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Survey report from the joint Norwegian/Russian Ecosystem Survey in the Barents Sea and adjacent waters, August – October 2016

Institute of Marine Research - IMR

Polar Research Institute of Marine Fisheries and Oceanography - PINRO

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1 BACKGROUND

The aim of this survey is to monitor the status of abiotic and biotic factors and changes of these in the Barents Sea ecosystem. The survey is named "The Barents Sea Ecosystem Survey" (BESS) and has been undertaken annually in the autumn since 2004. The survey is conducted jointly by the Institute of Marine Research (IMR) in Norway and the Knipovich Polar Research Institute of Marine Fisheries and Oceanography (PINRO) in Russia.

The survey plan and tasks were agreed upon at the annual IMR-PINRO Meeting in March 2016. Both sides had to use different vessels than earlier, Norway would rent a commercial vessel, MS "Eros", to replace RV "G.O.Sars" and Russia would use RV "Frithjof Nansen" instead of RV "Vilnyus".

It was decided to conduct the survey from north to south, starting with the coverage of capelin. It was also decided to give high priority to covering the whole survey area with bottom trawl stations to maintain the index series on demersal fish. It was decided not to use bottom trawl by MS "Eros", as the performance would be unknown. Thus, RV "Johan Hjort" should take all the Norwegian bottom trawl stations and MS "Eros" would take pelagic trawl stations and hydrographical stations including plankton. RV "Frithjof Nansen" would take as many Russian combined bottom and pelagic trawl stations as possible. Due to available ship time RV "Helmer Hanssen" would operate north of Svalbard in late September – early October and would not take part in the synoptic coverage attempted by the other vessels. Thus, information on the 0-group, pelagic and demersal species in parts of this area may not be comparable to data collected by RV "Johan Hjort" and MS "Eros".

The agreed cruise plan was followed, however, with minor adjustments. The aim was to cover almost the same cruise tracks with both MS "Eros" and RV "Johan Hjort", but this became difficult and some stations were exchanged between the vessels. At the end of the survey RV "Johan Hjort" covered a large area alone doing pelagic and bottom trawling and hydrographical stations.

The Norwegian vessels did not carry out bottom trawl east of the delimitation line in the Loop hole in the Barents Sea, outside the economic zones. An application for bottom trawling was sent from Norwegian authorities to Russia, but permission to conduct bottom trawling was denied. This issue was raised at the planning survey meeting in March 2016, however without any positive result. Thus, important information on the bottom species (cod, Greenland halibut and snow crab) in this area is not resolved, as the Russian vessel neither did trawling in this area.

Thus, the 14th joint Barents Sea autumn ecosystem survey (BESS) was carried out during the period from 17th August to 5th October 2016. Research vessel tracks and trawl stations during the 2016 ecosystem survey are shown in Figure 1.1. Hydrography and plankton stations are shown in Figure 1.2.

Research vessel "Johan Hjort" covered the northern part of the Barents Sea from August, 19 to September 2. MS "Eros" also covered the northern parts from August 17 to September 7. Then RV "Johan Hjort" covered the central part from September 2 to 15 and the southern parts from September 15 to 30. MS "Eros" covered the central and western parts from September 2 to 20. Research vessel "Helmer Hanssen" covered the areas north and west of Svalbard from September 24 to October 5. Research vessel "Frithjof Nansen" covered the northern and eastern parts of Barents Sea from August 9 to September 30 (Figure 1.1).

This report is produced on internet (www.imr.no) and will be assembled into a pdf-report at a later stage. However, some parts will be available later on the Internet (www.imr.no) and only presented there. A website dedicated to collating all information from the ecosystem survey including all the previous reports, maps, etc. is being produced (http://www.imr.no/tokt/okosystemtokt_i_barentshavet/nn-no). Post-survey information which is not included in the written report (e.g. plankton and fish stomach samples which need long processing time) may thus be found at this website.

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

The sampling manual for 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 methodological and technical descriptions of equipment, the trawling and capture procedures by the samplings tools, and the methods that are used in calculating the abundance and biomass for the biota. The manual is continuously updated.

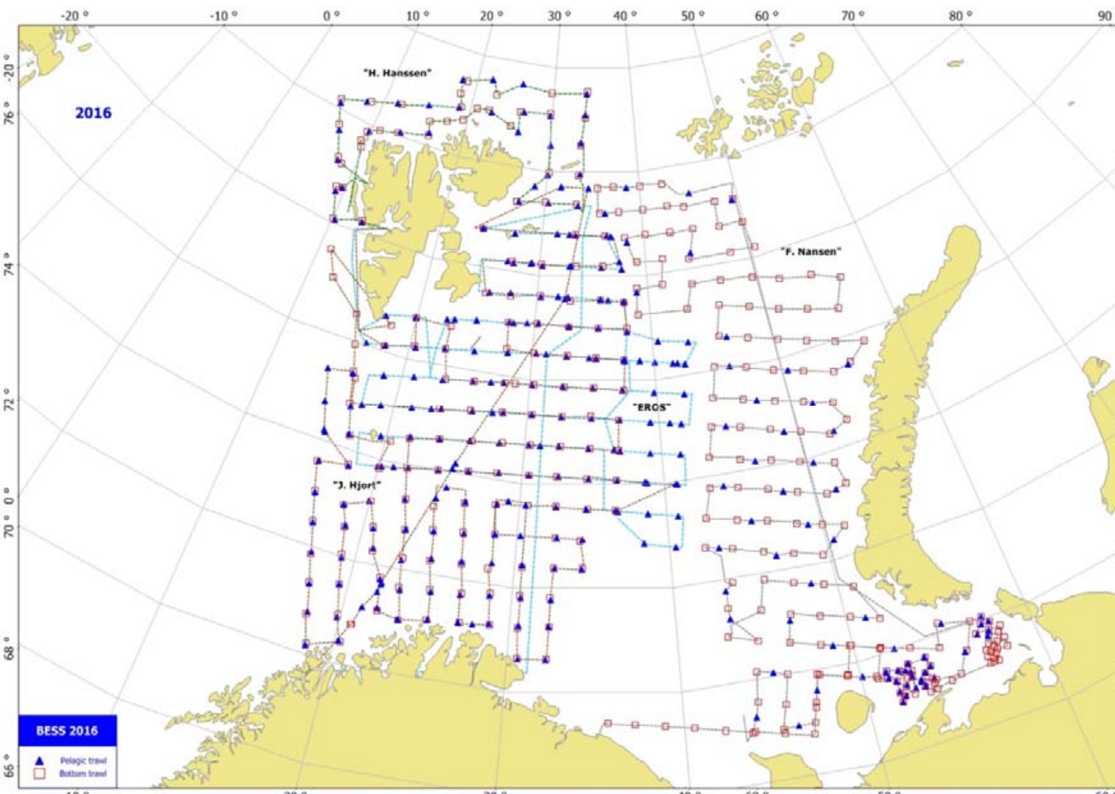


Figure 1.1 Ecosystem survey, August-October 2016. Research vessel tracks and trawl stations.

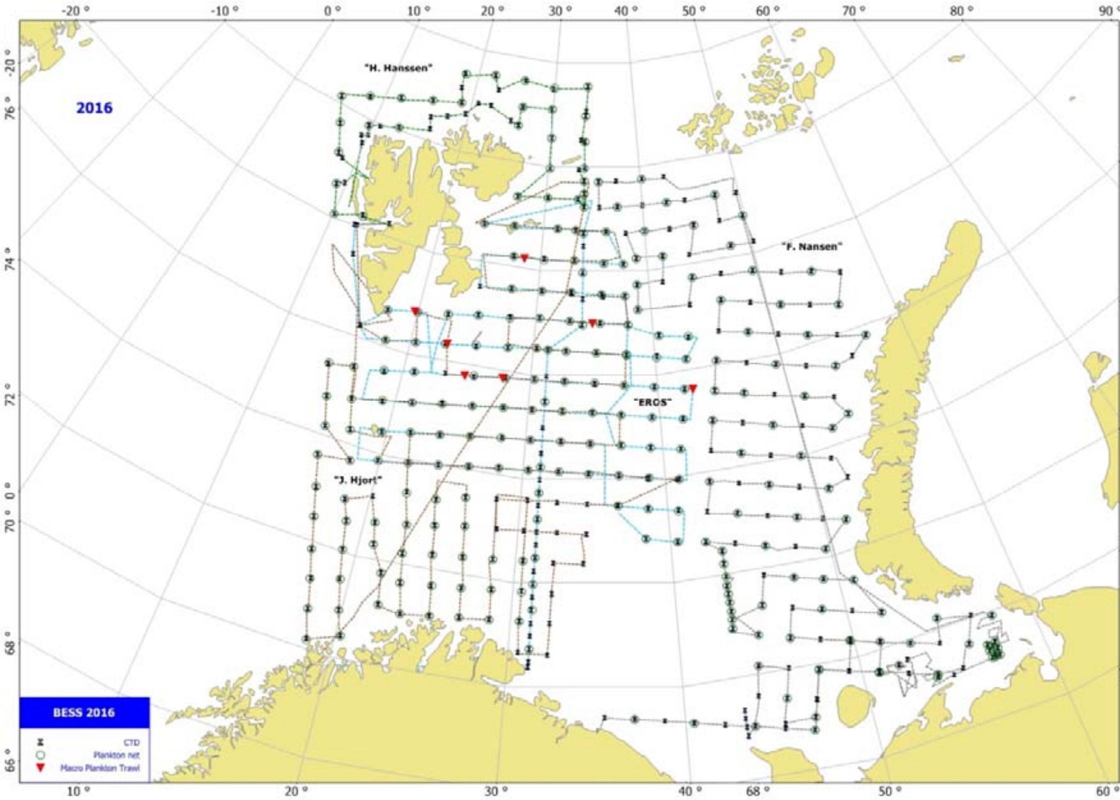


Figure 1.2 Ecosystem survey, August-October 2016. Hydrography and plankton stations.

2 DATA MONITORING

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. Thesedata 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

Data collected during the ecosystem survey is stored using the IMR infrastructure developed through the Sea2Data project. The infrastructure facilitates long term storage of scientific data and gives scientists access to these data both through an API and direct download.

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 the marine environment

3.1 Hydrography

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

3.1.1 Oceanographic sections

Fig 3.1.1.1 shows the temperature and salinity conditions along the standard oceanographic section 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 2016 the Vardø–North Section was sampled all the way to about 80ºN. The mean Atlantic Water (50–200 m) temperature in the Fugløya–Bear Island Section was 0.6°C higher than the long-term mean for the period 1965–2015 (Table 3.1.1.1). Going further east to the Vardø–North Section, the mean Atlantic Water (50–200 m) temperature anomaly was 0.7°C. Both sections show a weak temperature decrease compared to 2015.

The Kola and Kanin Sections cover the flow of Coastal and Atlantic waters in the southern Barents Sea. In August–September 2016, the Kola Section was not carried out. The outer part of the Kanin Section had the highest (since 1965) temperature of 5.5°C in the 0–200 m that was 1.9°C higher than the long-term mean for the period 1965–2016 and 0.9°C higher than in 2015 (Table 3.1.1.1).

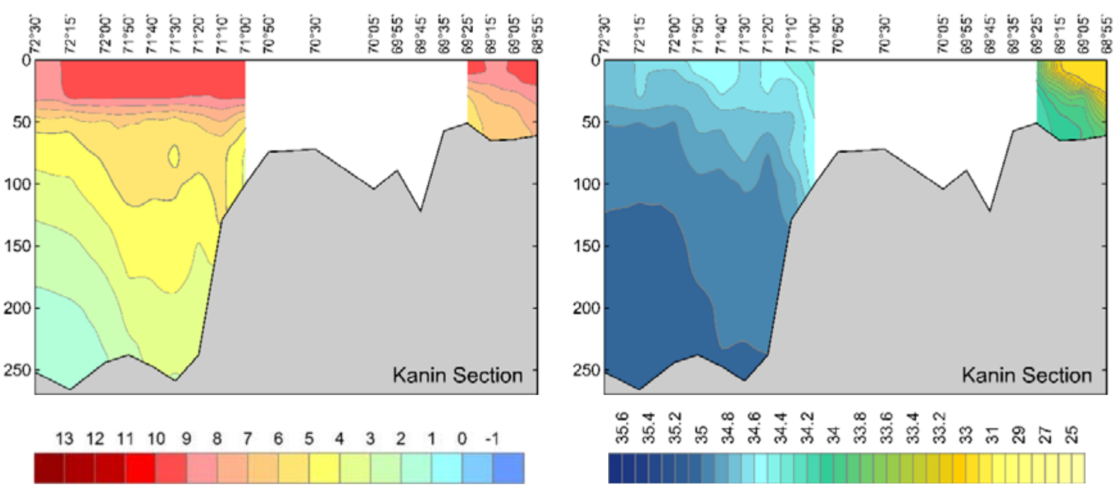


Figure 3.1.1.1. Temperature (°C, left panel) and salinity (right panel) along the Kanin oceanographic section in August–September 2016

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 1965–2016. 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
2015	8.5	4.8	5.7	6.1	4.6	-	-	5.6	6.6
2016	-	-	-	-	5.5	-	-	5.1	6.5
Average 1965–2015	7.6	4.0	4.9	4.5	3.6	5.8	4.8	4.4	5.9

3.1.2 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 1931–2010.

The surface temperature was on average 1.8°C higher than the long-term mean all over the Barents Sea (Fig. 3.1.2.9). The largest temperature anomalies (>2.5°C) were mainly observed in the eastern and south-eastern parts and resulted from anomalously warm air masses over those areas. The smallest positive anomalies (<0.5°C) took place in the south-western Barents Sea. Compared to 2015, the surface temperature was higher (by 1.1°C on average) in most of the Barents Sea (two thirds of the surveyed area), especially in the north-western and south-eastern parts. The surface waters were on average 0.4°C colder than in 2015 mostly in the south-western and central Barents Sea.

Arctic waters were, as usual, most dominant in the 50–100 m layer north of 77°N (Fig. 3.1.2.3 and 3.1.2.5). The temperatures at depths of 50 and 100 m were higher than the long-term mean (on average, by 1.8 and 1.5°C respectively) all over the Barents Sea. Compared to 2015, the 50 and 100 m temperatures were higher (on average, by 0.7 and 0.6°C respectively) in most of the Barents Sea (five sixths of the surveyed area). Negative differences (–0.3°C on average) in temperature between 2016 and 2015 took place only in some local areas.

The bottom temperature was in general 1.6°C above the average throughout the Barents Sea (Fig. 3.1.2.10). The largest temperature anomalies (>2.5°C) were mainly observed over the Spitsbergen Bank and in the Pechora Sea. Compared to 2015, the bottom temperature was on average 0.8°C higher almost all over the Barents Sea. Small negative differences in temperature between 2016 and 2015 were on average –0.2°C, occupied only about 6% of the surveyed area and were mainly found in the south-western Barents Sea. In August–September 2016, the area occupied by water with temperatures below zero was much smaller than in the previous year, and near the bottom, it was the smallest since 1965 – the year when this joint survey started. 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 salinity was on average 0.5 higher than the long-term mean almost all over the Barents Sea with the largest positive anomalies (>0.5) mainly north of 75°30'N, especially in the area of the Great Bank, and east of 48°E, especially west and south of Southern Island of the Novaya Zemlya Archipelago (Fig. 3.1.2.11). The large negative anomalies were only observed north of Kolguev Island. In August–September 2016, the surface waters were saltier than in 2015 in about 60% of the surveyed area with the largest positive differences in the Pechora Sea, along the Novaya Zemlya Archipelago and south of the Spitsbergen Archipelago. Negative differences in salinity between 2016 and 2015 were mainly found in the central and north-eastern Barents Sea as well as north of Kolguev Island.

The bottom salinity was slightly higher (by up to 0.1) than the long-term mean in about four fifths of the surveyed area and it was close to that in 2015 (Fig. 3.1.2.12). Negative anomalies were mainly found in the south-eastern Barents Sea, especially in the Pechora Sea. The largest differences in salinity between 2016 and 2015 were observed in shallow waters between Bear and Hopen Islands (positive values) and in the south-eastern Barents Sea (negative values).

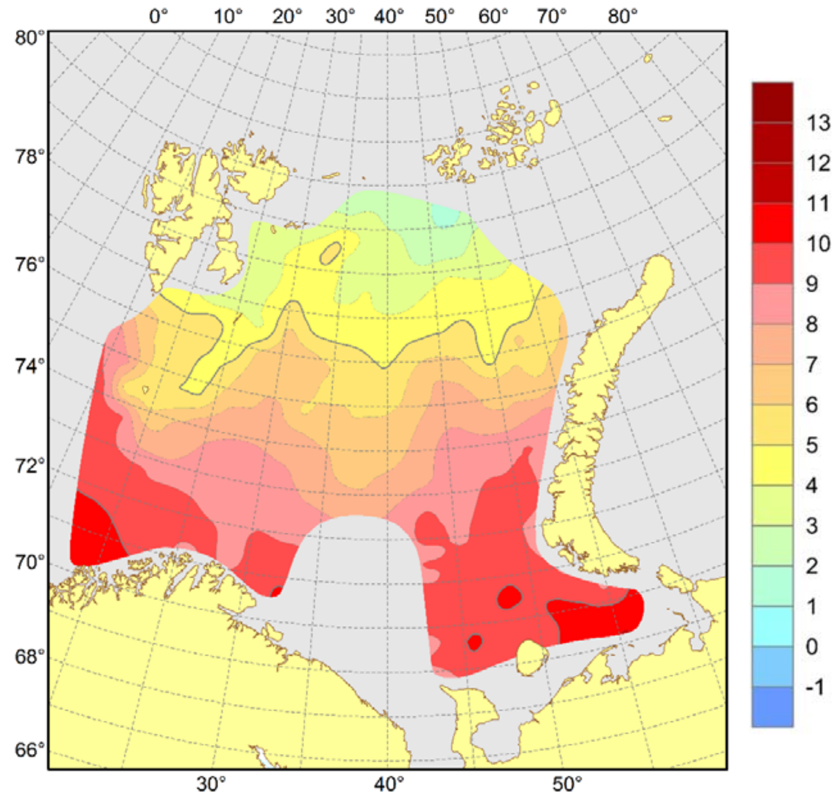


Figure 3.1.2.1 Distribution of surface temperature (°C), August–September 2016

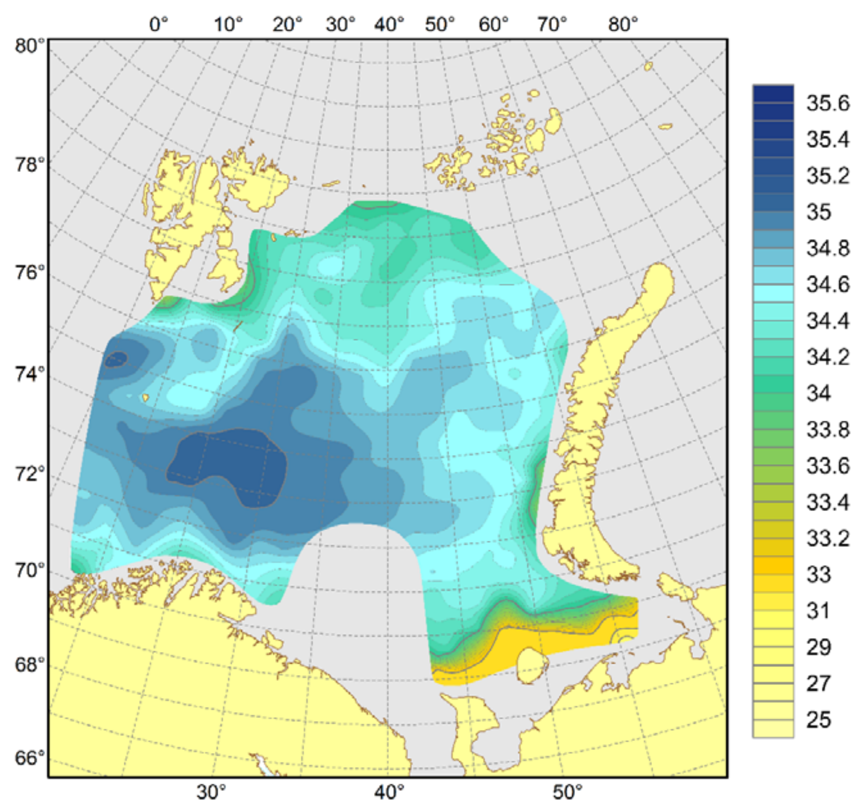


Figure 3.1.2.2. Distribution of surface salinity, August–September 2016

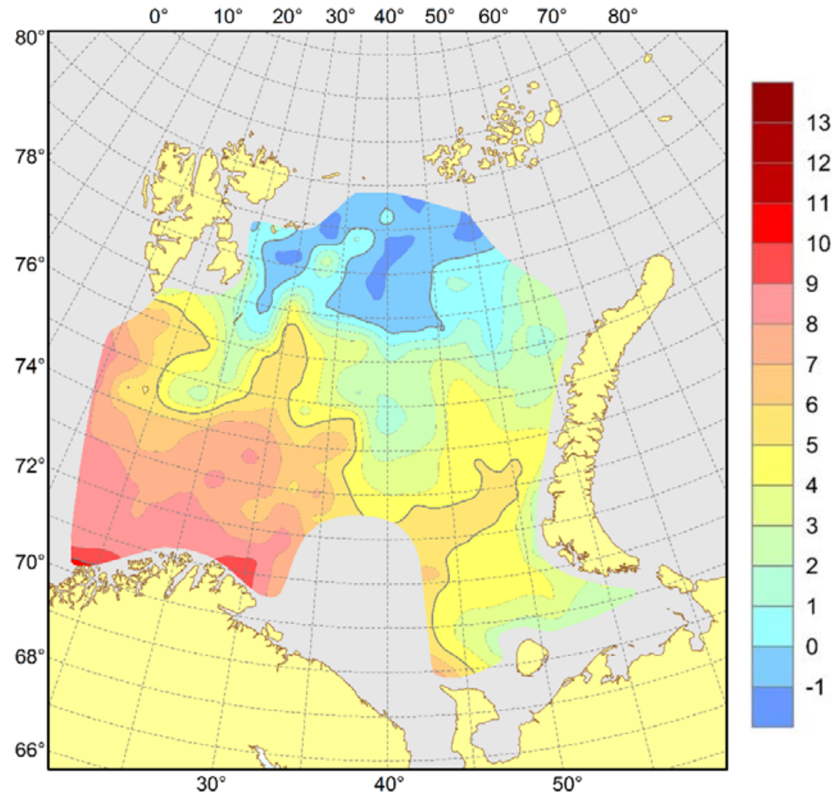


Figure 3.1.2.3. Distribution of temperature (°C) at the 50 m depth, August–September 2016

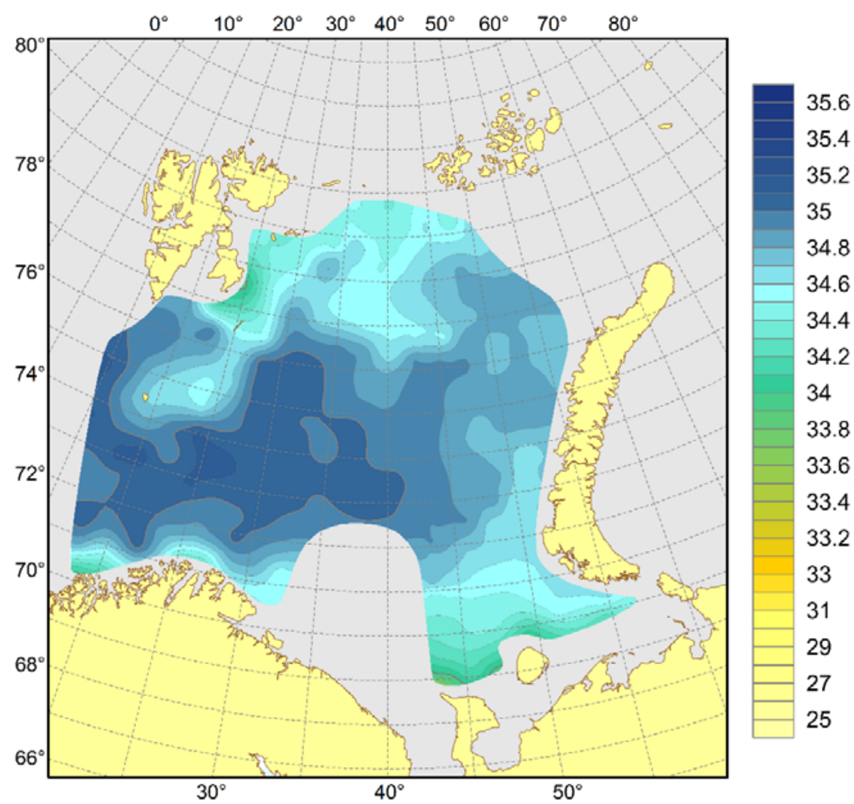


Figure 3.1.2.4. Distribution of salinity at the 50 m depth, August–September 2016

