 1815)				3	3
			Majidae	Chionoecetes opilio	(Fabricius, 1788)	4		11	50	65
				Hyas araneus	(L., 1758)	7	10	18	67	102
				Hyas coarctatus	Leash, 1815	19				19
				Hyas sp.			1		7	8
			Paguridae	Pagurus bernhardus	(L., 1758)	2	8			10
				Pagurus pubescens	(Kroeyer, 1838)	5	1	17	77	100
				Pagurus sp.				1		1
			Pandalidae	Atlantopandalus propinqvus	(G.O. Sars, 1870)		10	1		11
				Pandalus borealis	Kroeyer, 1837	66	65	63	179	373
				Pandalus montagui	Leach, 1814	12	3	1		16
			Pasiphaeidae	Pasiphaea multidentata	Esmark, 1886	1			21	22
				Pasiphaea tarda	Krøyer, 1845		9			9
			Sergestidae	Eusergestes arcticus	(Kroeyer, 1855)				2	2
		Euphausiacea	Euphausiidae	Euphausiidae g. sp.				1	2	3
				Meganyctiphanes norvegica	(M. Sars, 1857)		29	1	29	59
				Thysanoessa inermis	(Kroeyer, 1846)			2		2
		Isopoda		Isopoda g. sp.					1	1
			Aegidae	Aega psora	L., 1758	6	1			7
				Aega sp.		4	1			5
				Rocinela danmoniensis	Leach, 1818	2				2
				Syscenus sp.		1				1

			Cirolanidae	Natatolana borealis	(Lilljeborg, 1851)	1				1
			Eurycopidae	Munnopsurus giganteus	(G.O. Sars, 1877)		2			2
			Idotheidae	Saduria sabini	(Kroeyer, 1849)	8		7	58	73
				Saduria sibirica	(Birula, 1896)				3	3
			Munididae	Munida sp.				2		2
				Munida tenuimana	Sars, 1872	1				1
			Munnopsidae	Munnopsis typica	M. Sars, 1861			1		1
			Paranthuridae	Calathura brachiata	(Stimpson, 1854)			1		1
		Mysidacea	Boreomysidae	Boreomysis arctica	(Kroeyer, 1861)		2			2
	Pycnogonida	Pantopoda		Pycnogonida g. sp.					10	10
			Callipallenidae	Pseudopallene brevicolis	G.O. Sars, 1891	2		3		5
				Pseudopallene malleolata	(G.O. Sars, 1879)			3		3
			Colossendeidae	Colossendeis angusta	G.O. Sars, 1877		2		14	16
				Colossendeis proboscidea	(Sabine, 1824)	1	1	1	15	18
				Colossendeis sp.					43	43
			Nymphonidae	Boreonymphon abyssorum	(Norman, 1873)	7	16	21		44
				Boreonymphon ossiansarsi	Knaben, 1972	1		7		8
				Boreonymphon sp.		3				3
				Nymphon elegans	Hansen, 1887	1		10		11
				Nymphon gracilipes	Heller, 1875		1	25		26
				Nymphon grossipes	(Fabricius, 1780)		5	7		12
				Nymphon hirtipes	Bell, 1853	9	32	62		103
				Nymphon hirtum	(Fabricius, 1780)		4			4