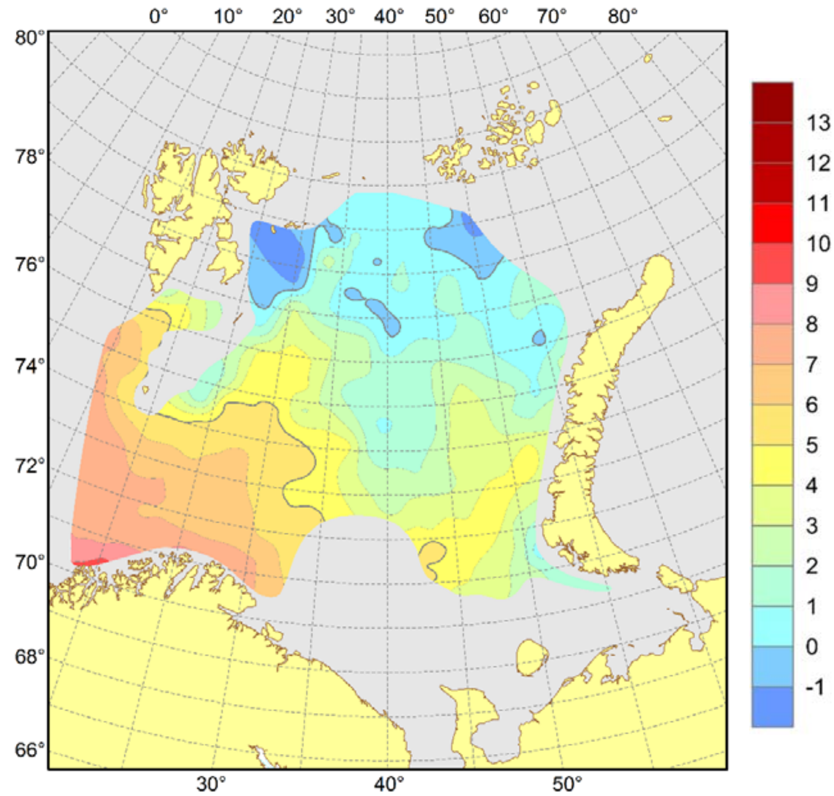


Figure 3.1.2.5. Distribution of temperature (°C) at the 100 m depth, August–September 2016

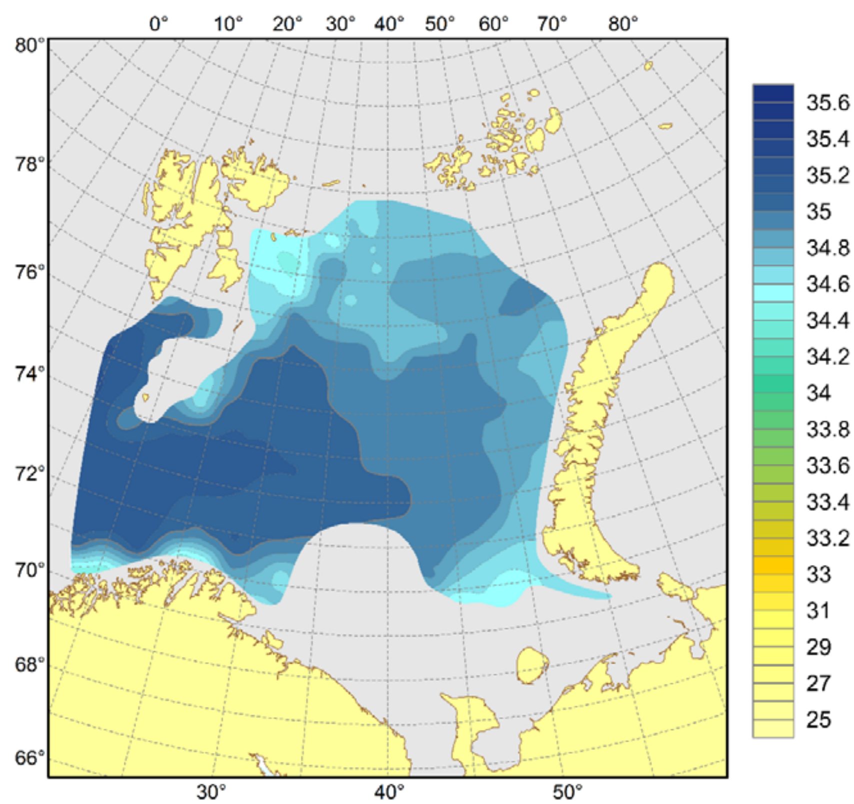


Figure 3.1.2.6. Distribution of salinity at the 100 m depth, August–September 2016

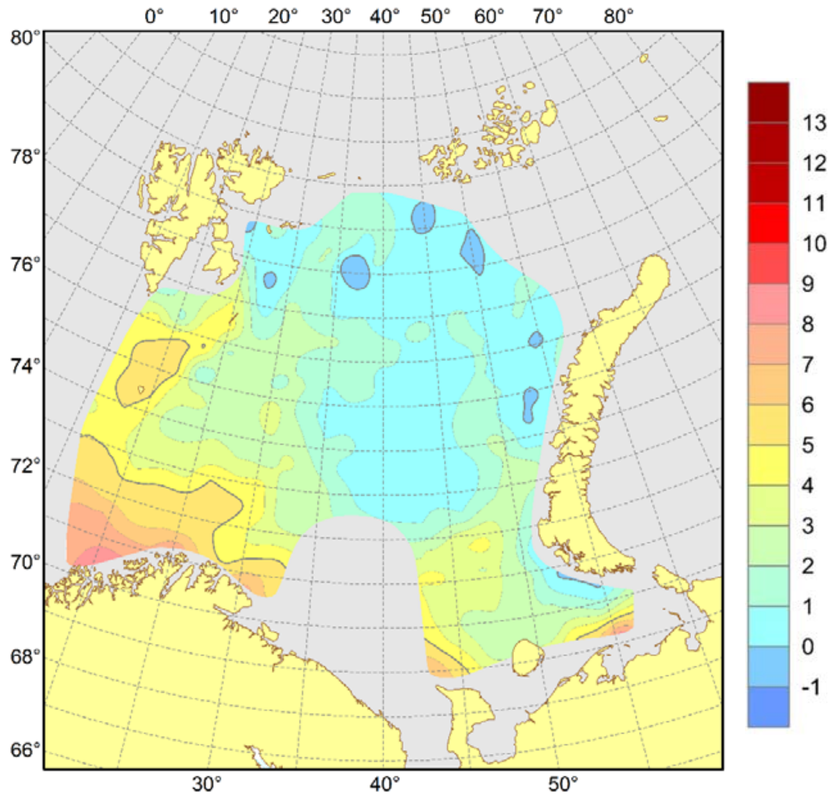


Figure 3.1.2.7. Distribution of temperature (°C) at the bottom, August–September 2016

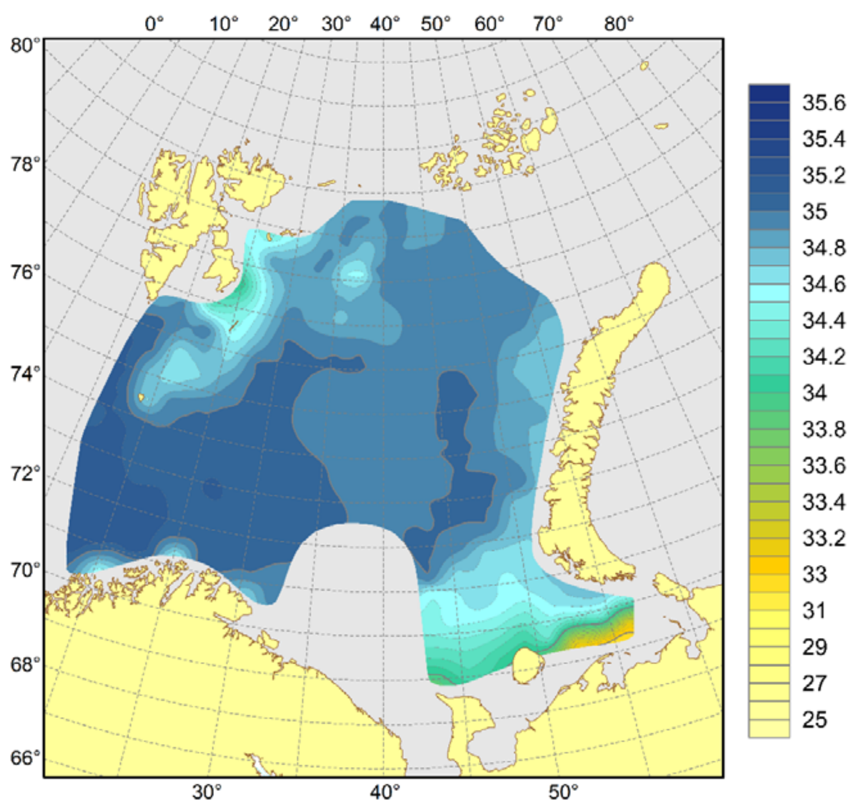


Figure 3.1.2.8. Distribution of salinity at the bottom, August–September 2016

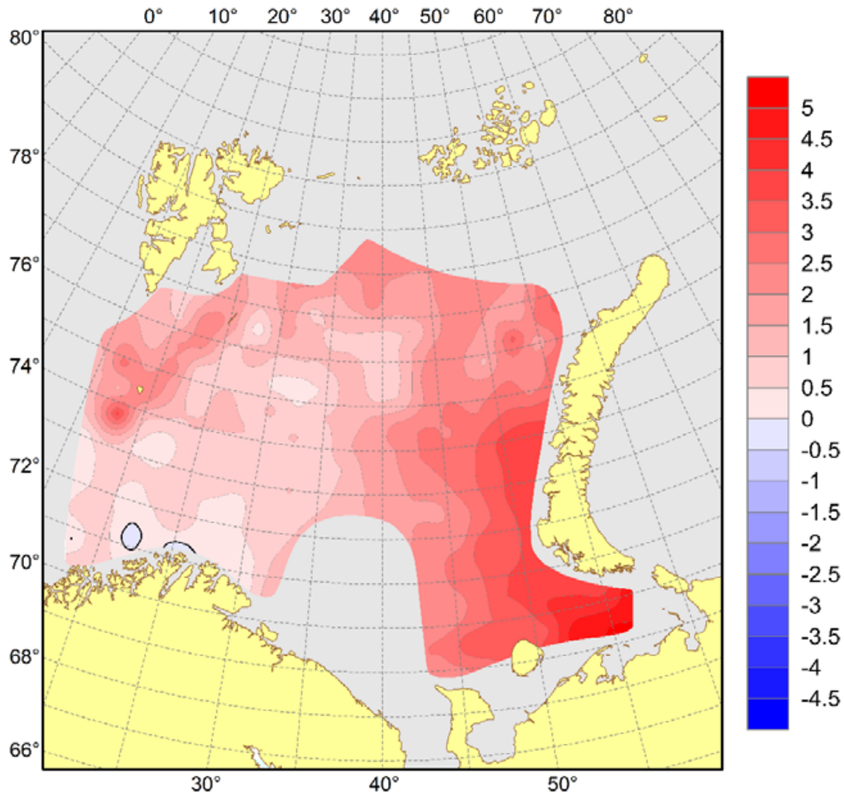


Figure 3.1.2.9. Surface temperature anomalies (°C), August–September 2016

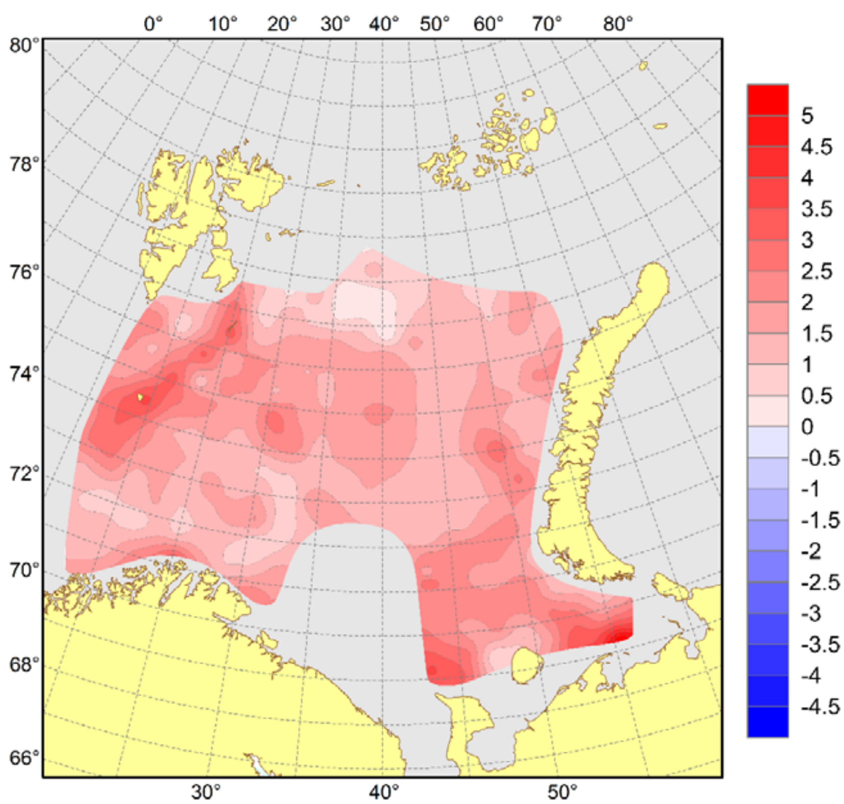


Figure 3.1.2.10. Temperature anomalies (°C) at the bottom, August–September 2016

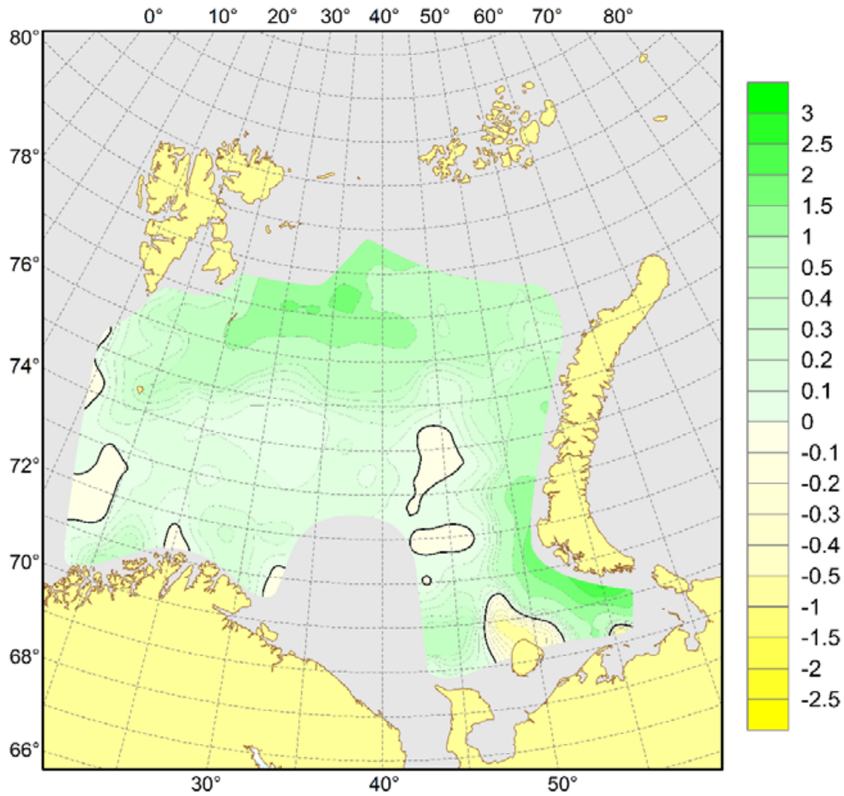


Figure 3.1.2.11. Surface salinity anomalies, August–September 2016

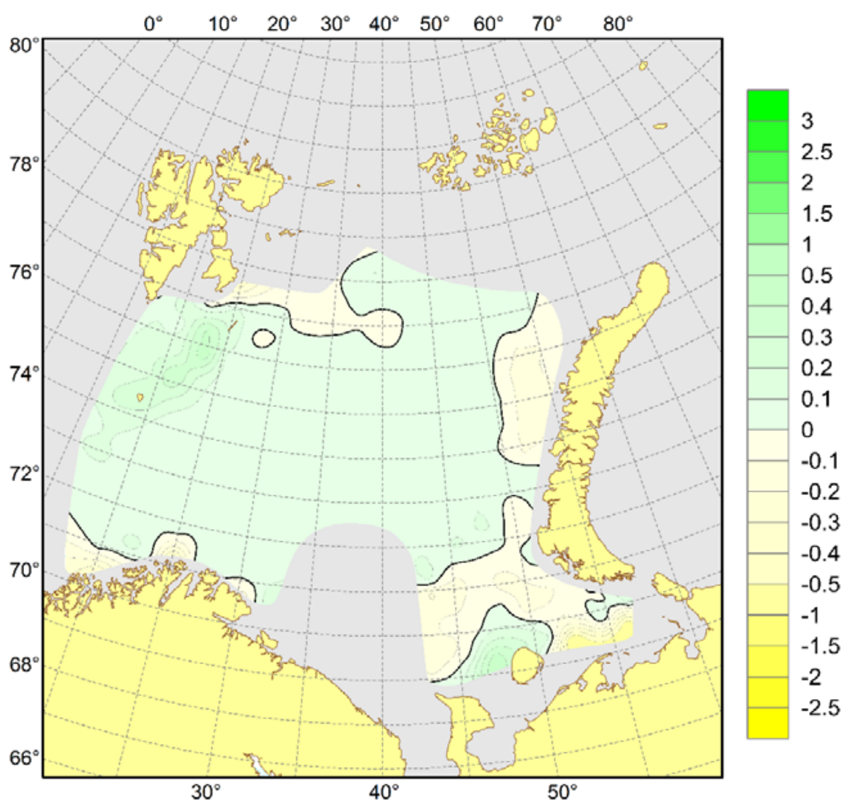


Figure 3.1.2.12. Salinity anomalies at the bottom, August–September 2016

3.2. Anthropogenic matter

Text by Pavel Krivosheya, Tatiana Prokhorova and Bjørn Einar Grøsvik
Figures by Pavel Krivosheya

Floating anthropogenic matter in 2016 was observed only onboard vessel "Fridtjof Nansen". Anthropogenic matter in trawls was observed onboard all vessels, both Russian and Norwegian. As usual, in areas of intensive fishery and navigation anthropogenic matter was more often observed.

Plastic dominated among anthropogenic pollutants on the water surface (Fig. 3.2.1). Floating anthropogenic matter was distributed predominantly along the branches of the main currents. Thus, registered polluting objects could be dumped directly in some areas and have been brought from other areas. Much more floating matter was found around the Novaya Zemlya Archipelago and west off Franz Josef Land, compared to 2015.

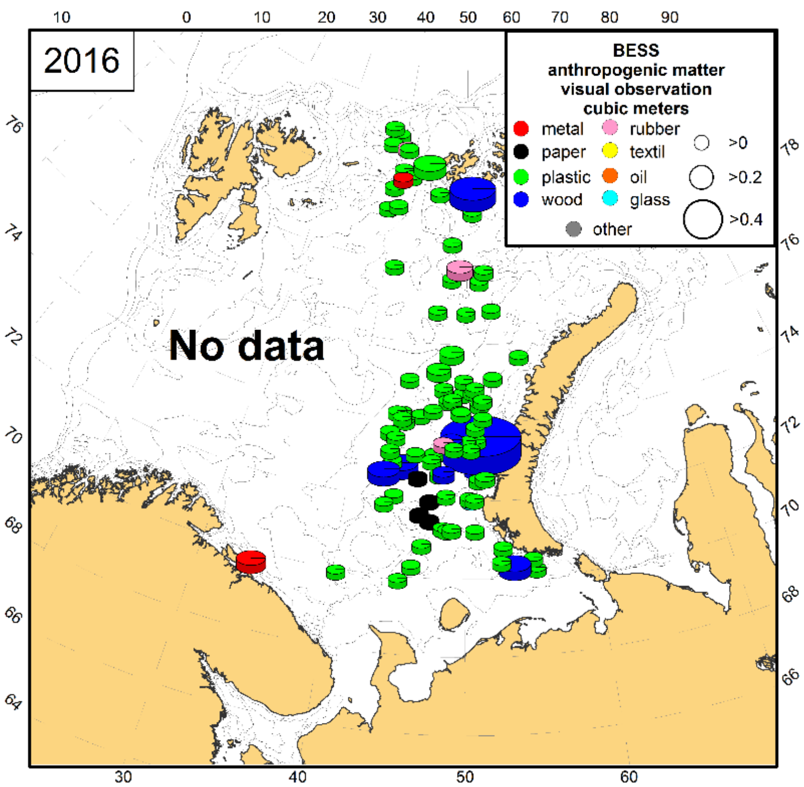


Figure 3.2.1 Type of observed anthropogenic matter (m^3) at the surface in the BESS 2016

In trawls, as in previous years, plastic dominated from all anthropogenic matter, both in pelagic and bottom trawls (Fig. 3.2.2-3.2.3). The number of registrations of anthropogenic matter in pelagic trawls was similar to what we observed in 2015, but weight of catched matter has been considerably lower. It was also observed the almost absence of anthropogenic matter in Russian zone. It could be due to using vessel "Frithjof Nansen" instead of "Vilnyus". This, probably slightly changed surface catchability of the trawl.

Plastic also dominated the litter content from the bottom trawls.. Only in shallow waters in the south-eastern part of the Barents Sea wood dominated the bicatch. Wood might be brought to the area by ocean currents from the eastern seas because of the timber-rafting from the Siberian rivers, as well as it might be lost from ships. In 2016 a decrease in number of trawls with anthropogenic matter have been observed, compared with 2015.