				Nymphon leptocheles	G.O. Sars, 1888		1			1
				Nymphon longimanum	Sars, 1888			1		1
				Nymphon longitarse	Kroeyer, 1845		3			3
				Nymphon macronyx	G.O. Sars, 1877			1		1
				Nymphon mixtum	Kroeyer, 1844-45			7		7
				Nymphon schimkewitschi	Losina-Losinsky, 1929		6			6
				Nymphon serratum	G.O. Sars, 1879	2		4		6
				Nymphon sp.		14		6	13	33
				Nymphon stroemi stroemi	Kroeyer, 1845	9	16	4		29
				Nymphonidae g. sp.					90	90
			Pycnogonidae	Pycnogonum litorale	(Strom, 1762)	1				1
Mollusca				Mollusca g. sp.			1			1
	Bivalvia	Cardiiformes	Cardiidae	Cardiidae g. sp.					1	1
				Cerastoderma edule	(L., 1758)				1	1
				Clinocardium ciliatum	(Fabricius, 1780)	12	7	18	56	93
				Serripes groenlandicus	(Bruguiere, 1789)			1	13	14
			Myidae	Mya sp.					7	7
				Mya truncata	L., 1767			2	2	4
			Tellinidae	Macoma calcarea	(Gmelin, 1791)			2	10	12
				Macoma sp.					4	4
		Cuspidariiformes	Cuspidariidae	Cuspidaria arctica	(M. Sars, 1859)	1	2	8	19	30
				Cuspidaria sp.		2				2
		Luciniformes	Astartidae	Astarte borealis	Schumacher, 1817			1	18	19

				Astarte crenata	(Gray, 1842)		8	16	77	101
				Astarte sp.		24		12	3	39
			Hiatellidae	Hiatella arctica	(L., 1767)		5	13	21	39
		Mytiliformes	Arcidae	Bathyarca glacialis	(Gray, 1842)	24	17	9	6	56
				Bathyarca pectunculoides	(Scacchi, 1834)	4	2			6
				Bathyarca sp.					13	13
			Mytilidae	Modiolus modiolus	(L., 1758)				5	5
				Musculus laevigatus	(Gray, 1824)			8	1	9
				Musculus niger	(Gray, 1824)			1		1
				Musculus sp.				1	3	4
				Mytilus edulis	L., 1758				3	3
				Mytilus sp.					2	2
		Nuculiformes	Nuculanidae	Nuculana pernula	(Mueller, 1779)			2	1	3
				Nuculana sp.					1	1
			Yoldiidae	Yoldia hyperborea	(Torell, 1859)		1	4		5
				Yoldiella intermedia	(M. Sars, 1865)				1	1
		Pectiniformes	Pectinidae	Chlamys islandica	(O.F. Mueller, 1776)	11	23	28	68	130
				Chlamys sulcata	(O.F. Mueller, 1776)				3	3
				Pseudamussium septemradiatum	(Mueller, 1776)	14				14
			Propeamussiidae	Arctinula greenlandica	(Sowerby, 1842)	11	12	15	33	71
				Cyclopecten imbrifer	(Lovén, 1846)		2			2
	Cephalopoda	Octopoda		Octopoda g. sp.					1	1

			Bathypolypodinae	Bathypolypus arcticus	(Prosch, 1849)	4	12	10	22	48
				Benthoctopus sp.					5	5
			Cirroteuthidae	Cirroteuthis muelleri	Eschricht, 1836		2			2
		Sepiida	Sepiolidae	Rossia moelleri	Steenstrup, 1856		1			1
				Rossia palpebrosa	Owen, 1834	9	8	10	32	59
				Rossia sp.				1	51	52
		Sepiolida	Sepiolidae	Sepietta oweniana	(d'Orbigny, 1841)	1				1
		Teuthida		Teuthida g. sp.					5	5
			Gonatidae	Gonatus fabricii	(Lichtenstein, 1818)	16	30	8	5	59
			Ommastrephidae	Todarodes sagittatus	(de Lamarck, 1798)				3	3
				Todaropsis eblanae	(Ball, 1841)				1	1
	Gastropoda			Gastropoda g. sp.					19	19
		Bucciniformes	Beringiidae	Beringius ossiani	(Friele, 1879)	3		2	4	9
			Buccinidae	Aulacofosus brevicauda	(Deshayes, 1832)	1				1
				Buccinidae g. sp.					1	1
				Buccinum angulosum	Gray, 1839				9	9
				Buccinum belcheri	Reeve, 1855				2	2
				Buccinum ciliatum ciliatum	(Fabricius, 1780)		1	2	7	10
				Buccinum elatior	(Middendorff, 1849)		2	3	37	42
				Buccinum finmarchianum	Verkruezen, 1875		1	17		18
				Buccinum fragile	Verkruezen in G.O. Sars, 1878		8		2	10
				Buccinum glaciale	L., 1761			3	15	18