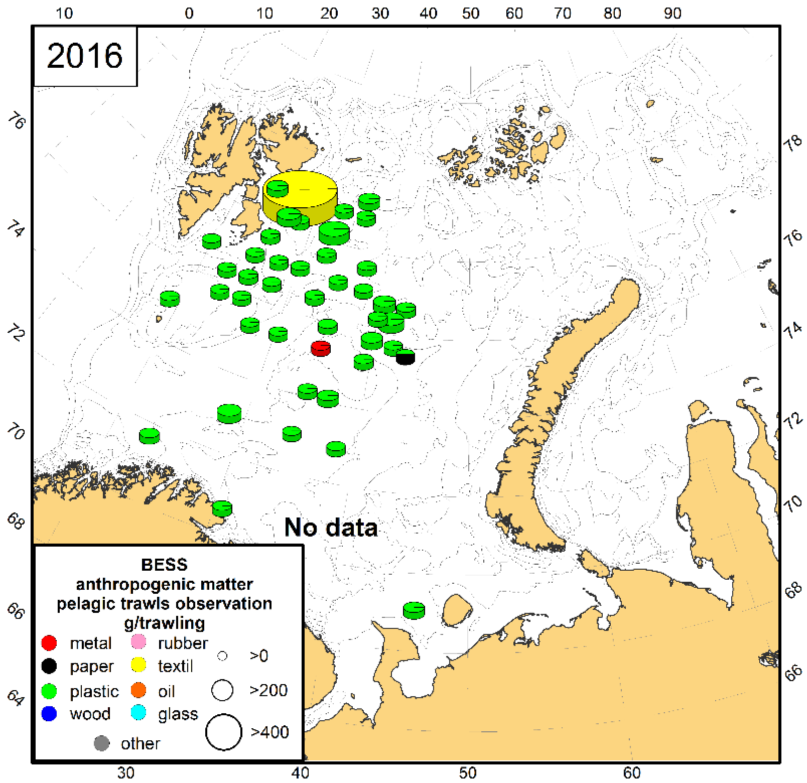


Figure 3.2.2 Type of litter collected in the pelagic trawls (g) in the BESS 2016

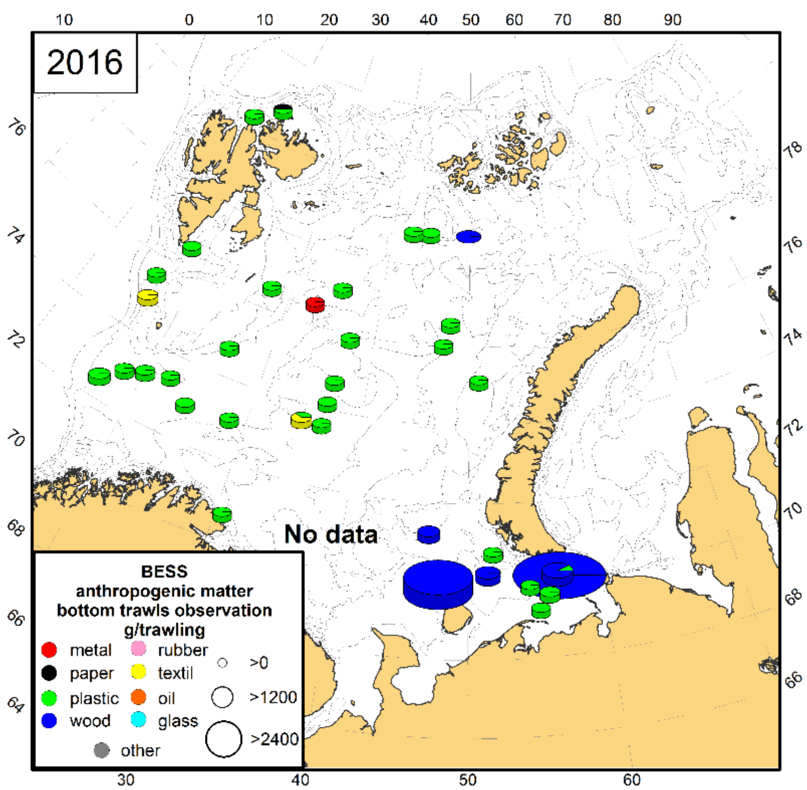


Figure 3.2.3 Type of litter collected in the bottom trawls (g) in the BESS 2016

4 MONITORING THE PLANKTON COMMUNITY

4.1 Phytoplankton, chlorophyll a and nutrients

By Stuart Larsen, Mona Ring Kleiven and Espen Bagøien

Phytoplankton samples for subsequent species and abundance analyses in the laboratory were collected from a total of 68 stations during the Norwegian part of the Barents Sea Ecosystem cruise in 2016. Phytoplankton samples of 100 ml were taken from CTD casts for the upper and lower photic zones. These comprised 4 samples each of 25 ml combined from 5, 10, 20, and 30 meters. At many of the stations, an additional 100 ml sample of seawater was collected from 50 metres depth. The samples were fixed with Lugol's solution. Of these, 20 samples representing mixed water from the upper 30m, were selected for species analyses by microscopy. These analyses were restricted to 20 samples due to constraints in laboratory capacity. However, if time permits, one or two additional samples collected north/northeast of Svalbard (marked in blue in Fig. 4.1.1), will also be analysed taxonomically. To date 15 samples have been analysed, and the rest are expected to be ready by early 2017.

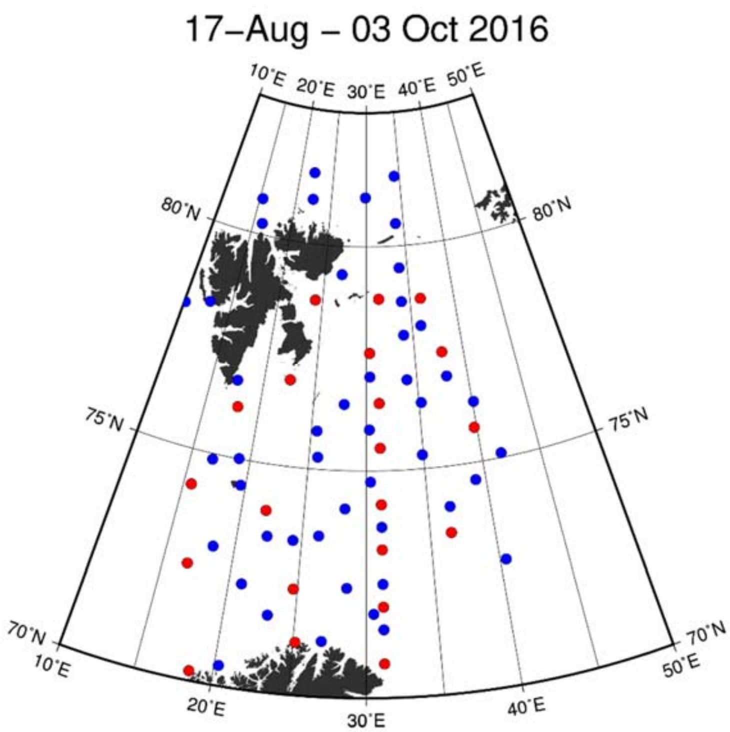


Figure 4.1.1. Stations where samples for phytoplankton species abundances and composition were collected during the Norwegian part of the Barents Sea Ecosystem cruise in 2016 (17. Aug – 3. Oct). Red points indicate the 20 stations selected for taxonomic analysis in the laboratory, while blue points indicate the remaining 48 locations where samples were taken, but not chosen for species analysis. Note that if time permits, one or two additional stations north/northeast of Svalbard, here marked with blue, will also be analysed for species abundances.

Nutrient and chlorophyll samples were as a rule collected from various predefined depths at all CTD stations where some type of plankton sampling was made (Fig. 4.1.2). This would roughly be about 160 stations in total, with each station comprising samples from various depths. The nutrient samples (20 ml) were preserved with chloroform (200 µl), and thereafter kept at about 4°C until subsequent chemical analysis on shore at IMR. The chlorophyll-samples were collected by filtering 263 ml of seawater through glass-fibre filters, which were then frozen at about -18°C until subsequent extraction of pigments in acetone and thereafter fluorometric analysis in the IMR laboratory on shore. Concentrations of nitrate, nitrite, silicate and phosphate, along with chlorophyll and phaeopigments, in all collected samples are now being analysed. The results are expected to be available by early 2017.

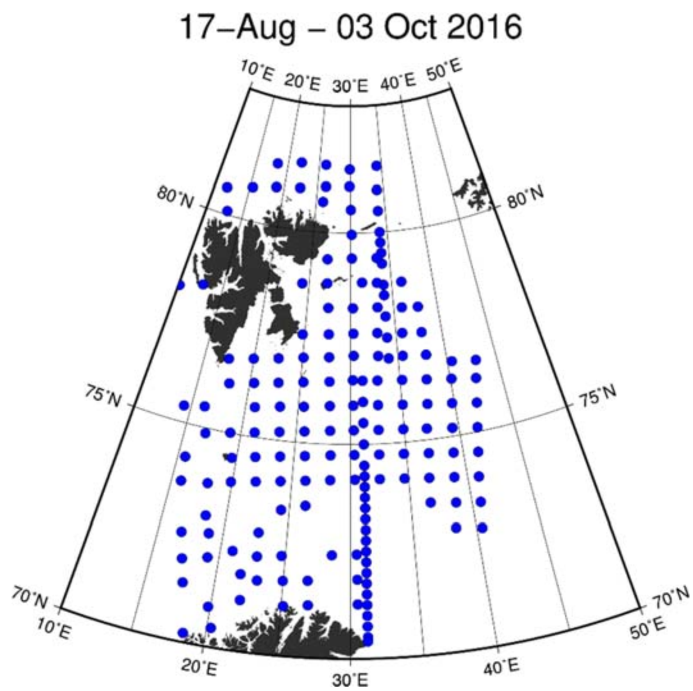


Figure 4.1.2. Stations where samples for chlorophyll and nutrients were collected during the Norwegian part of the Barents Sea Ecosystem cruise in 2016 during 17. Aug – 3. Oct.

4.2 Zooplankton

4.2.1 Mesozooplankton biomasses and spatial distributions

Text and figure by Espen Bagøien, Andrey Dolgov, Irina Prokopchuk, Tor Knutsen and Valentina Nesterova.

The total number of sampling stations for monitoring of mesozooplankton biomass in 2016 was 221, lower than in 2015 when 263 stations were sampled. The Norwegian part of the survey applied the WP2 net, and the Russian part the Juday net. Both gears used mesh-size 180 µm, and previous investigations have shown that the total zooplankton biomass sampled by the two gears are comparable.

The distribution of biomasses collected during BESS 2016 is shown in Figure 4.2.1.1.

The average biomass estimated for 2016 (6.6 g dry-weight m^{-2}, st.dev. 6.1) is not directly comparable with that for 2015 (7.3 g m^{-2}), since the area coverage differed for the two years. Challenges in covering “exactly” the same area across years is inherent in such large-scale monitoring. The biomass value here presented is the arithmetic average of all stations shown in Fig. 4.2.1.1. A main difference in the survey coverage in 2016 versus 2015 was that a region just north of the Russian Kola peninsula, between ca. 69-73 °N and 30-45 °E, could not be monitored in 2016 due to military activity. The coverage in the northernmost regions between Svalbard/Spitsbergen and Franz Josef Land, and just south of Franz Josef Land, were reduced in 2016 compared to 2015. Finally, an area off southwestern Svalbard was not sampled in 2016, as opposed to the previous year.

Despite somewhat differing spatial coverages, the general biomass distributions show similarities for 2016 and 2015, although some differences also appear. Both years, the highest biomasses (> 10 g m^{-2}) were located in the western and northern parts of the survey area, including northwest and north of Svalbard/Spitsbergen and south of Franz Josef Land. In addition, a sub-region towards the southwest (ca. 73-75 °N, 40-50 °E) displayed elevated levels both years. Comparatively lower biomasses (< 3 g m^{-2}) were typical on the Svalbard Bank (northeast of Bear Island), in the central Barents Sea, and easterly and south-easterly parts of the survey area both years.

The most obvious between-year difference was that the area between the southern tip of Svalbard and northern Norway, west of ca. 20 °E, showed reduced biomass levels in 2016 compared to in 2015. In 2016 the high-biomass “patch” (> 10 g m^{-2}) off northern Norway was limited to area the south of ca. 75 °N. The lack of sampling in the region just north of Kola, prevents evaluation of the easterly extent of this high-biomass patch.

Several factors may impact the levels of zooplankton biomasses in the Barents Sea, including;

- Supply of zooplankton by advection from the Norwegian Sea – mediated by ocean currents
- Local zooplankton production rates - which are linked to temperature, nutrient conditions and primary production rates
- Predation from carnivorous zooplankters (jellyfish, krill, hyperiids, chaetognaths, etc.)
- Predation from planktivorous fishes including capelin, young herring, polar cod, cod, saithe, haddock, redfish
- Predation from mammals and seabirds

The relationships between mesozooplankton biomasses and spatial distributions, and ecosystem components such as ocean currents, hydrography, and abundances/distributions of relevant predators will be evaluated in more detail in WGIBAR.

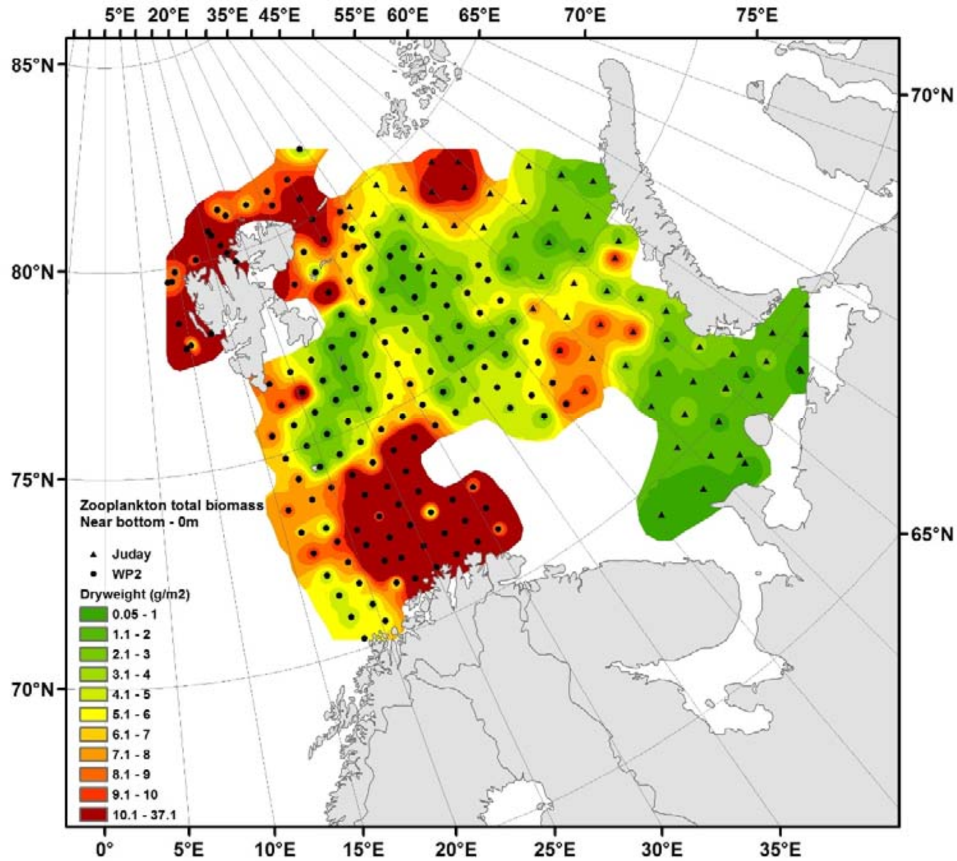


Figure 4.2.1.1. Distribution of total zooplankton biomass (g m^{-2}, dry-weight) in the near-bottom – 0 m layer during BESS 2016. The data visualized were collected by WP2-net (IMR) and Juday-net (PINRO), both with mesh-size 180 µm. Interpolation made in ArcGIS v.10.3, module Spatial Analyst, using the method of inverse data weighting (default settings).

4.2.2 *Calanus* species abundances and composition along the Fugløya-Bear Island transect

Text by Espen Bagøien and Padmini Dalpadado

Data-preparation and figures by Jon Rønning

The Fugløya – Bear Island transect, with sampling stations located at fixed positions, crosses the western entrance to the Barents Sea. Since 1995 the number of annual transect coverages per year has been 5-6, except for 4 and 3 coverages in 2012 and 2013, respectively. Five to eight stations are normally sampled per coverage, depending on weather conditions. In this report, four stations representing different water masses (Coastal Water, Atlantic Water, and mixed Atlantic/Arctic waters), from all coverages during 1995-2016, have been analyzed with respect to composition of the three most abundant *Calanus* species; *C. finmarchicus*, *C. glacialis* and *C. hyperboreus*. All copepodite stages are included in these analyses. In addition, we have examined the proportions of *C. finmarchicus* versus *C. helgolandicus* (stage V and adults) in the samples.

C. helgolandicus is quite similar in appearance to *C. finmarchicus*, but is a more southerly species with a different seasonal spawning period. *C. helgolandicus* has in recent years become more frequent in the North Sea and southern parts of the Norwegian Sea (e.g. the Svinøy transect), and it is expected that its abundance might increase in the western part of the Barents Sea in the years to come. Results so far show 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).

Although the abundance of *C. finmarchicus* displays inter-annual variability, a comparison of four aggregated groups of years shows rather stable values, with the latest period (2013-2016) displaying a slight increase (Table 4.2.2.1, Figure 4.2.2.1). The highest abundances of *C. finmarchicus* were recorded in 2010 over the whole transect except for the northernmost location at 74º00'N, where the abundance was considerably lower, as well as for the second northernmost station in 2015 which was slightly higher than the same station in 2010 (Figure 4.2.2.2). On average over all years since 2004, the location at 73º30'N shows the highest number of *C. finmarchicus*.

As expected, *C. glacialis* is generally most abundant at the two northernmost stations, which typically represent of a mixture of Atlantic and Arctic waters. The highest annual average abundance per station (ca 15 000 ind. m^{-2}) was observed for 1997 for the station at 73.30 °N (not shown). The abundance of *C. glacialis* seems to have decreased during the period 2006- 2014, with a very low abundance recorded in 2008, and during 2012-2014. However, the registered abundances were much higher again in 2015 and 2016 (Table 4.2.2.1, Figure 4.2.2.1). Low and rather similar average abundances of *C. glacialis* were calculated for the 3 aggregated periods 2013-2016, 2007-2012 and 2001-2006 (~ 370 - 520 ind. m^{-2}, Table 4.2.2.1). In contrast, a much higher average abundance of this species (ca. 1 900 ind. m^{-2}) was calculated for the early period 1995-2000.

The abundance of the larger species *C. hyperboreus* along the FB section has been low during all periods (Table 4.2.2.1, Figure 4.3.2.1) The highest average abundance (~180 ind. m^{-2}) for this species was found for the period 2001-2006.

Table 4.2.2.1. Average copepodite abundance of the 3 *Calanus* species (ind. m^{-2}) during 4 different periods from 1995 to 2016. These averages are based on the annual averages for all stations and all coverages, and are visualized in Figure 4.2.2.1.

Period	*C. finmarchicus*	*C. glacialis*	*C. hyperboreus*
1995-2000	27234	1877	108
2001-2006	20518	517	179
2007-2012	36201	407	49
2013-2016	43935	366	67

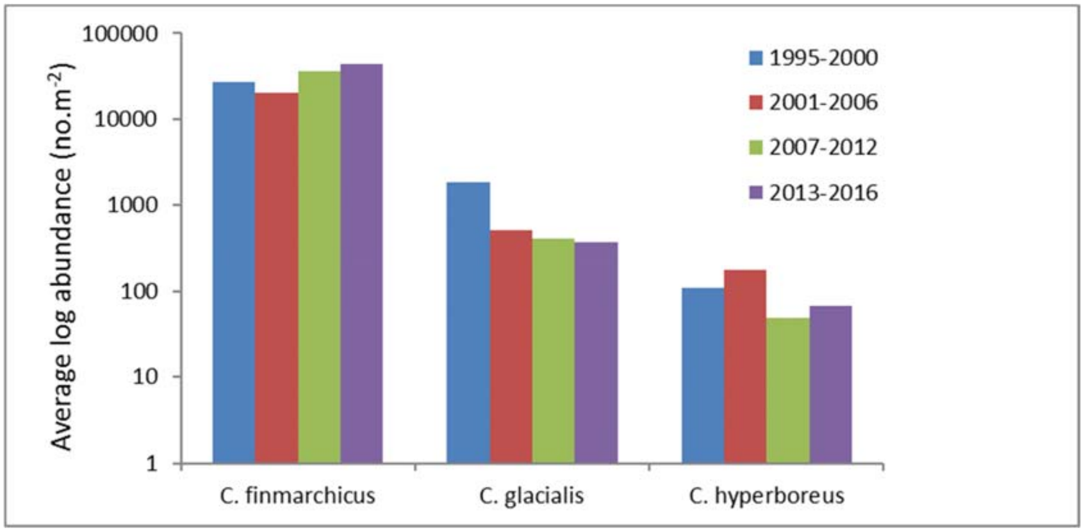


Figure 4.2.2.1. Abundance of *Calanus* species along the FB section during four periods: 1995-2000, 2001-2006, 2007-2012 and 2013-2016. All 4 stations and all coverages are included in the calculations. Note that the y-axis is on $\log_{10}$-scale.

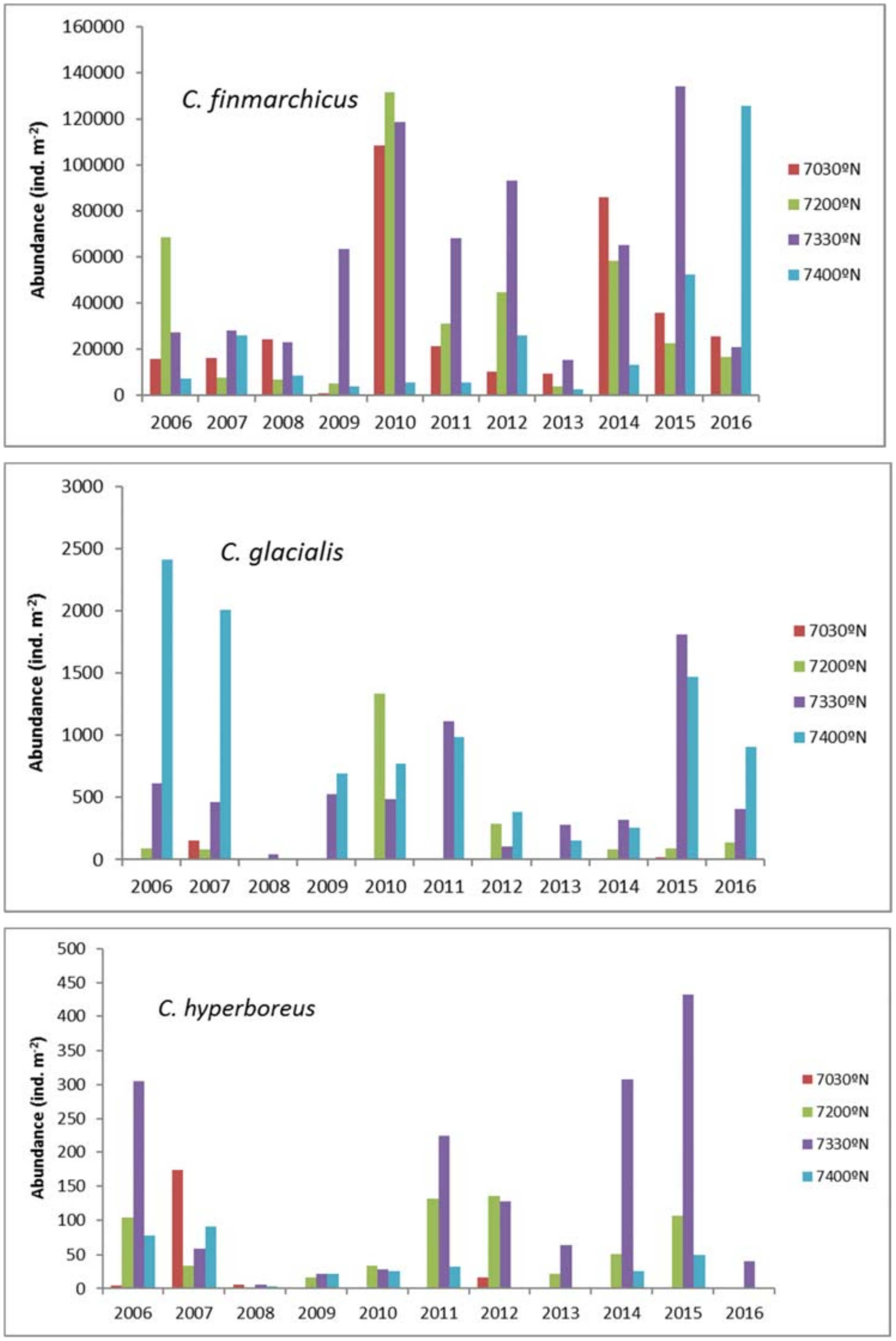


Figure 4.2.2.2. Copepodite abundances for 3 *Calanus* species along the FB section during the period 2006 - 2015. On a few occasions, when a target station was lacking, the nearest available station that was sampled was analysed and used in this study. The bars represent the annual averages of the 5-6 coverages per year (except for 4 and 3 coverages in 2012 and 2013, respectively), with each colour representing a particular station.

4.2.3 Biomass indices and distribution of krill and amphipods

by E. Eriksen, P. Dalpadado. T. Prokhorova and A. Dolgov

Figure by E. Eriksen

In 2016, the krill and amphipods taken by standard pelagic trawl were identified to species level at 88 % of all stations. Some part of the southern Barents Sea was not covered and west, north and northeast of Svalbard/Spitsbergen, covered by "H. Hanssen" one month later than the main area (more information see in "1. Background"). For krill and amphipods, we chose to include the "H. Hanssen" data in the estimation despite the non-synoptical coverage. This is because this area is included as a standard, and further since these groups perform dial vertical migrations, and therefore are assumed to be less affected by horizontal transport by upper currents than fish larvae.