				Buccinum hydrophanum	Hancock, 1846	4	10	15	62	91
				Buccinum micropoma	Jensen in Thorson, 1944			5		5
				Buccinum polare	Gray, 1839				5	5
				Buccinum sp.		5		3	7	15
				Buccinum undatum	L., 1758			1	18	19
				Colus altus	(S. Wood, 1848)			2	9	11
				Colus holboelli	(Moeller,1842)	3	1			4
				Colus islandicus	(Mohr, 1786)	9	6	5	51	71
				Colus kroyeri	(Moeller,1842)			4	1	5
				Colus pubescens	(Verrill, 1882)	2		7		9
				Colus sabini	(Gray, 1824)	6	3	3	60	72
				Colus sp.		2		6	59	67
				Colus turgidulus	(Jeffreys, 1877)	4		5		9
				Eggs Buccinidae g. sp. sp.					1	1
				Neptunea communis	(Middendorff, 1901)				8	8
				Neptunea denselirata	Brogger, 1901	7		5	23	35
				Neptunea despecta	(L., 1758)	5	1	1	11	18
				Neptunea sp.					2	2
				Neptunea ventricosa	(Gmelin, 1789)				10	10
				Pyrulofusus deformis	(Reeve, 1847)			1	1	2
				Turrisipho dalli	(Friele in Tryon, 1881)				1	1
				Turrisipho lachesis	(Moerch, 1869)	2	1	7	2	12
				Turrisipho sp.		3			29	32

				Volutopsis norvegicus	(Gmelin, 1790)	4	2	7	14	27
			Muricidae	Boreotrophon sp.				2		2
				Boreotrophon truncatus	(Stroem, 1767)		1			1
		Cephalaspidea		Opistobranchia g. sp.		1				1
			Philinidae	Philine finmarchica	G.O. Sars, 1878	7	8		2	17
				Philinidae g. sp.		1		33		34
			Scaphandridae	Scaphander punctostriatus	(Mighels & Adams, 1842)				12	12
				Scaphander sp.		1				1
		Cerithiiformes	Naticidae	Bulbus smithi	Brown, 1839	12		1	8	21
				Cryptonatica affinis	(Gmelin, 1791)		9	6	29	44
				Lunatia pallida	(Broderip & Sowerby, 1829)	1	3	14	15	33
				Lunatia sp.					1	1
				Naticidae g. sp.				1		1
			Velutinidae	Limneria undata	(Brown, 1838)	3	3	6	2	14
				Onchidiopsis glacialis	(M. Sars, 1851)	2	5	1		8
				Onchidiopsis sp.					1	1
				Velutina sp.				7		7
				Velutina velutina	(Mueller, 1776)		3			3
		Coniformes	Turridae	Propebela turricula	(Montagu, 1803)		1			1
		Nudibranchia		Nudibranchia g. sp.			4	28	17	49
			Aeolidiidae	Aeolidia papillosa	(L., 1762)				10	10
				Aeolidia sp.					1	1