Euphausiids

In 2016, krill were widely distributed in the Barents Sea (Figure 4.2.3.1). The biomass values expressed in the report are in g wet wt. m^{-2}. In 2013, the highest catches were mostly distributed in the central area, in 2014, in the western area, in 2015, in the south and southeast of Svalbard/Spitsbergen, while in 2016, widely. The night catches in 2016, (mean 13.48 gram per m^2), were higher than long term mean (7.49 gram per m^2) and slightly lower than in 2015 (14.22 gram per m^2).

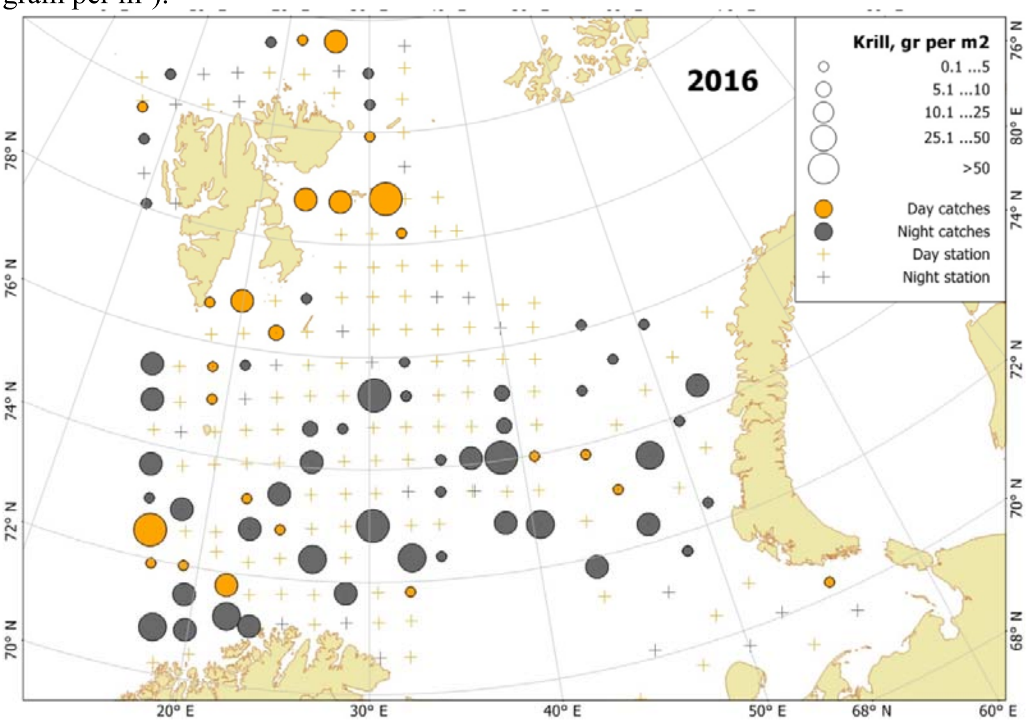


Figure 4.2.3.1. Krill distribution, based on pelagic trawl stations covering the upper water layers (0-60 m), in the Barents Sea in August-October 2016.

The number of the night stations in 2016 was approximately half of the day stations during the survey (Table 4.2.3.1). During the night, most of krill migrate to upper water layer for feeding, and therefore it is more available for the trawl. Higher catches (more than 50 grams per m^2) were observed in the western, central and east of Svalbard/Spitsbergen areas.

Based on the euphausiid species identification in 2016, *Meganyctiphanes norvegica* and *Thysanoessa inermis* were widely observed in the Barents Sea, while *Thysanoessa longicaudata* were mostly observed in the western and *Thysanoessa raschii* in the eastern areas (Figure 4.3.3.2).

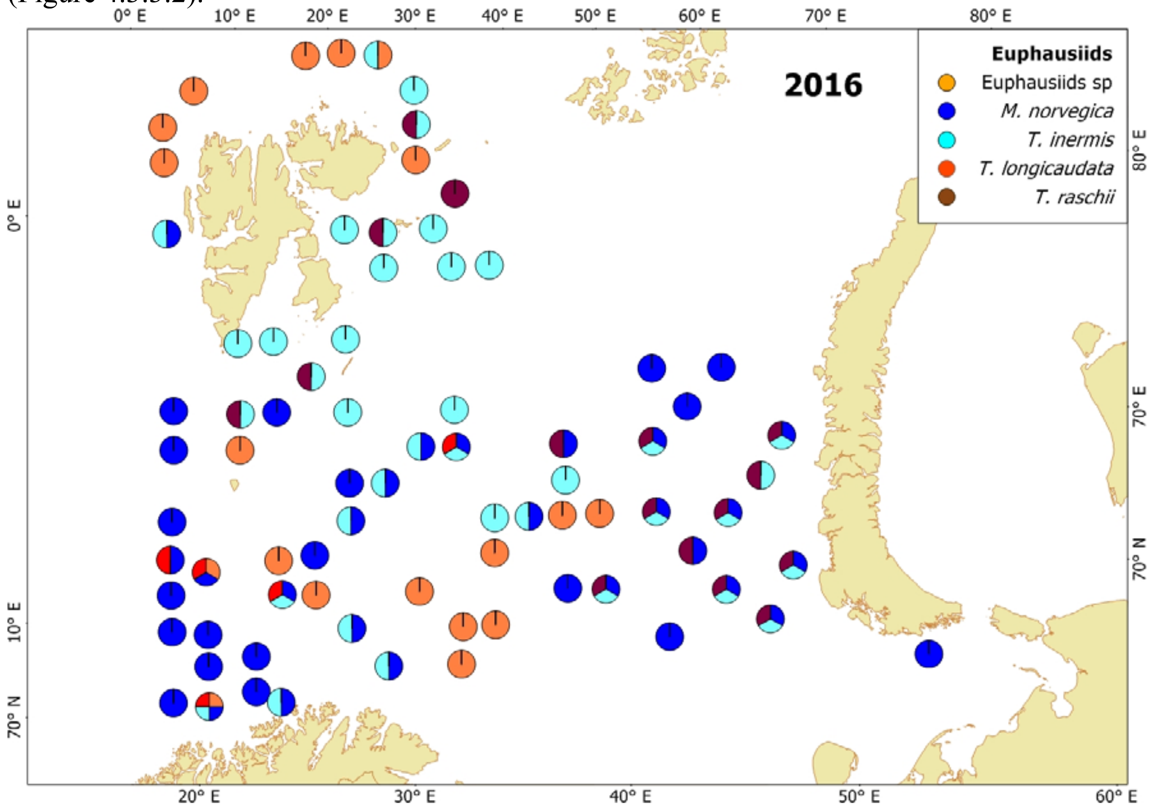


Figure 4.2.3.2. Krill species distributions, based on trawl stations both day and night, covering the upper water layers (0-60 m), in the Barents Sea in August-October 2016. The proportions are based on wet weights.

Table 4.2.3.1. Day and night total catches (gram per m^2) of krill taken by the pelagic trawl in the upper water layers (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
2015	199	9.70	54.43	97	14.22	44.61
2016	122	16.56	54.81	78	13.48	19.66
1980-2015	215	2.34		94	7.49	

In 2016, the total biomass of krill was estimated as 12.7 million tonnes wet wt. It is much lower than in 2015 and higher than long term mean (8.8 million tonnes) and rather high even after the heavy feeding summer season.

Amphipods (mainly Hyperiids)

In 2016, amphipods were found in the northern Barents Sea (Figure 4.2.3.3). In 2012 and 2013 no amphipods were observed in pelagic catches, while in 2014 some restricted catches were taken north for Svalbard/Spitsbergen and in 2015 several high catches were taken east of Svalbard/Spitsbergen.

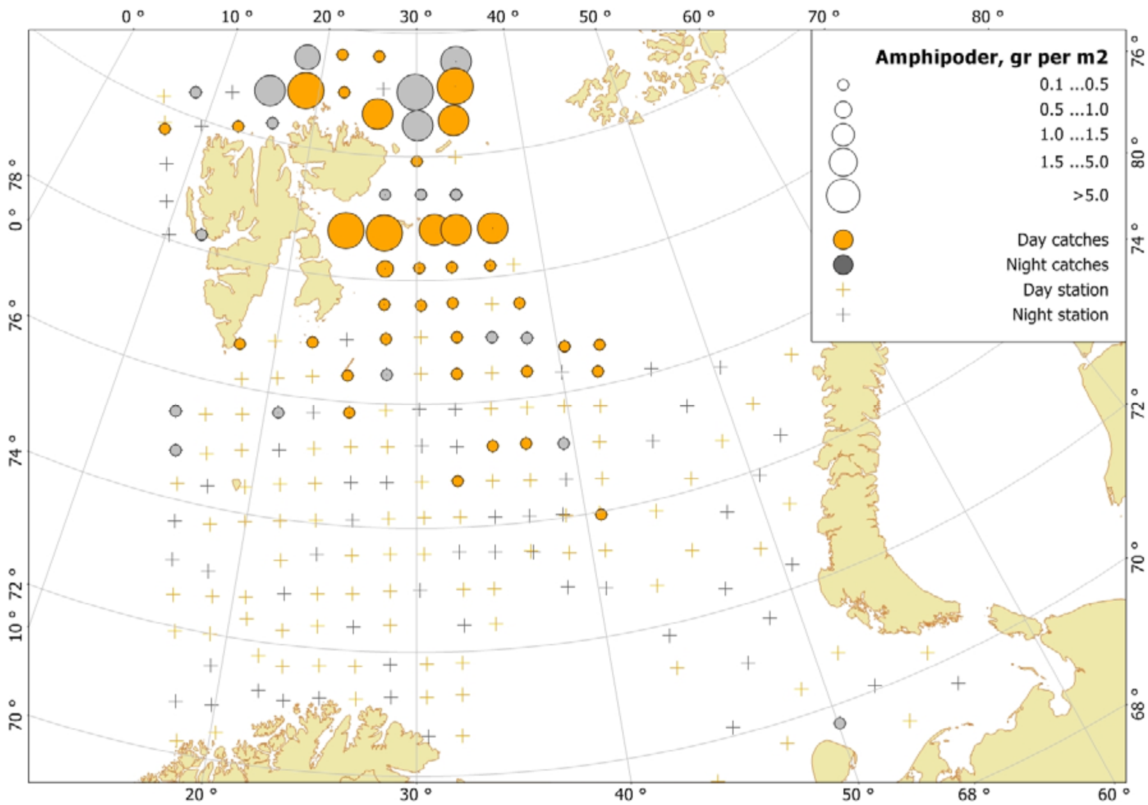


Figure 4.2.3.3. Amphipods distribution, based on trawl stations covering the upper water layers (0-60 m), in the Barents Sea in August-October 2016.

In 2016, the highest catches were taken north and east of Svalbard/Spitsbergen, and were mostly represented by the Arctic *Themisto libellula* (Figures 4.2.3.3 and 4.2.3.4). In 2016, the mean catches taken during the day were higher than night catches, and were 2.1 and 0.6 gram per m^2. In 2016, the estimated biomass of amphipods was 615 thousand tonnes for the covered area, that was slightly higher than in 2015. In addition to Themisto sp, low catches of *Hyperia galba*, which is biologically associated with jellyfish, were found in the northern part of the central area, where jellyfish were abundant (Figure 4.2.3.4). Other hyperiids (from genus Hiperia and Hyperoche) also occurred and dominated in some catches, but their abundance was very low.

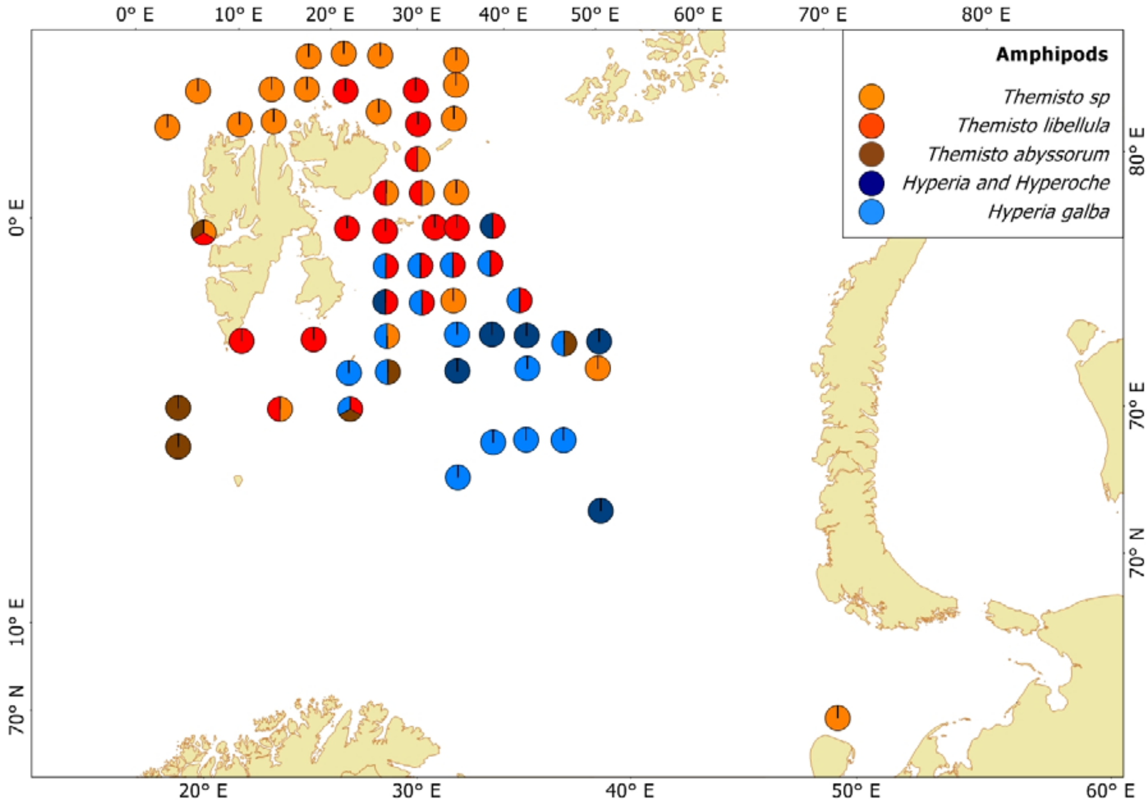


Figure 4.2.3.4. Proportions of amphipod species, based on trawl stations both day and night, covering the upper water layers (0-60 m) in the Barents Sea in August-September 2016. For abundances see Figure 4.3.3.3.

4.2.4. Biomass indices and distribution of jellyfish

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

Estimates on distribution and abundances (biomass) of gelatinous zooplankton, are based on records from the standard pelagic trawl, 0-60 m depth. Gelatinous zooplankton was sorted from all trawl catches, identified to lowest taxonomic level possible and recorded as total wet weight per taxon.

In August-September 2016, lion's mane jellyfish (*Cyanea capillata*; Scyphozoa) was the most common jellyfish species, both with respect to weight and occurrence (average catch of 21.9 kg per nmi), widely distributed in the entire survey area (Figure 4.2.4.1). The biomass values per station were generally lower than in 2015, and ranged between 6 and 56 000 kg per sq nmi. The proportion of stations with high biomass (> 10 000 kg per sq nmi) was slightly lower in 2016 (20% of total number of stations) than in 2015 (24% of total number of stations).

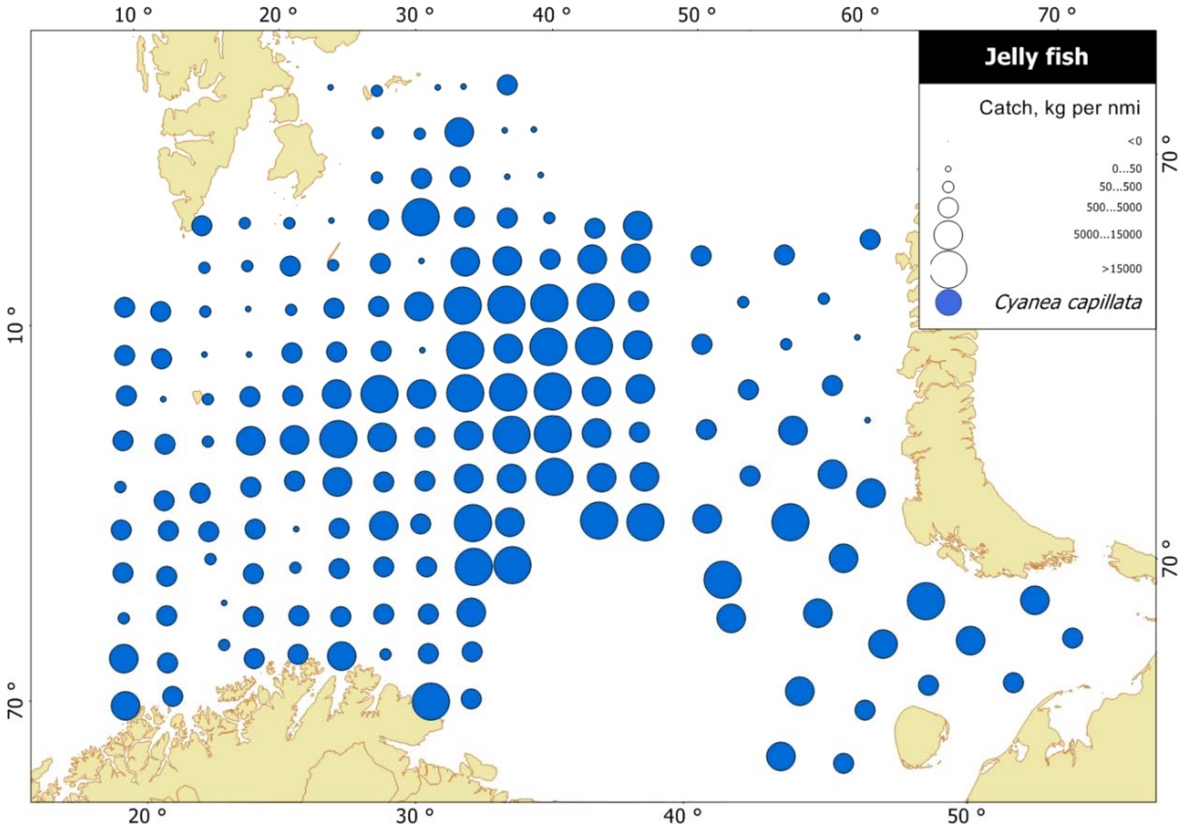


Figure 4.2.4.1. Distribution of *Cyanea capillata* (wet weight; kg per sq nmi) in the Barents Sea, August-October 2016. Catches both day and night from standard pelagic trawl 0-60 m depth.

The horizontal distribution of *C. capillata* was similar to previous years (2014 and 2015), with highest biomass concentrations in the central and southeastern area (> 15 tonnes per sq nmi). Similar to previous years, low abundances were recorded in the westernmost area between Norway and Svalbard (< 50 kg per sq nmi).

The moon jellyfish (*Aurelia aurita*; Scyphozoa*)* was the second most abundant jellyfish species by total weight (with average catch of 1.2 kg per nmi) in August-October 2016, mainly distributed in the southern part of the survey area, associated with warm and low salinity coastal waters (Figure 4.2.4.2). The highest abundances (4000-14850 kg per sq nm) were recorded along the Norwegian coast and south of Novaya Zemlya.

The whitecross jellyfish (*Staurostoma mertensii*; Hydrozoa) is a common arctic species. In August-October 2016, this species was distributed in the northern and southeastern part of the survey area, with maximum abundances in the central Barents Sea (Figure 4.2.4.2). The average catch of 0.6 kg per nmi.

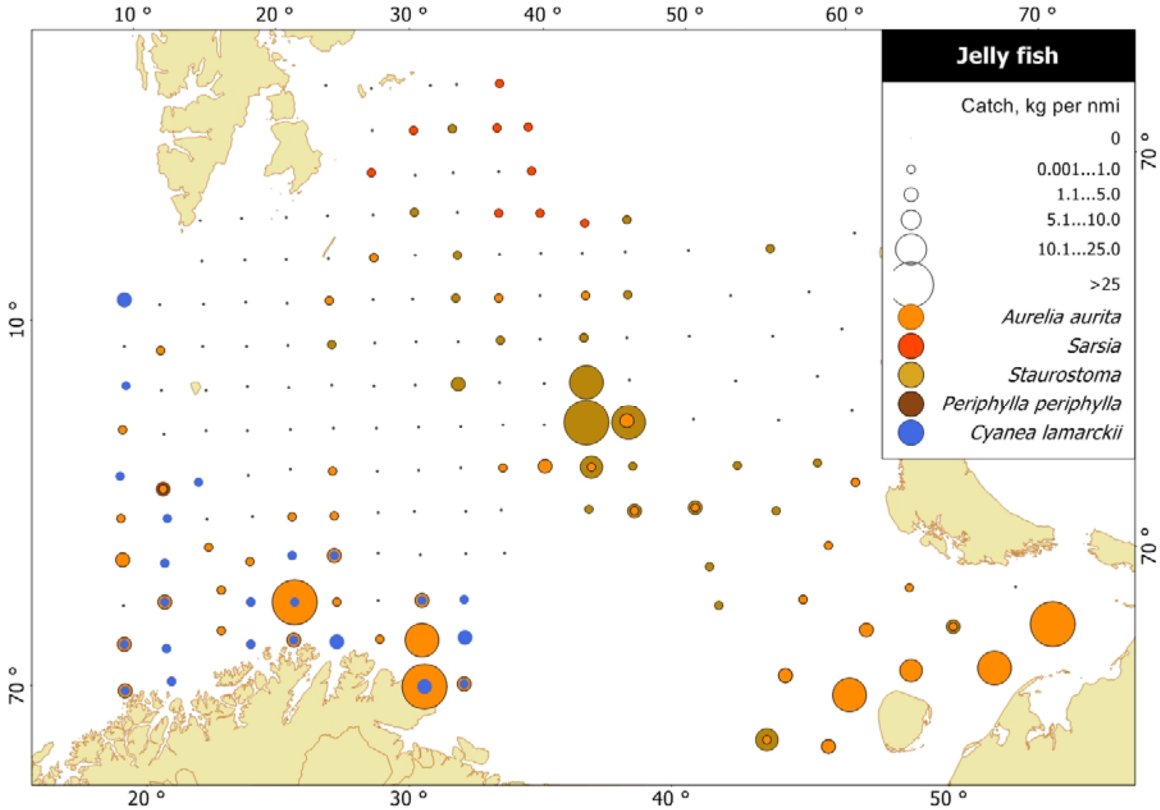


Figure 4.2.4.2. Distribution of five taxa of gelatinous plankton (wet weight; kg per sq nmi) in the Barents Sea, August-October 2016. Catches both day and night from standard pelagic trawl 0-60 m depth.

The blue stinging jellyfish (*Cyanea lamarckii*; Scyphozoa) is considered to be a more temperate species than *C. capillata*, but in recent years this species has increased its distributional range northward. The first and northernmost observation of *C. capillata* in the Barents Sea was observed on the BESS in autumn 2014. In 2016 the species had a wider geographical distribution compared to previous years (Figure 4.3.4.2), with records from 32 stations in the western area (75°24’N; 14°22’E to 71°49’N; 32°22’E), with average catch of 0.1 kg per nmi. To our knowledge this is the easternmost record of *C. capillata* in the Barent Sea. It is believed that, *C. lamarckii* is not able to reproduce in the Barents Sea, and the presence of this warm-temperate species may be linked to the inflow of Atlantic Water.

Single specimens of helmet jelly *Periphylla periphylla* were caught on three stations between 71° 46' - 75° 24' N and 14° 22' -21°46' E with average catch of 0.03 kg per nmi (Figure 4.2.4.2). Both the abundance and area of distribution was less in 2016 compared to previous year.

The small hydromedusae *Sarsia* sp was recorded in trawl catches (with average catch of 0.004 kg per nmi) north of the polar front (Figure 4.2.4.2).

Long-term trend

The estimated total biomass of *C. capillata* in upper water layers (0-60 m) of the Barents Sea in August-October 2016 was 1.6 million tonnes (Figure 4.2.4.3). This is less than in 2015 (2.5 million tonnes), and close to the long term mean 2011-2015 (1.2 million tonnes). The interannual variation in total biomass of gelatinous zooplankton, (dominated by *C. capillata*) estimated from the Barents Sea Ecosystem cruises 1980-2016 is considerable, with high peaks in 2001 and 2014 (5 million tonnes) and minimum low in 1997 (0.02 million tonnes). During the last 6 years (2011-2016) the estimated total biomass of jellyfish has been above the long term mean, but has decreased since 2014.

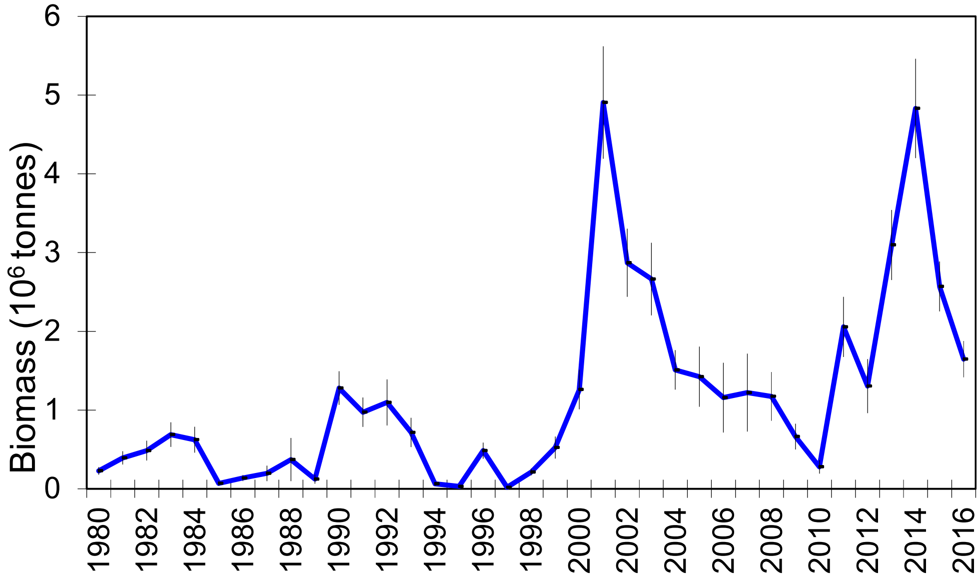


Figure 4.2.4.3. Estimated total biomass of the jellyfish *C. capillata* in the survey area of BESS August-September 1980-2016. 95% confidence interval indicated by grey line. Catches from Harstad trawl 0-60 m depth.

Trawling is a harsh sampling method for gelatinous zooplankton, and the data presented here should be considered as semi-quantitative data. The trawl does not sample the entire water column, the filtered volume of water is not known, and small and fragile species will pass through the meshes of the trawl or get destroyed in the cod-end. The Harstad trawl probably have a higher catchability for large, robust scyphozoans (*P. periphylla, C. capillata*), than for the smaller *Aurelia aurita*, and even lower for fragile taxa such as ctenophores and small medusa. Nevertheless, we consider that the error in catchability is constant for each taxon, enabling taxon specific comparisons between years and between stations.

4.2.5 Sampling of macroplankton by use of the Macroplankton trawl

by Georg Skaret, Thor Klevjer and Espen Bagøien

During the Barents Sea Ecosystem cruise in Aug-Sep 2016, the Macroplankton-trawl (Melle et al. 2006) was employed *ad hoc* on 6 occasions from the vessel "Eros". The Macroplankton-trawl is developed specifically for quantitative sampling of macroplankton. It has a mouth-opening area of ca. 36 m^2, and a square mesh-size of 3x3 mm throughout the trawl from mouth-opening to cod-end. The sole purpose of applying the Macroplankton-trawl during the cruise was to sample targeted acoustic scattering layers (registrations) suspected to represent macrozooplankton. The objective was to identify the sound-scattering organisms and to establish their size-distributions. Since this particular trawling only targeted acoustic registrations, the values presented in the tables and figures below are not valid for estimating abundances in the water-column as a whole, nor generalizable. Also the Harstad trawl was applied on several occasions to identify the sound scattering organisms within targeted echo-layers assumed to represent macrozooplankton. However, this chapter is dedicated to presenting the results obtained with the Macroplankton trawl. This is to be considered a first step towards building a library comprising the acoustic properties of sound scattering layers formed by macroplankton along with corresponding data collected by the Macroplankton-trawl within such layers during the Barents Sea Ecosystem cruises. Hopefully such a library will in in due time enable an improved assessment of macroplankton abundances and distributions in the Barents Sea.

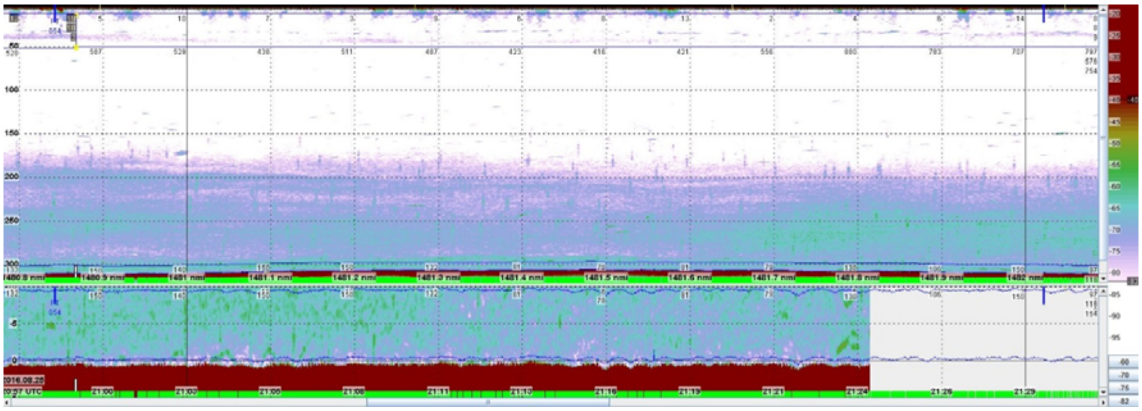
Table 4.2.5.1. Concentrations of main zooplankton groups (wet-weight, g per m^3). All Macroplankton trawls performed from "Eros". Depth refers to target depth during trawling.

Station	Date / Time	Lat	Lon	Depth	Biomass-density	Krill	Amphipods	Fish	Jellies	Other
76	2016-08-29 22:03:00	77.03698	34.91002	100	0.006	0.000	0.000	0.000	0.006	0.000
86	2016-08-31 08:33:00	76.35627	22.97552	30	0.068	0.000	0.000	0.003	0.065	0.000
96	2016-09-02 08:50:00	75.68557	42.73377	270	0.122	0.102	0.001	0.007	0.013	0.000
106	2016-09-04 06:57:00	75.89340	27.78977	190	0.124	0.023	0.000	0.003	0.098	0.000
109	2016-09-04 15:53:00	75.83273	24.82118	90	0.015	0.000	0.000	0.003	0.010	0.001
112	2016-09-05 09:12:00	76.82018	19.75813	80	0.108	0.097	0.000	0.006	0.004	0.000

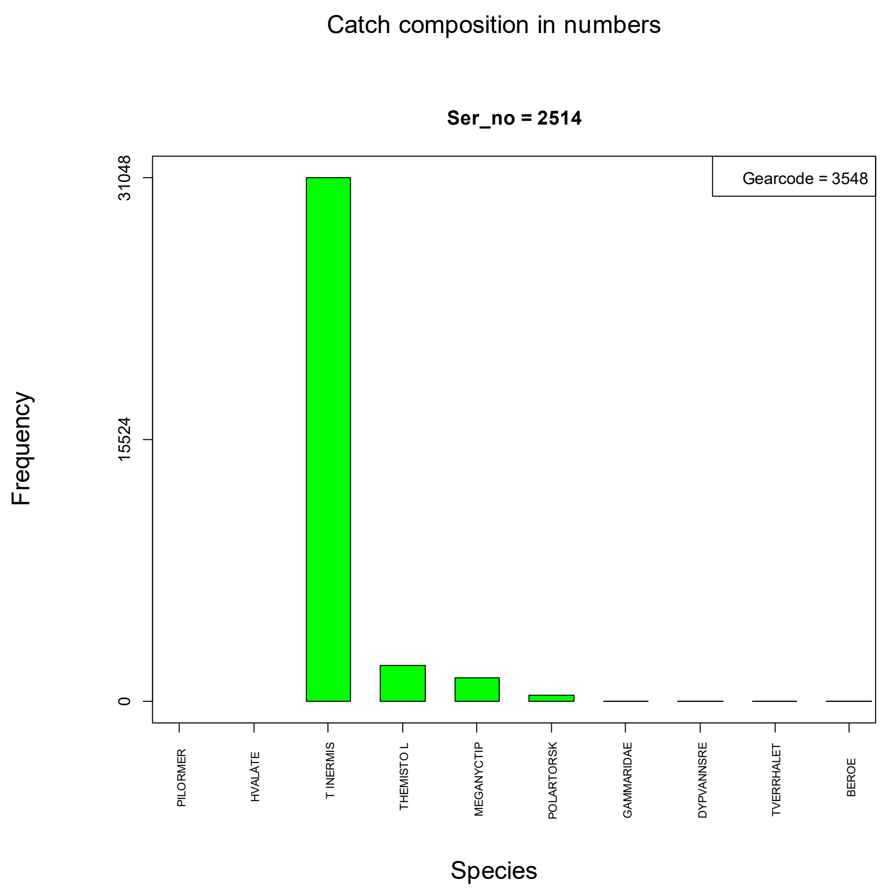
Table 4.2.5.2. Proportions (%) of total catch per main zooplankton group. All Macroplankton trawls performed from "Eros". Depth refers to target depth during trawling.

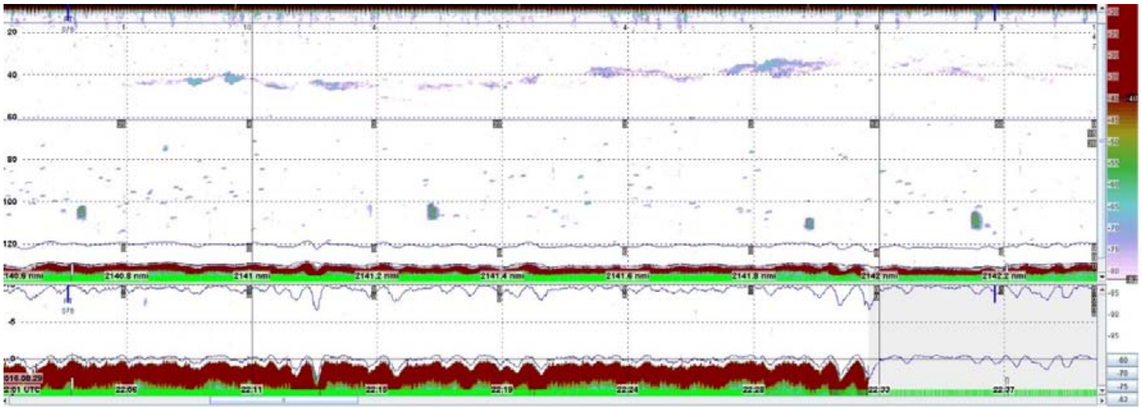
Station	Date / Time	Lat	Lon	Depth	Krill	Amphipods	Fish	Jellies	Other
76	2016-08-29 22:03:00	77.03698	34.91002	100	0	0	7	92	0
86	2016-08-31 08:33:00	76.35627	22.97552	30	0	0	4	96	0
96	2016-09-02 08:50:00	75.68557	42.73377	270	84	1	5	10	0
106	2016-09-04 06:57:00	75.89340	27.78977	190	19	0	2	79	0
109	2016-09-04 15:53:00	75.83273	24.82118	90	1	0	23	68	7
112	2016-09-05 09:12:00	76.82018	19.75813	80	90	0	6	4	0

Below we present some selected examples of the echograms and the size-distributions of the organisms in the corresponding catches from the Macroplankton-trawls.



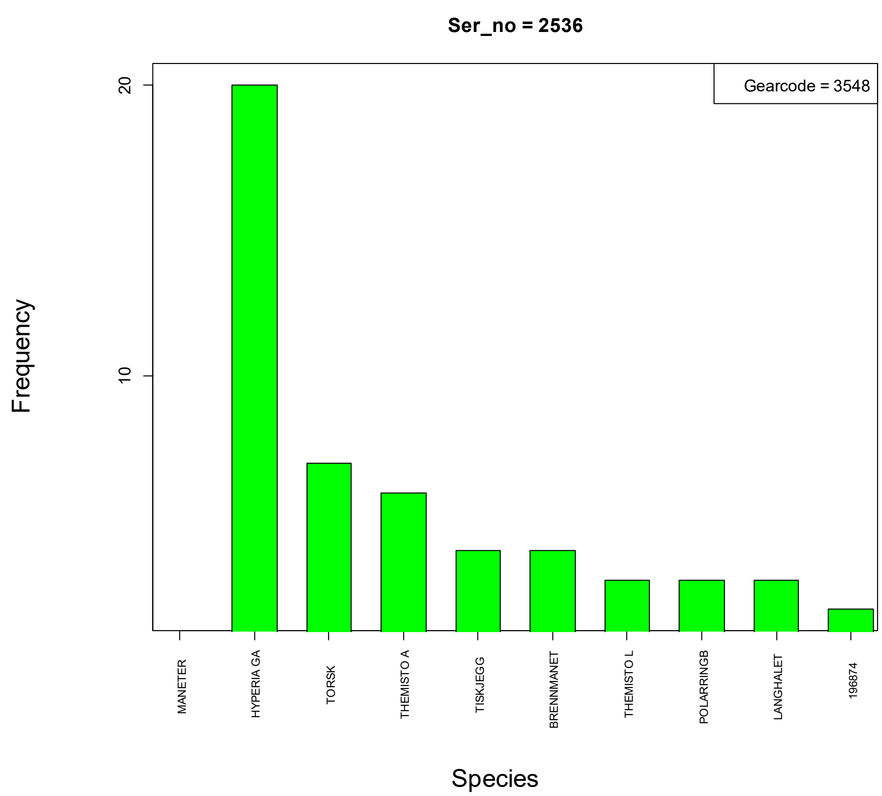
Ser_no 2514. Trawling on a scattering layer at depth of 300-310 m. 120 kHz echogram

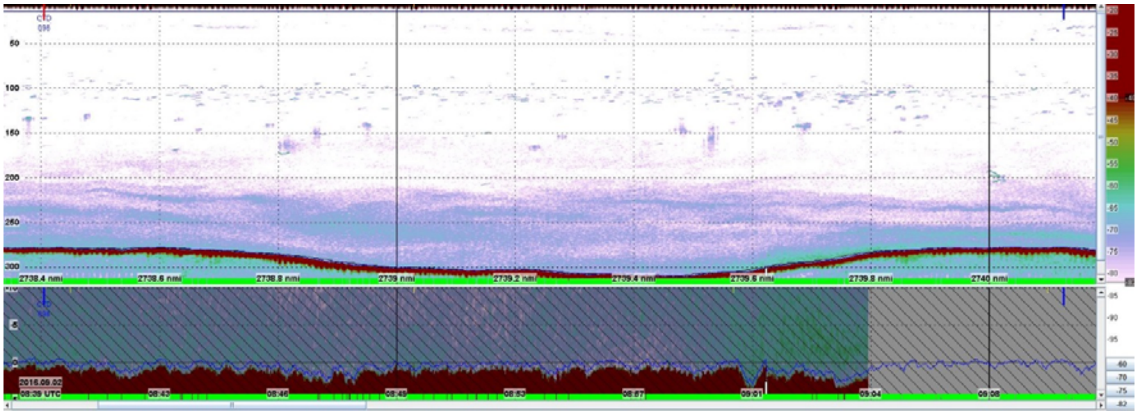




Ser_no 2536. Trawling on what appears to be patches of krill at depth of 100 m. 120 kHz echogram

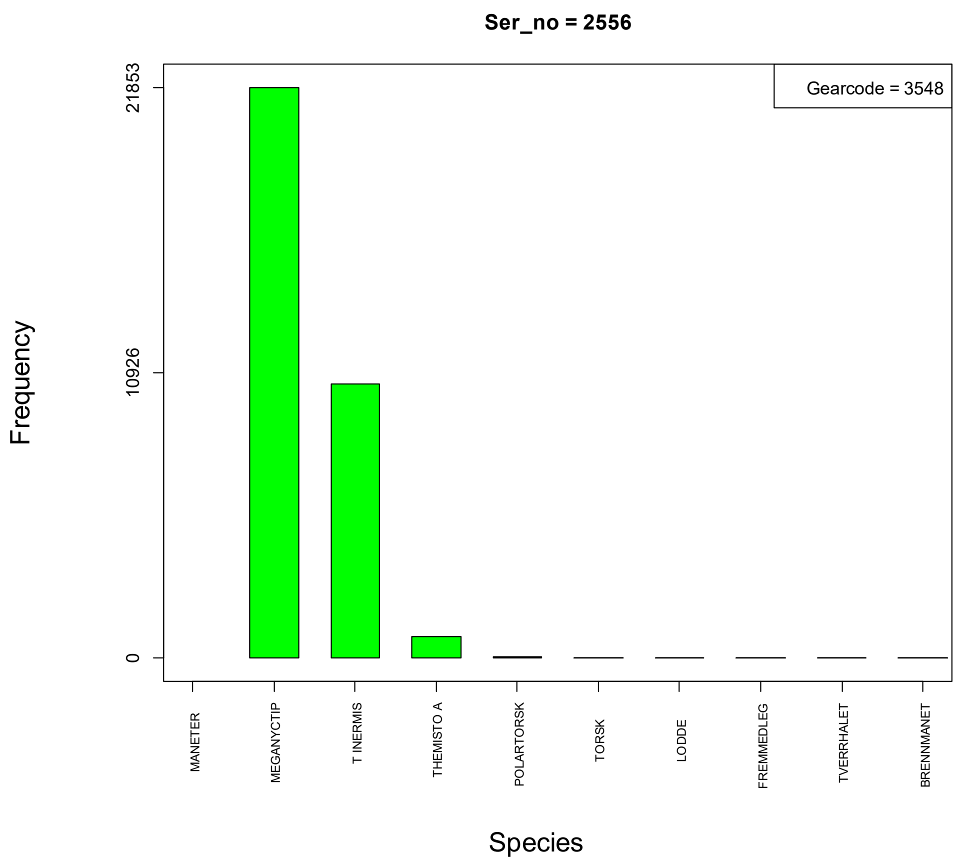
Catch composition in numbers





Ser_no 2556. Trawling on scattering layer at depth of 260-270 m. 120 kHz echogram

Catch composition in numbers



Reference:

Melle, W., Abrahamsen, M., Valdemarsen, J.W., Ellertsen, B., Knutsen, T. (2006). Design and performance of a new macro-plankton trawl in combination with a multiple cod-end system. SCOR Working Group 115, Mini Symposium on Standards for the Survey and Analysis of Plankton. Plymouth, England. 19-20 May 2006.

5 MONITORING THE PELAGIC FISH COMMUNITY

5.1 Fish recruitment, fish distribution ad abundance/biomass indices

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

Figures by E. Eriksen

The timing and coverage BESS 2016 was not optimal. Timing of "H. Hanssen" was not sufficient and caused not synoptic (one-month lag) coverage of the area west and north off the Svalbard/ Spitsbergen Archipelago. An area in the southern Barents Sea was not covered by the survey due to military exercises. The not synoptic coverage and lack of area coverage will impact the survey results and t distribution and abundance/biomass indices for some species (redfish, herring, Greenland halibut, polar cod) should be interpreted as minimum and not directly comparable with the results from earlier surveys.

The 2016-year class of capelin and sandeel was estimated as a strong. The 2016-year class of herring, haddock and long rough dab are close to the long term mean level. Poor year classes of cod, saithe, redfish, Greenland halibut and polar cod were observed. Abundance indices calculated for nine 0-group commercial fish species from 1980-2016 are shown in Tables 5.1.1 and 5.1.2.

The total biomass of the six most abundant 0-group fish (cod, haddock, herring, capelin, redfish and polar cod) was 1.9 million tonnes in August-September, which is close to long term mean of 1.8 million tonnes. Most of the biomass distributes in the central and north-central part of the Barents Sea. Biomass indices calculated for six 0-group fish species from 1993-2015 are shown in Table 5.1.3.

Length frequency distributions of the main species are given in Table 5.1.4. The survey started in the north with the coverage of capelin in 2016. It means that the northern and the northern part of the central areas were covered approximately one month earlier than usually. Despite early coverage, the length of most 0-group fish (capelin, cod, haddock, herring, saithe, redfish) were higher than the long term mean (1980-2016), even in the northern and central parts. Such length may indicate good living and feeding conditions for most of 0-group fish in 2016.

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 1980-2016.

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	0	0	128715
2013	94673	28224	161122	90108	62788	117428	7235	4721	9749	70972	8393	133550	928	310	1547
2014	48933	5599	92267	102977	72975	132980	4185	2217	6153	16674	5671	27677	77658	35010	120306
2015	147961	87971	207951	8744	3008	14479	6005	2816	9194	11207	0	25819	101653	40258	163048
2016	274050	157185	390915	16872	9942	23801	4029	1952	6107	32956	15793	50119	12941	1713	24168
Mean	94079			29224			4314			28491			59177		
Median	57390			16872			1706			18916			16092		

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
2015	47	0	101	27	2	52	575	361	789	128	18	237	6074	2001	10146
2016	3	0	7	6	1	12	601	0	1267	258	0	624	1180	128	2231
Mean	162			27			526			31208			8035		
Median	53			14			200			11211			4634		

Table 5.1.2. 0-group abundance indices (in millions) with 5% confidence limits, corrected for capture efficiency. LTM- long term mean of 1980-2016.