			Aldisidae	Aldisia sp.			4			4
			Cadlinidae	Cadlina laevis	(L., 1767)		5			5
			Dendronotidae	Dendronotus frondosus	(Ascanius, 1774)		1			1
				Dendronotus robustus	Verrill, 1870	1	3		24	28
				Dendronotus sp.		1		14	4	19
			Onchidoridiae	Onchidoridae g. sp.		7				7
			Onchidorididae	Acanthodoris pilosa	(Abildgaard in Müller, 1789)		2			2
		Patelliformes	Tecturidae	Capulacmaea radiata	(M. Sars, 1851)		1	2	11	14
		Pleurotomariiformes	Fissurellidae	Puncturella noachina	(L., 1771)		1			1
		Trochiformes	Calliostomatidae	Calliostoma formosum	(McAndrews & Forbes, 1847)	1	1			2
			Liotiidae	Moelleria costulata	(Moeller, 1842)				1	1
			Trochidae	Margarites costalis	(Gould, 1841)		2		7	9
				Margarites groenlandicus groenlandicus	(Gmelin, 1790)	1	2	5	2	10
				Margarites olivacea	(Brown, 1827)		1			1
				Margarites sp.		2		5	4	11
	Polyplacophora			Polyplacophora g. sp.				2	1	3
		Chitonida	Tonicellidae	Tonicella marmorea	(Fabricius, 1780)		1			1
		Lepidopleurida	Hanleyidae	Hanleya hanleyi	J.E. Gray, 1857	3	1			4
	Solenogastres			Solenogastres g. sp.		4	2			6
		Cavibelonia	Proneomeniidae	Proneomenia sluiteri	Huebrecht, 1880	1	2	2		5
				Proneomenia sp.			1			1

				Proneomenia thulensis	Thiele, 1900			3		3
Echinodermata	Asteroidea	Forcipulatidae	Asteriidae	Asterias rubens	L., 1758		3		15	18
				Asteriidae g. sp.			1	1	1	3
				Icasterias panopla	(Stuxberg, 1879)	12	14	31	106	163
				Leptasterias arctica	(Murdoch, 1885)				3	3
				Leptasterias groenlandica	(Steenstrup, 1857)		7			7
				Leptasterias muelleri	(M. Sars, 1846)		4	3		7
				Leptasterias sp.			3	8	14	25
				Stephanasterias albula	(Stimpson, 1853)			2		2
				Stichastrella rosea	(O.F. Mueller, 1776)	1				1
				Urasterias linckii	(Mueller & Troschel, 1842)	10	6	29	108	153
		Notomyotida	Benthopectinidae	Pontaster tenuispinus	(Dueben & Koren, 1846)	38	10	48	126	222
		Paxillosida	Astropectinidae	Bathybiaster vexillifer	(W. Thomson, 1873)		1		13	14
				Leptychaster arcticus	(M. Sars, 1851)	18	3	3	2	26
				Psilaster andromeda	(Mueller & Troschel, 1842)	2			9	11
			Ctenodiscidae	Ctenodiscus crispatus	(Retzius, 1805)	44	30	68	148	290
		Spinulosida	Echinasteridae	Henricia sp.		37	40	24	77	178
		Valvatida	Goniasteridae	Ceramaster granularis granularis	(Retzius, 1783)	14	3	1	3	21
				Ceramaster sp.					1	1
				Hippasteria phrygiana phrygiana	(Parelius, 1768)	7	3		27	37
				Pseudarchaster parelii	(Dueben & Koren, 1846)	1				1
			Poraniidae	Poraniomorpha bidens	Mortensen, 1932			1		1