	Capelin			Cod			Haddock			Herring			Saithe			Polar cod (east)			Polar cod (west)			Polar cod Tot
Year	Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index	Confidence limit		Abundance index
1980	740289	495187	985391	276	131	421	265	169	361	77	12	142	21	0	47	203226	69898	336554	82871	0	176632	286097
1981	477260	273493	681026	289	201	377	75	34	117	37	0	86	0	0	0	4882	1842	7922	46155	17810	74500	51037
1982	599596	145299	1053893	3480	2540	4421	2927	2200	3655	2519	0	5992	296	0	699	1443	154	2731	10565	0	29314	12008
1983	340200	191122	489278	19299	9538	29061	6217	3978	8456	195446	69415	321477	562	211	912	1246	0	2501	87272	0	190005	88518
1984	275233	161408	389057	24326	14489	34164	5512	3981	7043	27354	3425	51284	2577	725	4430	871	0	2118	26316	6097	46534	27187
1985	63771	5893	121648	66630	32914	100346	2457	1520	3393	20081	3933	36228	30	7	53	143257	39633	246881	6670	0	13613	149927
1986	41814	642	82986	10509	7719	13299	2579	1621	3537	93	27	160	4	0	9	102869	16336	189403	18644	125	37164	121513
1987	4032	1458	6607	1035	504	1565	708	432	984	49	0	111	4	0	10	64171	0	144389	631	265	996	64802
1988	65127	12101	118153	2570	1519	3622	1661	630	2693	60782	20877	100687	32	11	52	2588	59	5117	41133	0	89068	43721
1989	862394	690983	1033806	2775	1624	3925	650	448	852	17956	8252	27661	10	0	23	1391	0	2934	164058	15439	312678	165449
1990	115636	77306	153966	23593	13426	33759	3122	2318	3926	15172	0	36389	29	4	55	2862	879	4846	246819	0	545410	249681
1991	169455	74078	264832	40631	29843	51419	13713	10530	16897	267644	107990	427299	9	4	14	823828	366924	1280732	281434	0	799822	1105262
1992	2337	250	4423	166276	92113	240438	4739	3217	6262	83909	48399	119419	326	156	495	49757	0	104634	80747	12984	148509	130504
1993	952	289	1616	133046	58312	207779	3785	2335	5236	291468	1429	581506	1033	0	2512	297397	0	690030	70019	12321	127716	367416
1994	13898	70	27725	70761	39933	101589	4470	2354	6586	103891	0	212765	7	1	12	2139223	1230225	3048220	49237	0	109432	2188460
1995	2869	0	6032	233885	114258	353512	1203	686	1720	11018	4409	17627	415	196	634	6	0	14	195	0	390	201
1996	136674	69801	203546	280916	188630	373203	2632	1999	3265	549608	256160	843055	430	180	679	588020	368361	807678	46671	0	116324	634691
1997	189372	80734	298011	294607	218967	370247	1983	1391	2575	463243	176669	749817	341	162	521	297828	164107	431550	62084	6037	118131	359912
1998	113390	70516	156263	24951	15827	34076	14116	9524	18707	476065	277542	674589	182	91	272	96874	59118	134630	95609	0	220926	192483
1999	287760	143243	432278	4150	944	7355	2740	1018	4463	35932	13017	58848	275	139	411	1154149	728616	1579682	24015	3768	44262	1178164
2000	140837	6551	275123	108093	58416	157770	10906	6837	14975	469626	22507	916746	851	446	1256	916625	530966	1302284	190661	133249	248072	1107286
2001	90181	0	217345	4150	798	7502	4649	3189	6109	10008	2021	17996	47	0	106	29087	5648	52526	119023	0	252146	148110
2002	67130	36971	97288	76146	42253	110040	4381	2998	5764	151514	58954	244073	2112	134	4090	829216	496352	1162079	215572	36403	394741	1044788
2003	340877	146178	535575	81977	47715	116240	30792	15352	46232	177676	52699	302653	286	0	631	82315	42707	121923	12998	0	30565	95313
2004	53950	11999	95900	65969	47743	84195	39303	26359	52246	773891	544964	1002819	4779	2810	6749	290686	147492	433879	2892	989	4796	293578
2005	148466	51669	245263	72137	50662	93611	91606	67869	115343	125927	20407	231447	176	115	237	44663	22890	66436	25970	9987	41953	70633
2006	515770	325776	705764	25061	11469	38653	28505	18754	38256	294649	102788	486511	280	116	443	182713	73645	291781	15965	3414	28517	198678
2007	480069	272313	687825	42628	26652	58605	8401	5587	11214	144002	25099	262905	286	3	568	191111	57403	324819	22803	0	46521	213914
2008	995101	627202	1362999	234144	131081	337208	9864	1144	18585	201046	68778	333313	142	68	216	42657	5936	79378	619	25	1212	43276
2009	673027	423386	922668	185457	123375	247540	33339	19707	46970	104233	31009	177458	62	0	132	168990	70509	267471	154687	37022	272351	323677
2010	318569	201973	435166	135355	68199	202511	23669	14503	32834	117087	32045	202129	1066	362	1769	267430	111697	423162	12045	0	33370	279474
2011	594248	58009	1130487	448005	251499	644511	19114	14209	24018	83051	48024	118078	96	0	225	249269	100355	398183	4924	218	9629	254193
2012	988600	728754	1248445	410757	170242	651273	5281	2626	7936	177189	35046	2111493	229	5	453	25026	1132	48920	125306	0	357381	150332
2013	316020	127310	504731	385430	269640	501219	16665	11161	22169	289391	67718	511064	11	4	18	11382	0	29002	1011	262	1760	12393
2014	163630	31980	295280	464124	323330	604919	11765	6160	17371	136305	42164	230447	4	0	9	17349	5184	29515	5298	500	10096	22647
2015	457481	274631	640331	37474	17244	57704	15089	6204	23973	82749	0	190673	406	0	930	795	107	1484	49584	15385	83784	50380
2016	778784	479130	1078438	53796	30970	76622	5504	2791	8216	79439	38415	120464	10	0	21	1544	0	3718	9288	459	18117	10832
LTM	314184			114452			11740			163247			471			252074			65130			317204

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

Year	Capelin	Cod	Haddock	Herring	Polar cod	Redfish	Total biomass, in 1000 tonnes
1993	3	475	34	1035	125	8	1680
1994	6	666	54	173	485	118	1501
1995	2	1546	14	12	0	27	1599
1996	98	919	34	438	145	0	1634
1997	82	657	12	352	85	0	1188
1998	51	117	168	988	45	0	1368
1999	158	32	39	440	185	0	853
2000	55	319	44	404	395	15	1232
2001	51	11	58	9	35	0	165
2002						0	0
2003	149	160	115	471	15	0	909
2004	33	317	686	2243	125	0	3404
2005	60	431	749	406	30	30	1707
2006	335	181	329	1321	85	53	2304
2007	312	123	69	275	0	2139	2919
2008	396	632	54	106	75	536	1800
2009	197	955	346	289	145	201	2134
2010	100	786	134	254	55	255	1584
2011	228	1855	215	151	60	0	2509
2012	519	1429	39	1156	65	144	3352
2013	151	957	241	1363	5	4	2721
2014	67	965	100	169	15	205	1520
2015	272	130	178	98	11	231	921
2016	713	248	264	661	4	58	1948
Mean	175	603	164	554	95	168	1759

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						0.09	0.03		2.62	
15 - 19 mm			0.07	0.00		0.40	0.18		24.83	
20 - 24 mm			0.30			0.79	12.06		26.44	
25 - 29 mm	0.01		0.53			1.70	19.28		26.59	
30 - 34 mm	0.01	0.01	1.30	0.00		3.47	11.47		14.49	5.12
35 - 39 mm	0.01	0.01	6.47	0.01		13.79	8.48		4.24	34.76
40 - 44 mm	0.02		17.06	0.02		36.46	21.31		0.78	29.24
45 - 49 mm	0.31		17.42	0.16		28.54	15.31			15.74
50 - 54 mm	0.03		18.72	0.25		12.80	8.67	3.99		5.10
55 - 59 mm	0.50	0.02	22.60	0.23		1.94	2.52	9.98		0.72
60 - 64 mm	1.42	0.02	12.79	2.10			0.66	5.39		1.27
65 - 69 mm	3.94	0.01	2.62	5.55	19.60			29.94		1.02
70 - 74 mm	8.21	0.81	0.13	13.86				24.50		1.29
75 - 79 mm	14.94	0.12		26.80			0.02	8.72		1.15
80 - 84 mm	16.90	0.24		30.10	42.00			6.65		1.66
85 - 89 mm	19.74	0.71		13.85				10.82		0.87
90 - 94 mm	17.09	0.78		5.30						1.37
95 - 99 mm	8.94	1.49		1.10						0.05
100 - 104 mm	4.52	2.25		0.47	8.60					0.03
105 - 109 mm	2.40	2.51		0.13						0.00
110 - 114 mm	0.76	4.70		0.06	19.60					0.62
115 - 119 mm	0.14	6.74								0.01
120 - 124 mm	0.01	9.93								
125 - 129 mm	0.08	15.73								
130 - 134 mm		14.09			10.21					
135 - 139 mm		12.29								
140 - 144 mm		10.34								
145 - 149 mm		9.56								
150 - 154 mm		5.22								
155 - 159 mm		1.59								
160 - 164mm		0.84								
Mean length, cm	8.92	13.40	5.55	8.42	9.53	4.84	4.18	7.49	2.90	4.97
Long term mean length, cm	7.6	9.2	4.8	7.1	9.0	3.9	4.1	6.3	3.3	5.7

5.1.1 Capelin (*Mallotus villosus*)

The 0-group capelin were distributed widely in the Barents Sea (Figure 5.1.1.1). The area around Svalbard/Spitsbergen Archipelago were covered one month later than the main area and the southern Barents Sea was not completely covered. 0-group capelin densities close to these areas indicated that capelin distributed also in these mentioned above areas, and that capelin distribution were most likely wider that figure (5.1.1.1) showed. 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 2016, the highest concentrations of capelin were found in the north-central Barents Sea, and was like 2015.

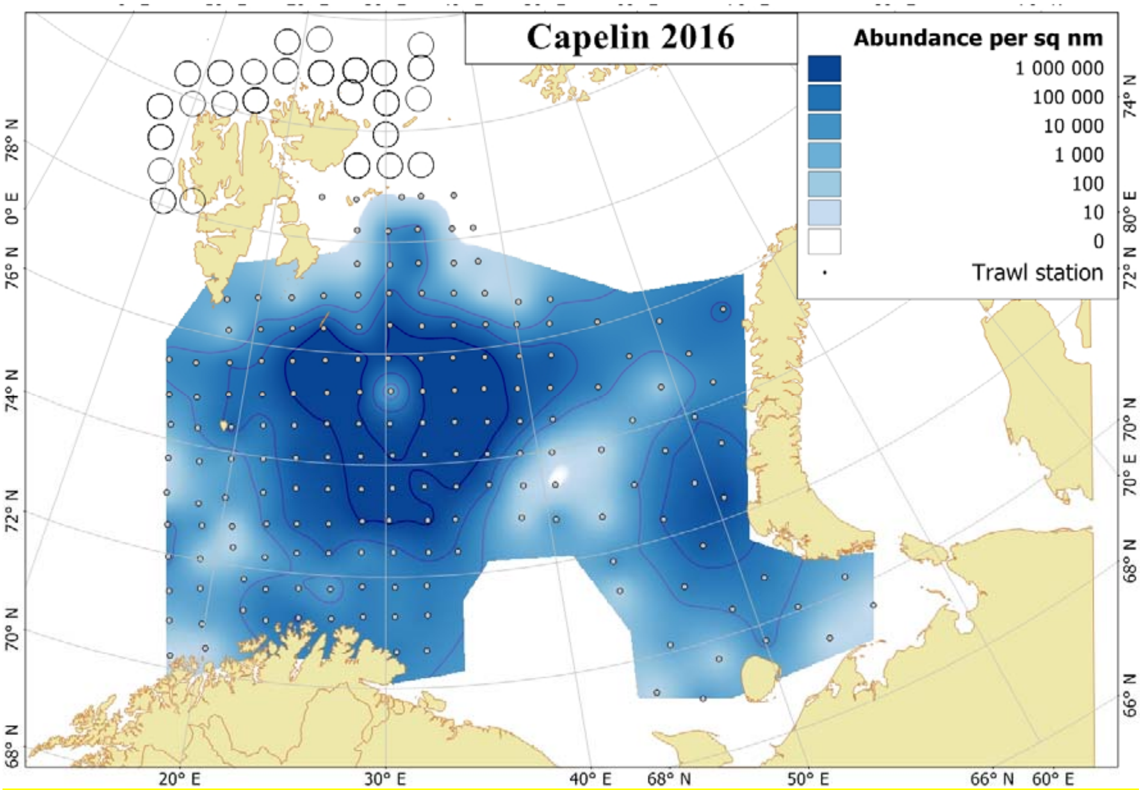


Figure 5.1.1.1. Distribution of 0-group capelin in August-September 2016. 0-group capelin distribution based on stations taken by J. Hjort and Eros (blue area) and stations taken one month later by H. Hanssen (circles).

The calculated density varied from 174 individuals to 33 million fish per square nautical mile, with mean density of 1.2 million fish per square nautical mile, that was much higher than in 2014 (174 thousand fish per square nautical mile) and 2015 (454 thousand fish per square nautical mile).

In 2016, sometimes were difficult to split 0-group and 1-year fish for individuals with 6-8 cm length, so otoliths from such fishes were analysed. The average length was 5.6 cm and was largest since 2003. The largest individuals were distributed in the northern area, while the smallest close to the Norwegian and Murman (Russia) coast. The capelin length varied from 1.5 to 7.6 cm, however length of most of fish (89%) were between 4.5 and 7 cm. Generally large individuals indicated a good growth and thus a sufficient feeding and living conditions during the first summer.

The 0-group capelin biomass was record high and was about 713 thousand tonnes, that was about 4 times higher than the long term level (175 thousand tonnes for period 1993-2016). The capelin biomass is shown in Table 5.1.3.

The abundance index of 0-group capelin in 2016 was very high and almost 3 times higher than the long term mean. The 2016-year class was found as very strong.

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 (Figure 5.1.1.2). Abundance of this part (0.4%) is low in comparison with 2015 (2%), 2014 (6%) and 2013 (8%). 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.

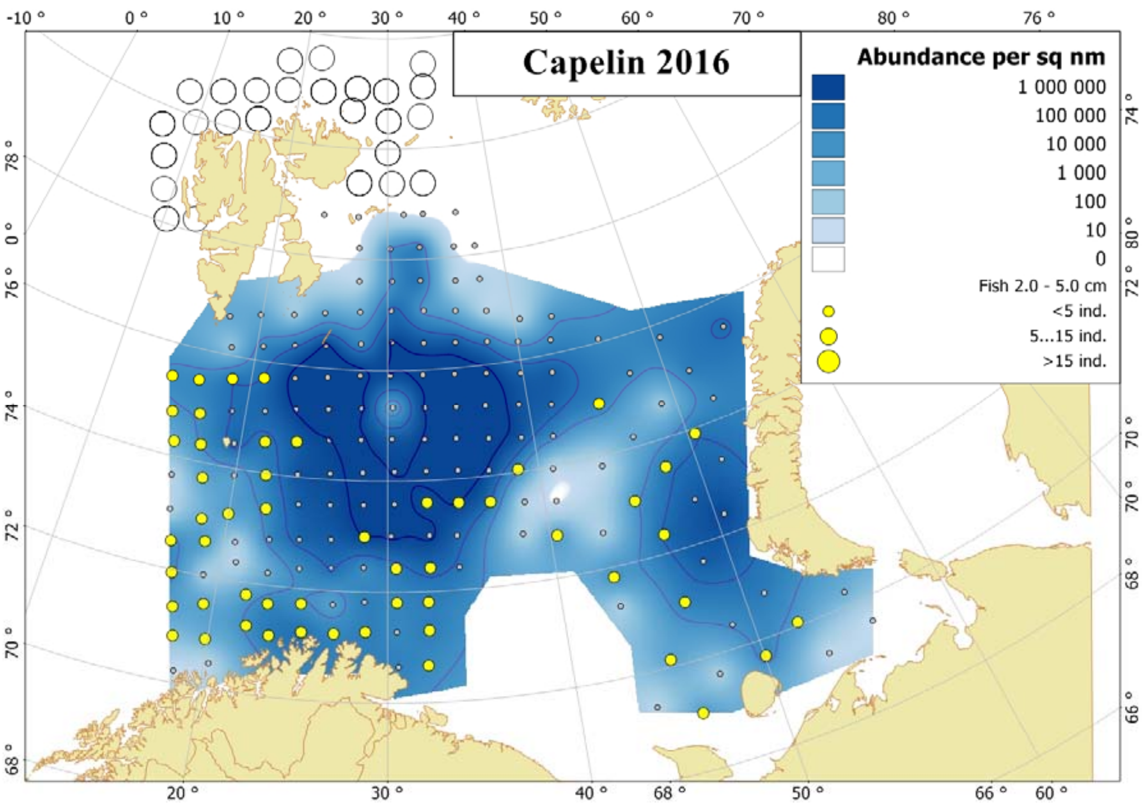


Figure 5.1.1.2. Distribution of small 0-group capelin of 15-30 mm body length, August- October 2016. 0-group capelin distribution based on stations taken by J. Hjort and Eros (blue area) and stations taken one month later by H. Hanssen (circles).

5.1.2 Cod (*Gadus morhua*)

In 2016, cod were found in the central, southern, eastern parts of the Barents Sea and northwest of Svalbard/Spitsbergen (Figure 5.1.2.1). The area around Svalbard/Spitsbergen Archipelago were covered one month later than the main area and the southern Barents Sea was not completely covered. In 2016, the 0-group cod were also found in deeper water layer (100-200m). The deeper layer was not regularly covered by trawl and only some catchers were taken to identify the acoustic registrations (Figure 5.1.2.1). Thus, the report present results from the standard coverage (0-60m) only, and should be interpreted as minimum. A unknown amount of cod was found in the central and north-central part of the Barents Sea in the deeper water layer, however this part was not estimated.

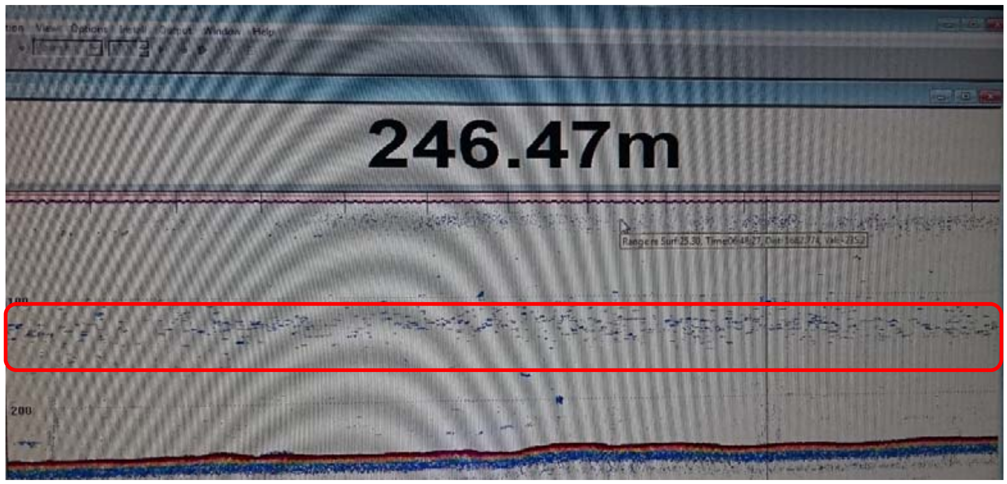


Figure 5.1.2.1. 0-group cod acoustic registrations in 100-150 m layer (76°24'N 37°36'E) in August 2016.

The calculated density was from 138 to 1.2 million fish per square nautical mile. The mean density was 50.3 thousand fish per square nautical mile, and it is 5.4 times lower than in 2015 (273 thousand fish per square nautical mile).

The length of 0-group cod was between 2.9 and 13.5 cm. Most of the fish (69%) were between 7.5 and 9.5 cm, with a mean length of 8.9 cm, which is highest from 2007 and higher than the long term of 7.6cm (Table 5.1.4).

The calculated density was from 138 to 1.2 million fish per square nautical mile. The mean density was 50.3 thousand fish per square nautical mile, and it is 5.4 times lower than in 2015 (273 thousand fish per square nautical mile).

The length of 0-group cod was between 2.9 and 13.5 cm. Most of the fish (69%) were between 7.5 and 9.5 cm, with a mean length of 8.9 cm, which is highest from 2007 and higher than the long term of 7.6cm (Table 5.1.4).

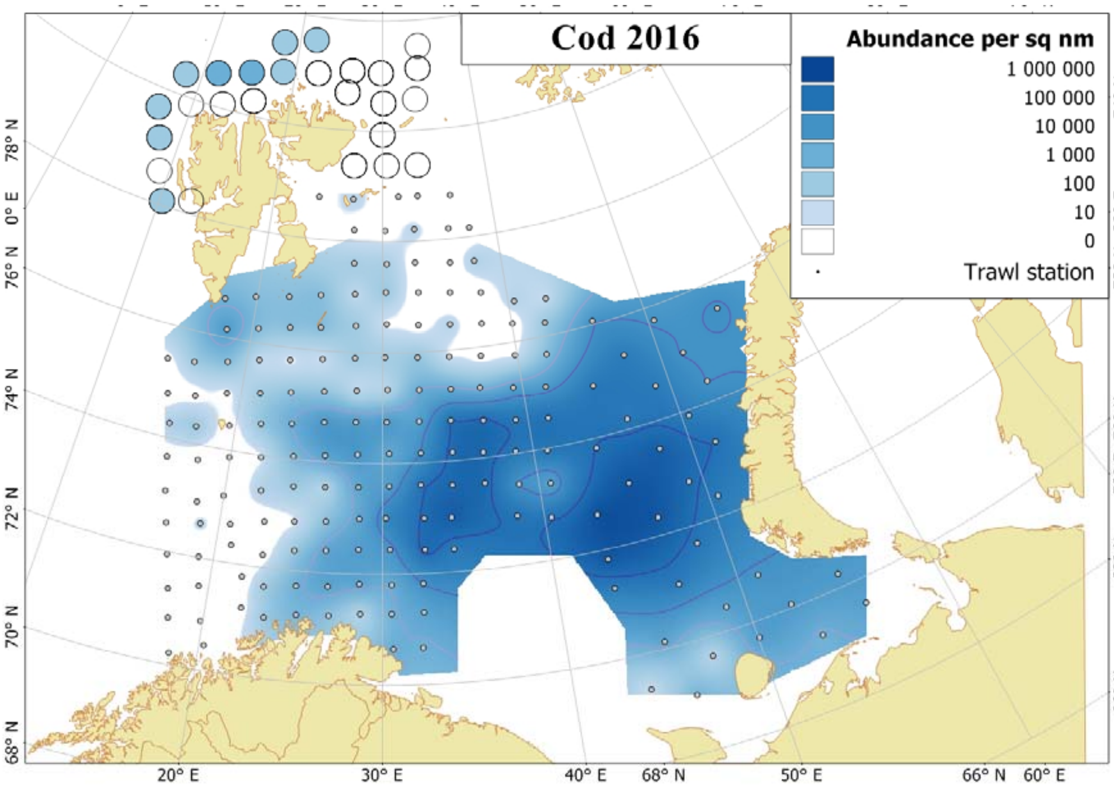


Figure 5.1.2.1. Distribution of 0-group cod, August-October 2016. 0-group cod distribution based on stations taken by J. Hjort and Eros (blue area) and stations taken one month later by H. Hanssen (circles).

The 0-group cod biomass (248 thousand tonnes) is 1.9 times higher than in 2015 (130 thousand tonnes) and 2.4 times lower than the long term mean (603 thousand tonnes) (Table 5.1.3).

The abundance index of 2016-year class (16872 million, not corrected for capture efficiency) is 1.9 times higher than in 2015 (8744 million) but 1.7 times lower than long term mean (29224 million). The 2016-year class could be characterized as a weak.

5.1.3 Haddock (*Melanogrammus aeglefinus*)

0-group haddock distributed widely in the western, central areas and north, west and east of of Svalbard/Spitsbergen in 2016 (Figure 5.1.3.1). The area around Svalbard/Spitsbergen Archipelago were covered one month later than the main area and the southern Barents Sea was not completely covered. Some haddock were also found in the eastern part. The main dense concentrations were found in the central part of the sea. Some amount of the 0-group haddock were observed acoustically between 100 and 150 m depth in the central and southwestern areas, thus the distribution and abundance indices for the 2016 is underestimated.

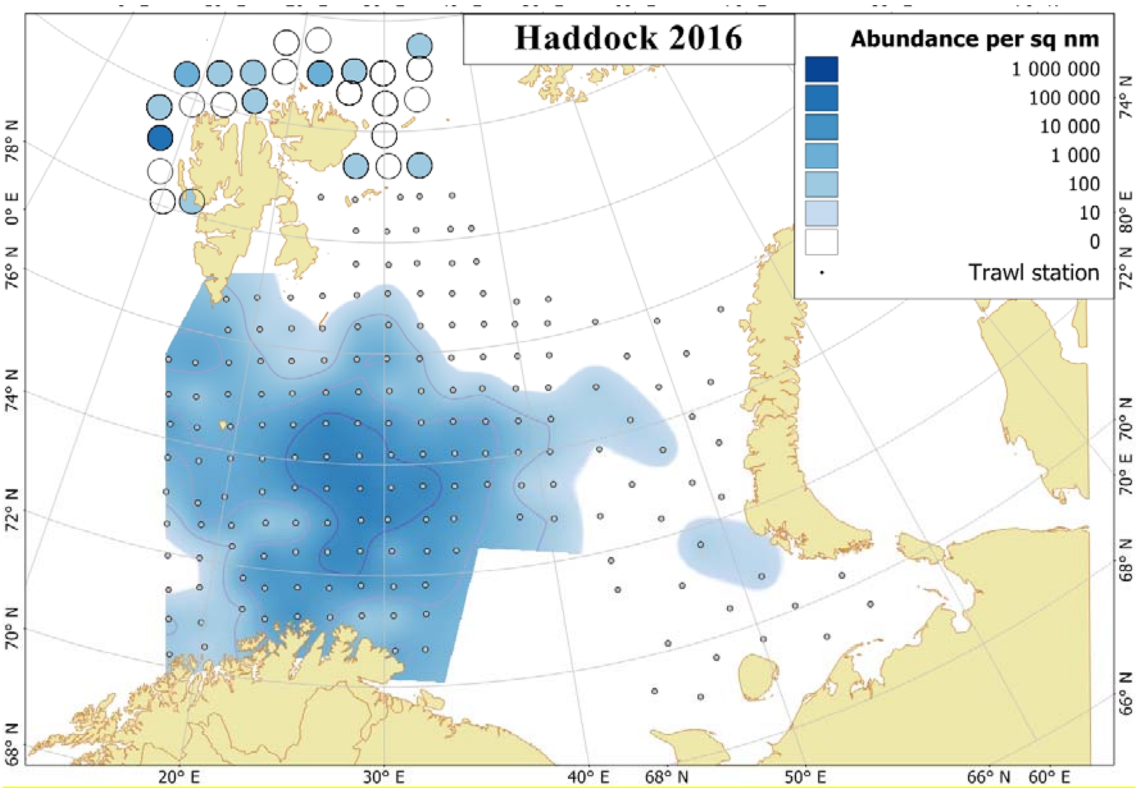


Figure 5.1.3.1. Distribution of 0-group haddock, August-October 2016. 0-group haddock distribution based on station taken by J. Hjort and Eros (blue area) and stations taken one month later by H. Hanssen (circles).

The calculated density varied between 154 and 577 thousand fish per square nautical mile. The mean calculated density per trawl was 18 thousand fish per square nautical mile, that is at same level as in 2015.

In 2016, sometimes were difficult to split 0-group and 1-year fish for individuals with 15-19 cm length, so otoliths from such fishes were analysed. The length of 0-group haddock varied between 3.0 and 16.9 cm, while the length of most fish (72%) was between 12.0 and 15.0 cm (Table 5.1.4). The mean length of haddock was 13.4 cm in 2016, and it is higher than long term mean of 9.2 cm and was is record high. The large 0-group haddock indicate a good growth during the first summer and thus suitable living conditions for haddock in 2016.

The 0-group haddock biomass was 264 thousand tonnes and it is higher than in 2015 (178 thousand tonnes) and the long term mean (164 thousand tonnes, for period 1993-2016) (Table 5.1.3).

The number of fish belonging to the 2016-year class is lower than in 2015 and close to the long-term mean and thus can be characterized as average year class.

5.1.4 Herring (*Clupea harengus*)

0-group herring were wider distributed than previous years and were found in the central, northern and eastern areas area and west of Svalbard/Spitsbergen in 2016. The main dense concentrations of herring were found in the central and eastern areas and west of Svalbard/Spitsbergen (Fig. 5.1.4.1). The distribution and abundance indices in 2016 most likely wider and higher, respectively due to lack of complete coverage in main 0-group herring area (the southern Barents Sea).

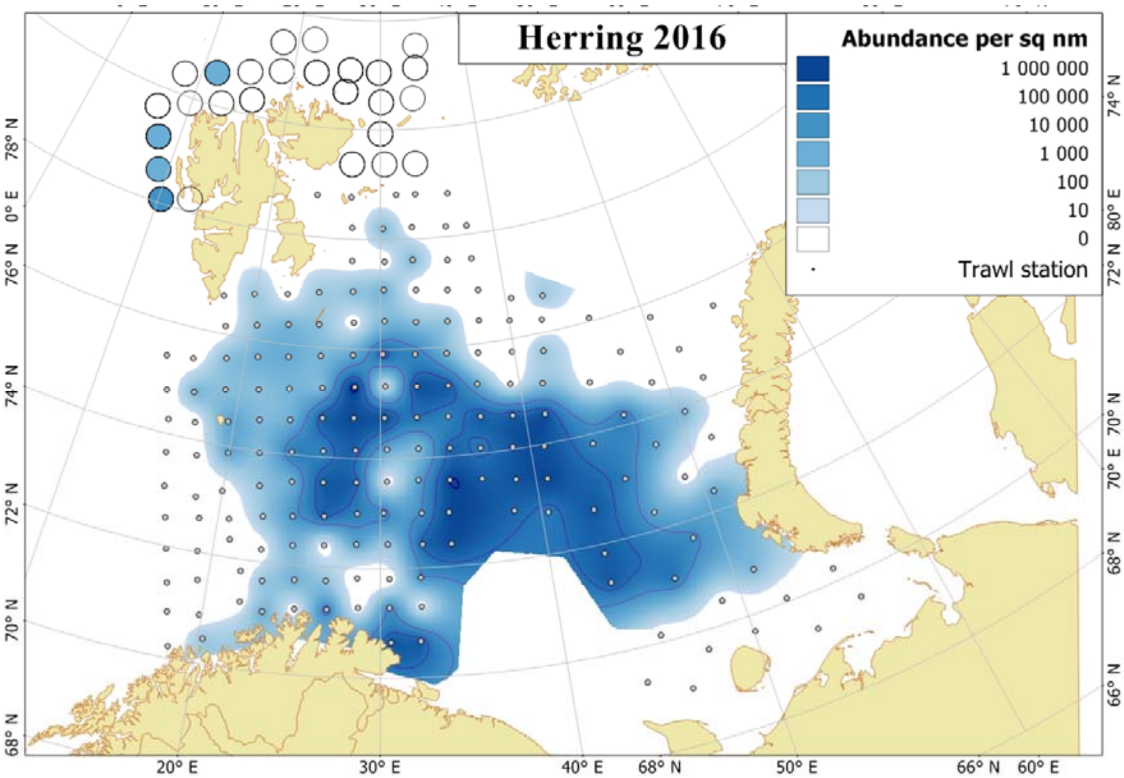


Figure 5.1.4.1. Distribution of 0-group herring, August-October 2016. 0-group herring distribution based on stations taken by J. Hjort and Eros (blue area) and stations taken one month later by H. Hanssen (circles).

The calculated density varied from 57 to 4.8 million fish per square nautical mile. The mean calculated density was 123 thousand fish per square nautical mile, and it is higher than in 2015 (30 thousand fish per square nautical mile) and 2014 (49 thousand fish per square nautical mile). In 2016, 0-group herring were observed in schools with older herring (age 1). Otolith were used to find maximum length of 0-group herring.

The length of 0-group herring varied between 3.0 and 11.5 cm, and most of the fish (85%) were 7.0- 9.5 cm long (Table 5.1.4). In 2016 the mean length of 0-group herring was 8.4 cm and it was highest since 2000. The large 0-group herring indicate a good growth during the first summer and thus suitable living conditions for off spring in 2016.

The 0-group herring biomass was 661 thousand tonnes and it is higher than last two years and slightly higher than the long term mean of 554 thousand tonnes (Table 5.1.3).

The 2016 year-class of herring was higher than two last years and slightly higher than the long term mean, and therefore can be characterized as average.

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 and east of Svalbard/Spitsbergen Archipelago. Polar cod of the eastern component distributes usually along the western coast of Novaya Zemlya, however in 2016 some few registrations were found there. The distribution and abundance indices in 2016 most likely wider and higher, respectively due to the area around Svalbard/Spitsbergen Archipelago were covered one month later than the main survey area.

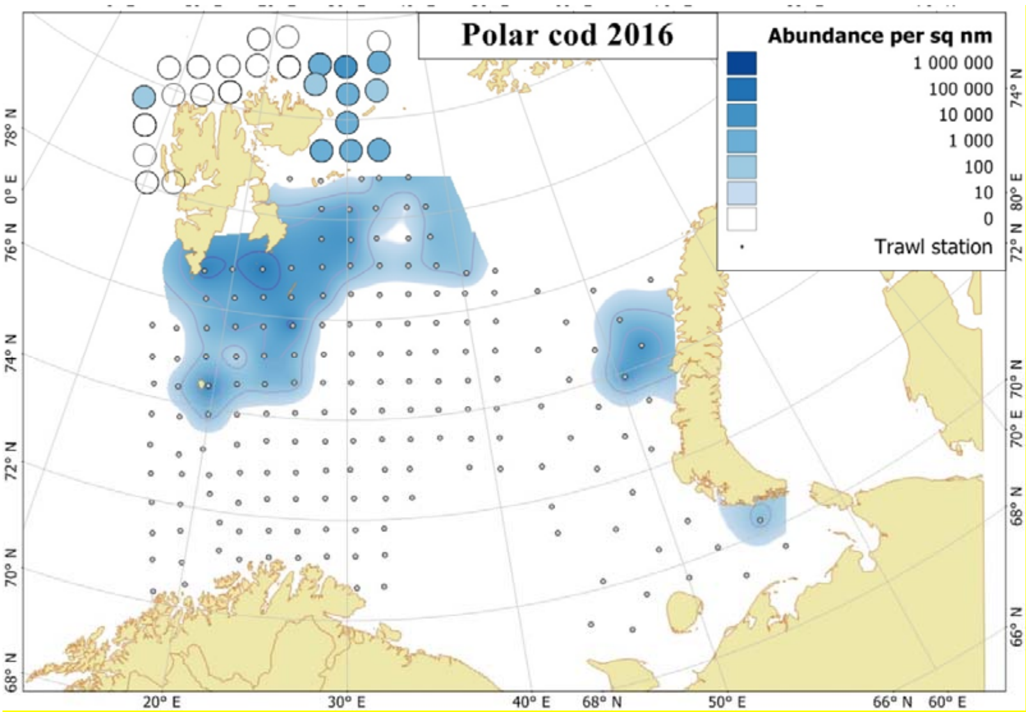


Figure 5.1.5.1. Distribution of 0-group polar cod, August- October 2016. 0-group polar cod distribution based on stations taken by J. Hjort and Eros (blue area) and stations taken one month later by H. Hanssen (circles).

The calculated density varied from 154 to 324 thousand fish per square nautical mile. The mean calculated density was 5.6 thousand fish per square nautical mile.

The length of polar cod varied between 1.5 and 8.0 cm, and most of the fish (88%) were between 2.0 and 5.0 cm long (Table 5.1.4). The mean length of 0-group polar cod (4.2 cm) was close to the long term mean of 4.1 cm.

The abundance index for each component was calculated separately. Calculated abundance of the western component was approximately 7 time low than the long term mean (Table 5.1.1). The abundance index of eastern component was low and only 0.8% of the long term mean. The 0-group polar cod biomass was only 4 thousand tonnes, that is 24 time lower the long term mean (Table 5.1.3). Several years the abundance indices of polar cod were extremely low and indicated worse living conditions or/and significant reduce the spawning biomass in the Barents Sea.

5.1.6 Saithe (*Pollachius virens*)

Saithe were found at 8 stations (5 pelagic and 3 bottom) in 2016. In 2015, saithe were mostly found in the western and central areas, while in 2016, saithe were found also in the southern and eastern areas (Figure 5.1.6.1).

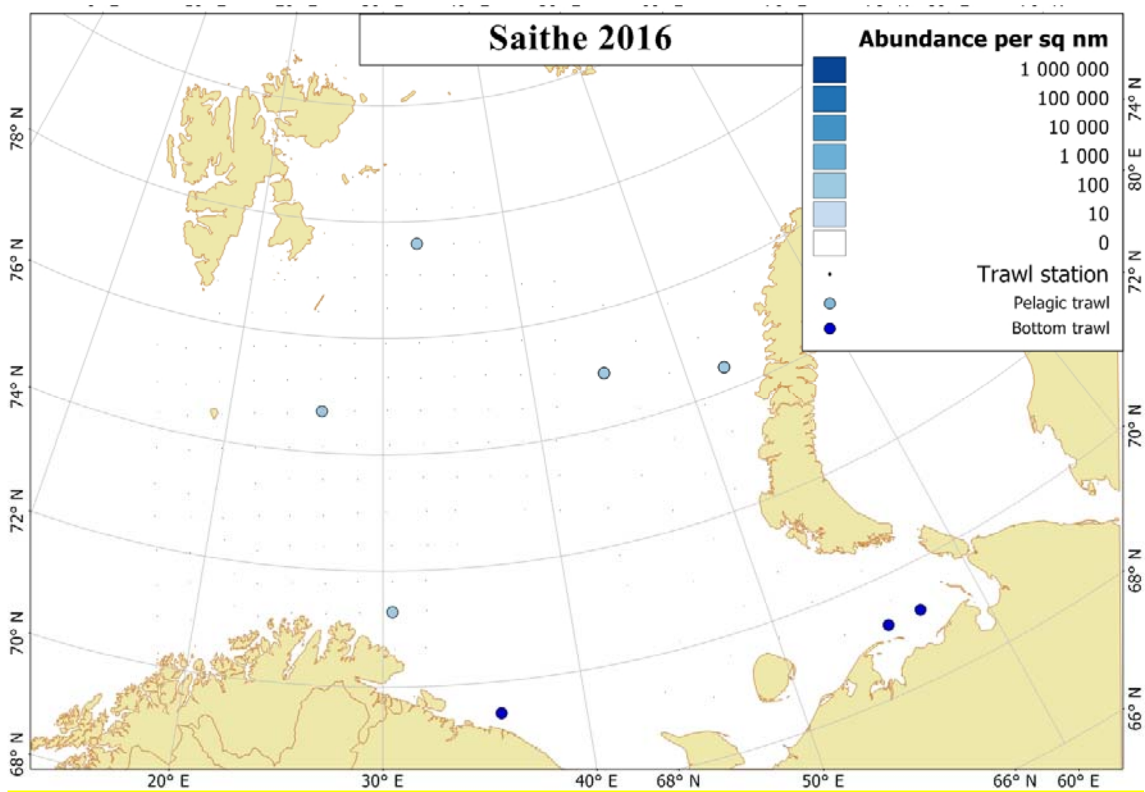


Figure 5.1.6.1. Distribution of 0-group saithe, August-September 2016.

The calculated density varied from 162.46 to 793.7 fish per square nautical mile. The mean calculated density was only 10.6fish per square nautical mile, and it is 12.2 times lower than in 2015.

The length of 0-group saithe varied between 7.0 and 13.9 cm. The mean length of saithe was 9,5 cm, which is highest since 2011 and higher than the long term mean of 9.0 cm (Table 5.1.4).

Since 2005 (except 2010 and 2015) abundance indices of 0-group saithe have been lower than the long term average. The 2016-year class is much lower than the long term mean. The 2016-year class of saithe in the Barents Sea may be characterized as very 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 were distributed in the western part of the Barents Sea and north for Svalbard/Spitsbergen (Figure 5.1.7.1). The distribution was reduced comparing to previous years. In 2016, area west of Svalbard, were 0-group redfish dense concentrations distribute traditionally, was covered one month later than neighbour areas and not included in the indices estimation and thus in the map. The densest concentrations were found in the central area.

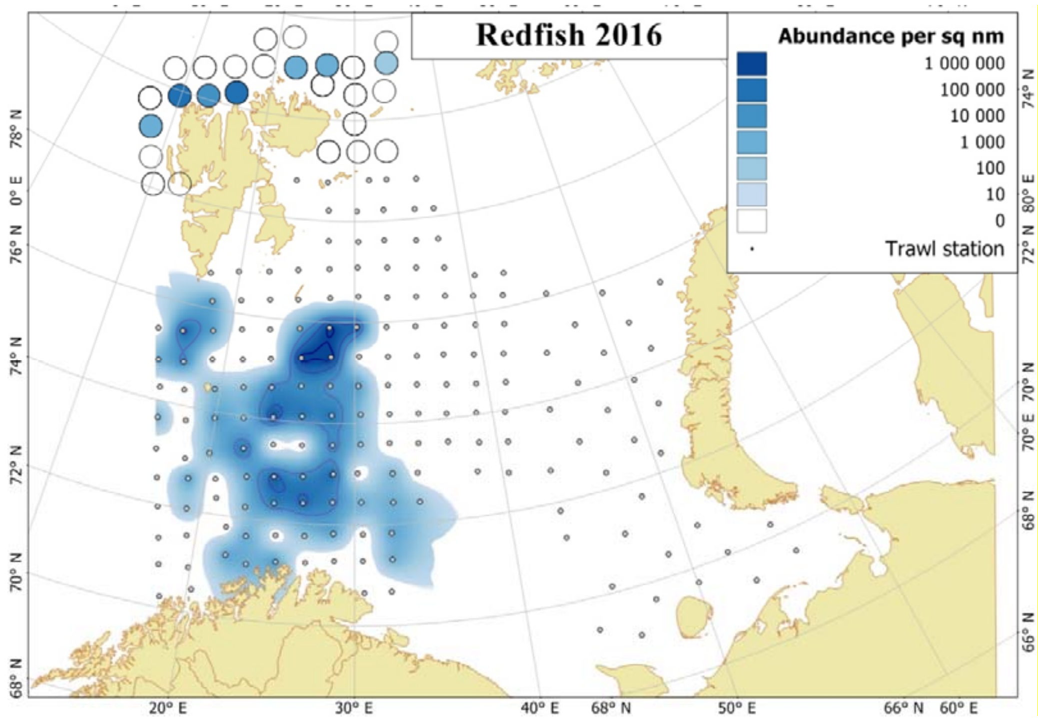


Figure 5.1.7.1. Distribution of 0-group redfishes (mostly *Sebastes mentella)*, August- October 2016. 0-group redfish distribution based on station taken by J. Hjort and Eros (blue area) and stations taken one month later by H. Hanssen (circles).

The calculated density was between 122 and 2.9 million fish per square nautical mile. Mean calculated density was 52.1 thousand fish per square nautical mile, which 5 times lower than in 2015.

In 2016, the length of 0-group redfish was 0.5-6.9 cm and the mean fish length was 4.8 cm. Most of the fish (92%) were 3.5-5.9 cm long. The mean fish length is higher than the long term mean of 3.9 cm (Table 5.1.4).

0-group redfish biomass in 2016 (58 thousand tonnes) was lower than in 2015 (231 thousand tonnes) and 3 times lower than the long term mean (Table 5.1.3).

The abundance of 0-group redfish is 7.9 times lower than in 2015 and 4.6 than the long term mean. So the 2015 year-class can be characterized as above weak. However, some 0-group fish may stay in the area, which not included (west of Svalbard), and most likely the abundance slightly higher.

5.1.8 Greenland halibut (*Reinhardtius hippoglossoides*)

Since 2005 only low concentrations 0-group Greenland halibut were found. Greenland halibut were mostly observed around the Svalbard/Spitsbergen, however in 2016, only north and south and southeast of Svalbard/Spitsbergen (Figure 5.1.8.1). The survey did not cover numerous of Svalbard/Spitsbergen fjords, where 0-group Greenland halibut are abundant, and therefore this index not give the real recruitment (at age 0) to the stock. Additionally, west and north of Svalbard/Spitsbergen was covered one month later than south and southeast and was not reported here.

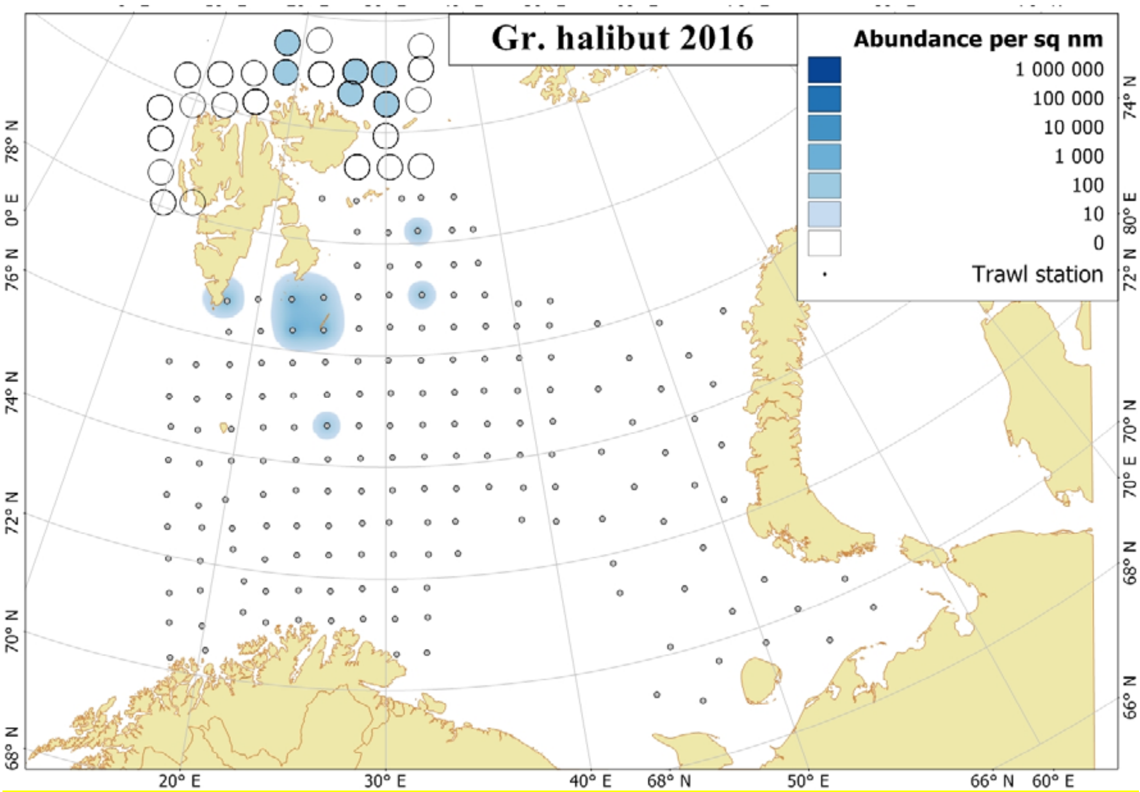


Figure 5.1.8.1. Distribution of 0-group Greenland halibut, August- October 2016. 0-group Greenland halibut distribution based on stations taken by J. Hjort and Eros (blue area) and stations taken one month later by H. Hanssen (circles).

Fish length varied between 3.0 and 9.2 cm, while most of the fish (69%) were between 6.0 and 8.0 cm. The mean length of fish was 7.5 cm, which is at same level as in 2015 and was highest recorded (Table 5.1.4).

The calculated density varied from 154 to 1.5 thousand fish per square nautical mile.

In 2016, Greenland halibut abundance index (6 million) was 4.5 times lower than in 2015 and the long term mean. The 2016-year-class index can be characterized as above weak. However, some 0-group fish may stay in the area, which not included (west and north of Svalbard), and most likely the abundance slightly higher.

5.1.9 Long rough dab (*Hippoglossoides platessoides*)

0-group long rough dab were distributed mainly in the northern part of the Barents Sea (Figure 5.1.9.1). 0-group long rough dab were taken both by pelagic and bottom trawl that indicated start of settlement. Thus, the abundance indices will be most likely underestimated in 2016

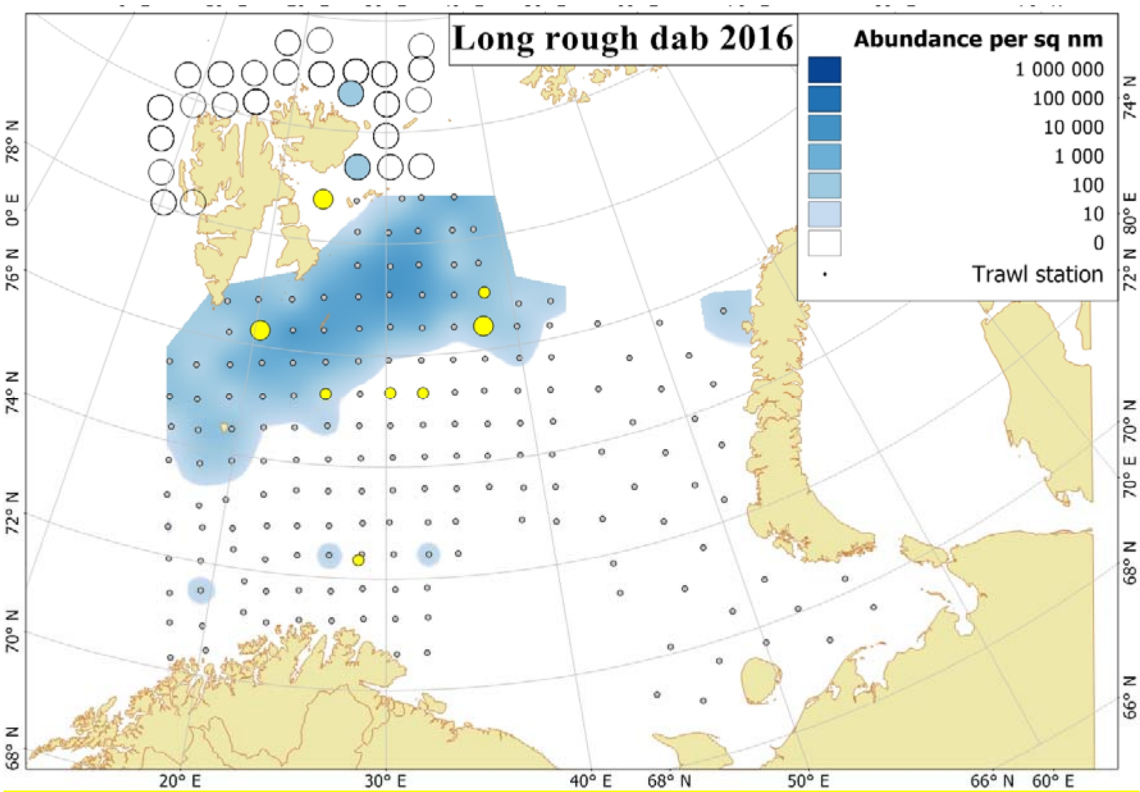


Figure 5.1.9.1. Distribution of 0-group long rough dab, August- October 2016. 0-group long rough dab distribution based on stations taken by J. Hjort and Eros (blue area) and stations taken one month later by H. Hanssen (circles). Yellow dots indicate bottom trawl catches.