				Poraniomorpha hispida	(Sars, 1872)	6	4	2		12
				Poraniomorpha sp.					1	1
				Poraniomorpha tumida	(Stuxberg, 1878)	2	5	13	58	78
				Tylaster willei	Danielssen & Koren, 1881				1	1
		Velatida	Korethrasteridae	Korethraster hispidus	W. Thomson, 1873	1	3	4		8
			Pterasteridae	Hymenaster pellucidus	W. Thomson, 1873	2	10	5	25	42
				Pteraster militaris	(O.F. Mueller, 1776)	16	11	19	45	91
				Pteraster obscurus	(Perrier, 1891)	1	8	6	28	43
				Pteraster pulvillus	M. Sars, 1861	10	26	14	7	57
				Pteraster sp.		1	1		1	3
			Solasteridae	Crossaster papposus	(L., 1768)	5	12	17	72	106
				Lophaster furcifer	(Dueben & Koren, 1846)	2	10	10	32	54
				Solaster endeca	(L., 1771)	2		4	71	77
				Solaster sp.		3		6		9
				Solaster syrtensis	Verrill, 1894	2	4	3		9
	Crinoidea	Bourgueticrinida	Bathycrinidae	Bathycrinus carpenteri	(Danielssen & Koren, 1877)		1			1
		Comatulida	Antedonidae	Heliometra glacialis glacialis	(Owen, 1833)	1	21	25	77	124
				Poliometra prolixa	(Sladen, 1881)		5	3	1	9
	Echinoidea	Echinoida	Echinidae	Echinus acutus	Lamarck, 1816	3				3
				Echinus sp.		14				14
			Strongylocentrotidae	Strongylocentrotus droebachiensis	O.F. Mueller, 1776		6	6	16	28
				Strongylocentrotus pallidus	(G.O. Sars, 1871)	2	47	43	101	193

				Strongylocentrotus sp.		13	1	4	4	22
		Pourtalesioida	Pourtalesiidae	Pourtalesia jeffreysi	Thomson, 1872		1			1
		Spatangoida	Spatangidae	Brisaster fragilis	(Dueben & Koren, 1846)	10		1	1	12
	Holothuroidea	Apodida	Chiridotidae	Chiridota laevis	(Fabricius, 1780)	1				1
			Myriotrochidae	Myriotrochinae g. sp.					1	1
				Myriotrochus rinkii	Steenstrup, 1851	6		15	4	25
				Myriotrochus sp.			1		4	5
		Aspidochirotida	Stichopodidae	Stichopus tremulus	(Gunnerus, 1767)	11				11
		Dendrochirotida	Cucumariidae	Cucumaria frondosa	(Gunnerus, 1867)	2	1	3	10	16
				Thyonidium drummondi	(Thompson, 1840)		1		1	2
				Thyonidium sp.				2	2	4
			Phyllophoridae	Pentamera calcigera	(Stimpson, 1851)				1	1
				Phyllophoridae g. sp.				1	17	18
			Psolidae	Psolus phantapus	Strussenfelt, 1765	3	2	3	20	28
				Psolus sp.		1			16	17
				Psolus squamatus	(O.F. Muller, 1776)		3			3
		Molpadiida	Caudinidae	Eupyrgus scaber	Luetken, 1857		3	1		4
			Molpadiidae	Molpadia arctica	von Marenzeller, 1878		6		12	18
				Molpadia borealis	(M. Sars, 1859)	23		28	68	119
				Molpadiidae g. sp.					17	17
	Ophiuroidea	Euryalida	Gorgonocephalidae	Gorgonocephalus arcticus	(Leach, 1819)		3	32	51	86
				Gorgonocephalus eucnemis	(Mueller & Troschel, 1842)		11	11	78	100
				Gorgonocephalus sp.		2	2	1	18	23

		Ophiurida	Ophiacanthidae	Ophiacantha bidentata	(Retzius, 1805)	17	34	66	99	216
			Ophiactidae	Ophiopholis aculeata	(L., 1767)	26	56	69	60	211
			Ophiomyxidae	Ophioscolex glacialis	Mueller & Troschel, 1842	5	15	48	79	147
			Ophiuridae	Ophiocten gracilis	(G.O. Sars, 1871)				13	13
				Ophiocten sericeum	(Forbes, 1852)	4	5	14	5	28
				Ophiopleura borealis	Danielssen & Koren, 1877			22	96	118
				Ophiura robusta	(Ayers, 1851)		1	8		9
				Ophiura sarsi	Luetken, 1855	32	46	44	103	225
				Ophiura sp.		3				3
				Stegophiura nodosa	(Luetken, 1854)				3	3
Brachiopoda				Brachiopoda g. sp.					4	4
	Rhynchonellata	Rhynchonellida	Hemithyrididae	Hemithyris psittacea	(Gmelin, 1790)	5	1	10	11	27
		Terebratulida	Cancellothyrididae	Terebratulina retusa	(L., 1758)	9	20	4		33
				Terebratulina sp.					1	1
			Dallinidae	Dallina septigera	(Lovén, 1846)	3				3
				Glaciarcula spitzbergensis	(Davidson, 1852)	2	1			3
			Macandreviidae	Macandrevia cranium	(Mueller, 1776)	6	3			9
			Terebratulidae	Liothyrella arctica	(Friele, 1877)	1				1
Bryozoa	Gymnolaemata			Bryozoa g. sp.			2	6	58	66
		Cheilostomida	Bicellariidae	Bugula sp.				3		3
				Dendrobeania sp.			1		1	2
			Celleporidae	Cellepora sp.			16	13	5	34
			Flustridae	Flustra sp.				26	31	57

				Securiflustra securifrons	(Pallas, 1766)			13		13
			Membraniporidae	Membranipora membranacea	(L., 1767)	1				1
				Membranipora sp.		1				1
			Myriaporidae	Myriapora coarctata	(M. Sars, 1863)		18	1		19
			Reteporidae	Retepora beaniana	King, 1846	8		5		13
				Retepora sp.		3	11	1	1	16
				Sertella septentrionalis	Jullen, 1933		7	2		9
			Rhamphostomellidae	Rhamphostomella sp.			2			2
			Schizoporellidae	Myriozoella sp.				2		2
			Scrupariidae	Eucratea loricata	(L., 1758)	1	6	13	7	27
			Smittinidae	Parasmittina jeffreysii	(Norman, 1903)			1		1
				Porella sp.			3	4	3	10
				Smittinidae g. sp.				1		1
		Ctenostomata	Alcyonidiidae	Alcyonidium disciforme	Smitt, 1872				11	11
				Alcyonidium gelatinosum	(L., 1767)			56	16	72
				Alcyonidium sp.			19		6	25
		Cyclostomata	Corymboporidae	Defrancia lucernaria	(M. Sars, 1851)		2			2
			Diastoporidae	Diplosolen intricarius	(Smitt, 1872)	1	8	3		12
			Horneridae	Hornera sp.		3				3
				Stegohornera lichenoides	(L., 1758)		31	8	1	40
			Lichenoporidae	Lichenopora sp.				2		2
Chaetognatha	Sagittoidea	Aphragmophora	Sagittidae	Sagitta sp.			1			1
Chordata	Ascidiacea			Ascidiacea g. sp.			19	15	68	102

		Aplousobranchia	Didemnidae	Didemnum albidum	(Verrill, 1871)			2		2
				Didemnum roseum	M. Sars, 1851		4			4
				Didemnum sp.		7	8			15
			Polycitoridae	Eudistoma vitreum	(Sars, 1851)	4	41			45
			Polyclinidae	Synoicum tirgens	Phipps, 1774			1		1
		Phlebobranchia	Ascidiidae	Ascidia prunum	(Mueller, 1776)			10		10
				Ascidia sp.		15	1			16
			Cionidae	Ciona intestinalis	(L., 1767)		1		18	19
				Ciona sp.					1	1
		Stolidobranchia	Molgulidae	Molgula sp.			10	1		11
			Pyuridae	Halocynthia pyriformis	(Rathke, 1806)	1		1		2
				Microcosmus glacialis	(M. Sars, 1859)			4		4
			Styelidae	Botryllus schlosseri	(Pallas, 1776)	12		14		26
				Dendrodoa aggregata	(Rathke, 1806)		2			2
				Dendrodoa sp.		1				1
				Styela coriacea	(Alder & Hancock, 1848)	2	1			3
				Styela rustica	(L., 1767)		3	1	6	10
				Styela sp.					2	2
Total						**1613**	**2281**	**2837**	**5966**	**12679**

JOINT REPORT

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