The calculated densities ranged between 174 and 235 thousand fish per square nautical mile with an average of 2.5 thousand fish per square nautical mile. That was higher than in 2014 (237 fish per square nautical mile) and 2015 (1.5 thousand fish per square nautical mile).

Fish length varied between 1.5 and 5.0 cm (Table 5.1.4). The mean length of fish was 2.9 cm and this is lower than the long term average (3.3 cm).

The long rough dab index in 2016 (601 million) was higher than in 2015 (575 million) and the highest since 2009 and slightly to the long term mean (526 million).

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 mainly found in the northern part of the Barents Sea. Spotted wolfish were found in the central part, while one Northern wolfish was found in the southern part.

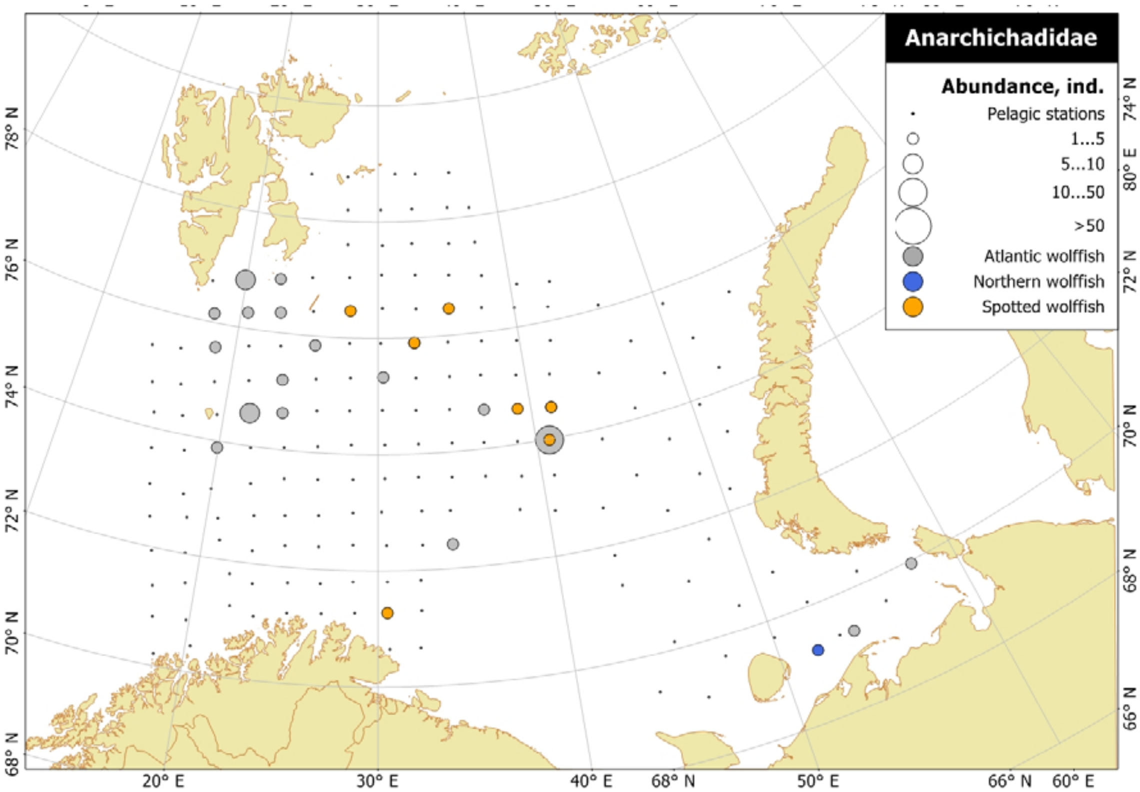


Figure 5.1.10.1. Distribution of 0-group wolffishes, August-October 2016.

The length of the 0-group Atlantic wolfish was 3.0-10.3 cm (mean length 7.1 cm), Spotted wolfish – 7.4-10.6 cm (mean length – 9.3 cm) and Northern wolfish – 6.2 cm.

No index is calculated for this species. But the trawl catches of 0-group wolffish 2016-year class was smaller than in 2015.

5.1.11 Sandeel (*Ammodytes marinus*)

In 2016, 0-group sandeel were widely distributed and found in the south-eastern and the western and north-central part of the Barents Sea (Figure 5.1.11.1). The denser concentrations were found in the western part, what is unusual.

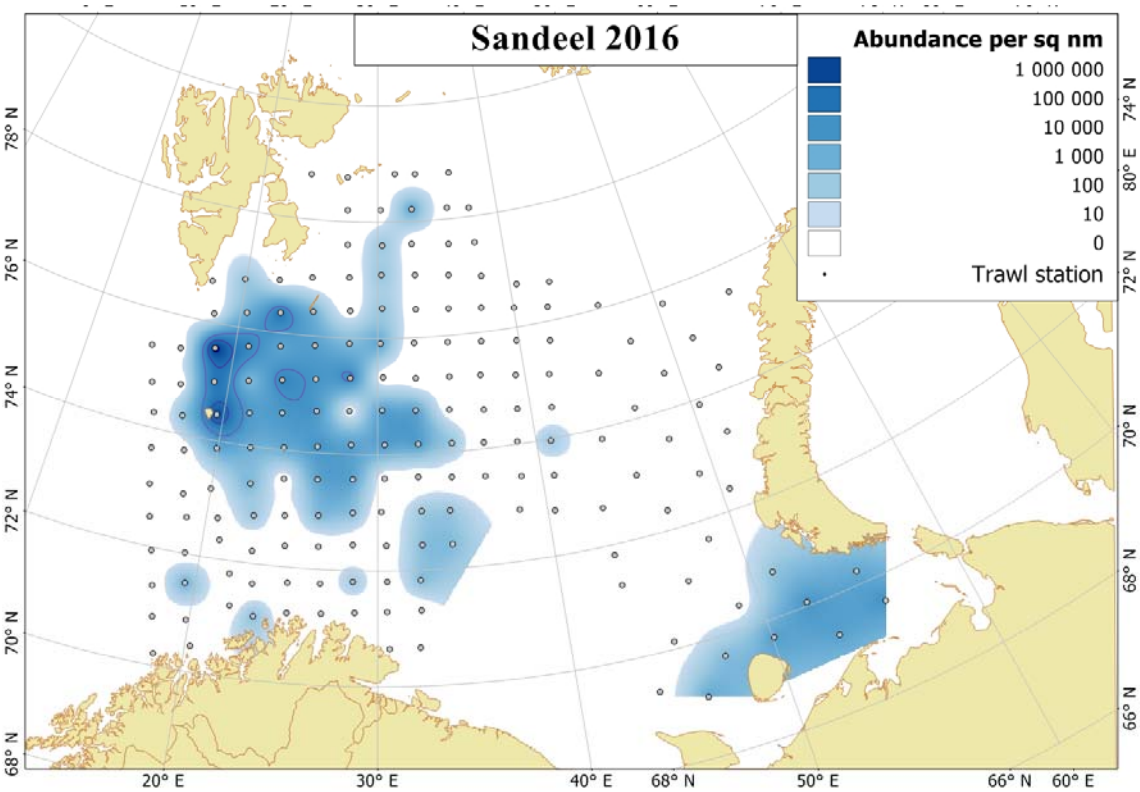


Figure 5.1.11.1. Distribution of 0-group sandeel, August-October 2016.

The calculated density was from 132 to 5.8 million fish per square nautical mile, with an average of 43 thousand fish per square nautical miles, that is higher than in 2012-2015.

The fish length varied between 3.0 to 12.5 cm with average length of 5.0 cm, which is lower than in 2012-2015 and the long term mean (5.7 cm).

The abundance and biomass of sandeel (9346 million and 4.7 thousand tonnes) was the highest since 2007 and is 1.6 times higher than the long term mean.

5.2 Pelagic fish abundance and distribution

Text by Dmitry Prozorkevich, Georg Skaret

Figures by Jaime Alvarez, Georg Skaret

5.2.1 Capelin (Mallotus villosus)

<u>Distribution</u>

The geographical density distribution of capelin is shown in Figure 5.2.1.1. The distribution was similar to the one in 2015, but less capelin was found in the eastern areas and very little capelin was found north of King Karls Land. The capelin aggregations were also in general smaller than in 2015. Young capelin (1+ year olds) were found in most samples, even the most northerly, only the capelin distributions furthest to the east and close to the Edge Island contained uniquely maturing capelin. When comparing the distribution with the one from previous surveys one must keep in mind that the survey was conducted a month before normal survey time in the northernmost areas.

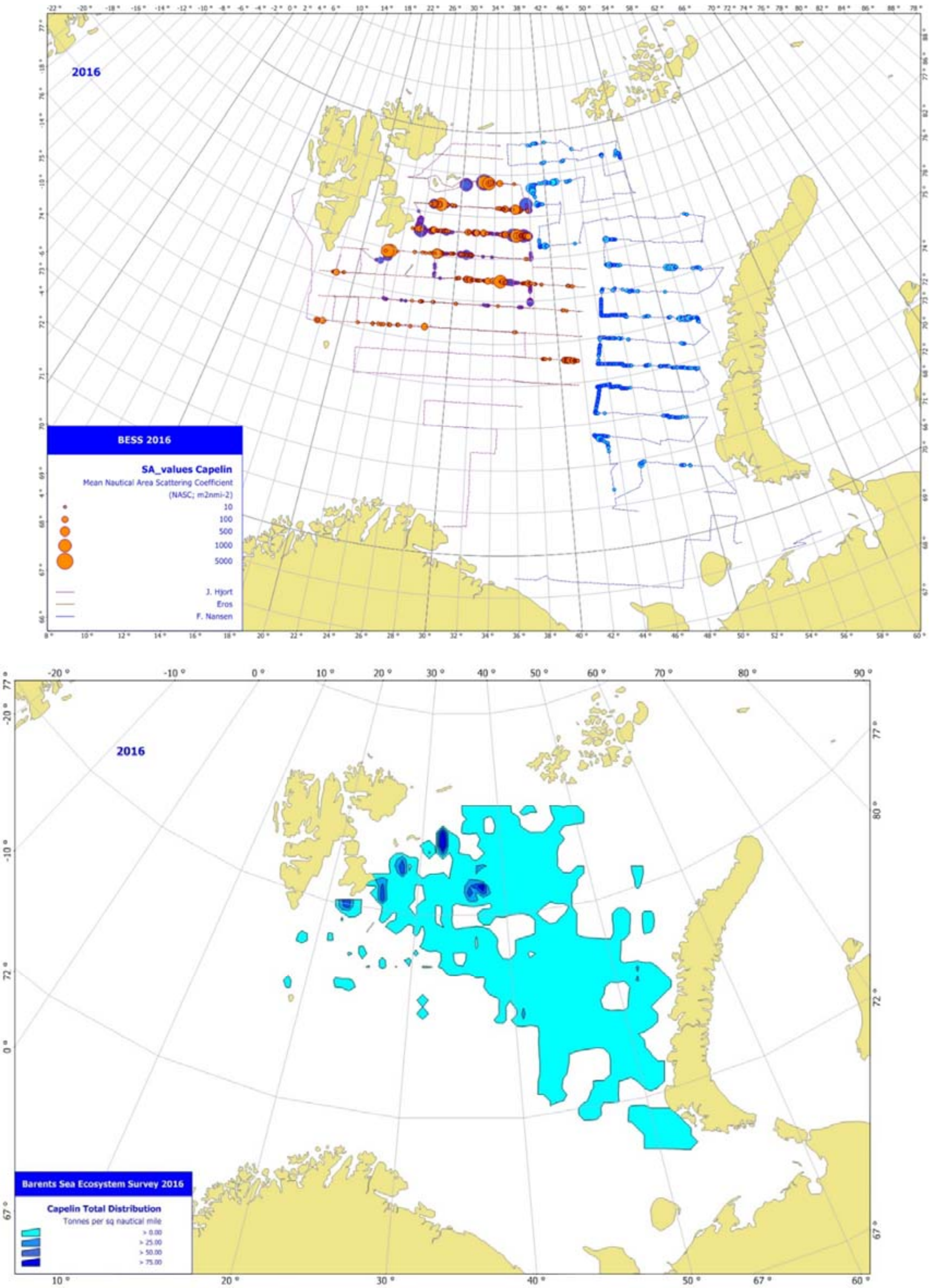


Figure. 5.2.1.1. Estimated geographical distribution of capelin in autumn 2016 shown as s_A values per nautical mile (upper), and transformed to tons/square nautical mile and interpolated using kriging (lower), from August-October 2016.

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. In 2016 capelin stock size abundance estimate was calculated using the new software StoX (used to be the software BEAM). The difference in stock size estimate by two softwares was estimated to about 6%. It was decided that the StoX software was acceptable for capelin stock estimation.

The main results of the abundance estimation in 2016 are summarized in Table 5.2.1.3. The 2015 estimate is shown on a shaded background for comparison. The total stock is estimated at about 0.33 million tonnes, which is well below the long term mean level (about 3 million tonnes, Table 5.2.1.2), and about 40% of the stock size estimated for 2015. About 55 % (0.18 million tonnes) of the 2016 stock has length above 14 cm and is considered to be maturing.

The 2015 year class (1-year group) consists, according to this estimate, of about 32 billion individuals. This estimate is well below the long-term average. The mean weight (4 g) is approximately the same as that measured last year and slightly above the long-term average. The biomass of the 2015 year class is about 0.12 million tonnes, which is the lowest since the 2005 year class, and well 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 estimate of 1-year-olds might be more uncertain than that for older capelin.

The estimated number for the 2014 year class (2-year group) is about 8 billion, which is the lowest estimated abundance of 2-year-olds since 1994. The mean weight of this group in 2016 is 15.3 g, which is the highest since 2007, and well above the long-term average (Table 5.2.1.2). The estimated biomass of the 2-year-olds is about 0.12 million tonnes in 2016; the lowest since 2003 and less than 10 % of the long term average.

The 2013 year class (3 year-olds) is estimated at about 3 billion individuals; Only about 1/4 of the amount of 3 year-olds observed in 2015. The mean weight of 25.2 g is more than a 50% increase from last years' mean weight and is more than 5 g above the long-term average. Total estimated biomass of 3-year-olds is about 75 thousand tonnes, which is well below the long-term average. The 2012 year class (now 4 years old) is estimated at about 165 million individuals with a mean weight of 24.7 g, adding up to a biomass of about 4 thousand tonnes. In general, the average weight of capelin increased quite markedly (figure 5.2.1.2).

The mature part of the stock is basis for the prognosis of spawning stock in spring 2017, 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 2017.

Table 5.2.1.1. Barents Sea capelin. Acoustic estimate in August-October 2016.

Length (cm)	Age group / year class				Sum (10^9)	Biomass (10^3 t)	Mean, weight (g)
	1 (2015)	2 (2014)	3 (2013)	4 (2012)			
7.5 - 8.0	2.753				2.753	4.34	1.6
8.0 - 8.5	2.247				2.247	3.80	1.7
8.5 - 9.0	3.005				3.005	5.97	2.0
9.0 - 9.5	3.501				3.501	9.06	2.6
9.5 - 10.0	5.956				5.956	17.90	3.0
10.0 - 10.5	3.129				3.129	11.28	3.6
10.5 - 11.0	1.915				1.922	8.20	4.3
11.0 - 11.5	1.968				1.968	10.27	5.2
11.5 - 12.0	1.978	0.076			2.054	12.63	6.2
12.0 - 12.5	3.032	0.218			3.250	23.60	7.3
12.5 - 13.0	1.191	0.272			1.463	12.08	8.3
13.0 - 13.5	0.682	0.773			1.455	13.97	9.6
13.5 - 14.0	0.248	0.975	0.011		1.233	13.47	10.9
14.0 - 14.5	0.022	1.383	0.064		1.468	19.95	13.6
14.5 - 15.0	0.016	1.169	0.158		1.343	20.88	15.5
15.0 - 15.5	0.007	1.353	0.120	0.059	1.539	27.04	17.6
15.5 - 16.0		0.841	0.562		1.403	28.97	20.7
16.0 - 16.5		0.675	0.626	0.068	1.369	30.73	22.5
16.5 - 17.0		0.171	0.420	0.004	0.595	15.24	25.6
17.0 - 17.5		0.146	0.612	0.009	0.767	22.81	29.7
17.5 - 18.0		0.005	0.232	0.025	0.263	8.47	32.3
18.0 - 18.5			0.132		0.132	4.88	37.0
18.5 - 19.0		0.007	0.042		0.050	1.84	37.2
19.0 - 19.5			0.008		0.008	0.36	44.3
TSN (10^9)	31.65	8.07	2.99	0.17	42.92		
TSB (10^3 t)	124.6	123.7	75.3	4.1		327.7	
Mean length (cm)	9.86	14.39	16.26	15.94	11.2		
Mean weight (g)	3.94	15.33	25.18	24.71			7.64
SSN (10^9)	0.045	5.750	2.978	0.165	8.938		
SSB (10^3 t)	0.66	102.43	74.36	3.75		181.2	

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 = 19.1 log (L) -74.0 dB

Year	Age										
	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	5.16
1974	1.06	3.5	3.06	5.6	1.53	8.9	0.07	20.8	+	25	5.72
1975	0.65	3.4	2.39	6.9	3.27	11.1	1.48	17.1	0.01	31	7.80
1976	0.78	3.7	1.92	8.3	2.09	12.8	1.35	17.6	0.27	21.7	6.41
1977	0.72	2	1.41	8.1	1.66	16.8	0.84	20.9	0.17	22.9	4.80
1978	0.24	2.8	2.62	6.7	1.20	15.8	0.17	19.7	0.02	25	4.25
1979	0.05	4.5	2.47	7.4	1.53	13.5	0.10	21	+	27	4.15
1980	1.21	4.5	1.85	9.4	2.83	18.2	0.82	24.8	0.01	19.7	6.72
1981	0.92	2.3	1.83	9.3	0.82	17	0.32	23.3	0.01	28.7	3.90
1982	1.22	2.3	1.33	9	1.18	20.9	0.05	24.9			3.78
1983	1.61	3.1	1.90	9.5	0.72	18.9	0.01	19.4			4.24
1984	0.57	3.7	1.43	7.7	0.88	18.2	0.08	26.8			2.96
1985	0.17	4.5	0.40	8.4	0.27	13	0.01	15.7			0.85
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			0.10
1988	0.07	3.4	0.35	12.2	+	17.1					0.42
1989	0.61	3.2	0.20	11.5	0.05	18.1	+	21.0			0.86
1990	2.66	3.8	2.72	15.3	0.44	27.2	+	20.0			5.82
1991	1.52	3.8	5.10	8.8	0.64	19.4	0.04	30.2			7.30
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	0.26	15.1	0.05	18.8			0.80
1994	0.09	4.4	0.04	11.2	0.07	16.5	+	18.4			0.20
1995	0.05	6.7	0.11	13.8	0.03	16.8	0.01	22.6			0.20
1996	0.24	2.9	0.22	18.6	0.05	23.9	+	25.5			0.51
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	1.70	3.8	1.59	14.4	0.95	27.9	0.08	37.7			4.32
2001	0.37	3.3	2.40	11.0	0.81	26.7	0.04	35.5	+	41.4	3.62
2002	0.23	3.9	0.92	10.1	1.04	20.7	0.02	35.0			2.21
2003	0.20	2.4	0.10	10.2	0.20	18.4	0.03	23.5			0.53
2004	0.20	3.8	0.29	11.9	0.12	21.5	0.02	23.5	+	26.3	0.63
2005	0.10	3.7	0.19	14.3	0.04	20.8	+	25.8			0.33
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	0.10	27.5	+	28.1			1.88
2008	0.97	3.1	2.80	12.1	0.61	24.6	0.05	30.0			4.43
2009	0.42	3.4	1.82	10.9	1.51	24.6	0.01	28.6			3.76
2010	0.74	3.0	1.30	10.2	1.43	23.4	0.02	26.3			3.50
2011	0.50	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	25.0			3.59
2013	1.04	3.2	1.81	8.4	0.94	15.9	0.16	23.2	0.00	29.1	3.96
2014	0.32	3.0	0.95	8.9	0.64	16.3	0.04	20.3			1.95
2015	0.14	4.0	0.40	10.6	0.20	16.2	0.09	20.4	0.00	28.1	0.84
2016	0.12	3.9	0.12	15.3	0.08	25.2	0.004	24.7			0.33
Average	0.66	3.66	1.34	11.0	0.82	19.8	0.16	24.7	0.06	28.1	2.98

Table 5.2.1.3. Table on summary of acoustic stock size estimates for capelin in 2015-2016.

Year class		Age	Numbers (10^9)		Mean weight (g)		Biomass (10^3 t)	
2015	2014	1	31.69	36.35	3.9	4.0	124.7	143.8
2014	2013	2	8.07	38.23	15.3	10.6	123.7	404.6
2013	2012	3	2.99	12.51	25.2	16.2	75.2	203.2
2012	2011	4	0.17	4.34	27.4	20.4	4.1	88.4
Total stock in:								
2016	2015	1-4	42.91	91.52	7.6	9.2	327.7	842.4
Target strength estimation based on formula: TS= 19.1 log (L) – 74.0, corresponding to $\sigma = 5.0 \cdot 10^7 \cdot L^{1.91}$								

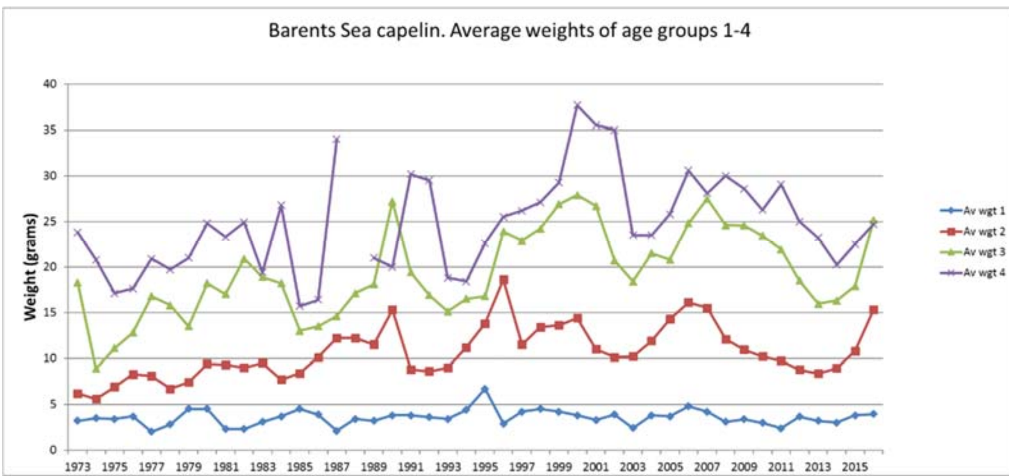


Figure 5.2.1.3. Weight at age (grams) for capelin from capelin surveys (prior to 2003) and BESS.

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 insignificant fishing on these age groups, the figures for total mortality constitute mainly natural mortality (M) given that the age groups are reliably monitored. 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 2003.

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

		Age			
Year	Year class	1 (10^9)	2 (10^9)	Mortality %	Mortality Z
1984-1985	1983	154.8	48.3	69	1.16
1985-1986	1984	38.7	4.7	88	2.11
1986-1987	1985	6.0	1.7	72	1.26
1987-1988	1986	37.6	28.7	24	0.27
1988-1989	1987	21.0	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	179.0	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	1.20
2004-2005	2003	51.2	13.0	75	1.37
2005-2006	2004	26.9	21.7	19	0.21
2004-2005	2003	51.2	13.0	75	1.37
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	313.0	166.4	47	0.63
2009-2010	2008	124.0	127.9	-3	-
2010-2011	2009	247.7	181.2	27	0.31
2011-2012	2010	209.6	156.4	25	0.29
2012-2013	2011	145.9	216.2	-	-
2013-2014	2012	324.5	106.6	67	1.11
2014-2015	2013	105.2	38.2	64	1.01
2015-2016	2014	36.4	8.1	78	1.50

5.2.2 Herring (*Clupea harengus*)

Distribution in 2016

Young herring was widely distributed in the southern Barents Sea in 2016 (Figure 5.2.2.1). from the west coast of Novaja Zemlja. to the edge of the continental slope in the western Barents Sea. The highest concentrations were found close to the coast of the mainland.

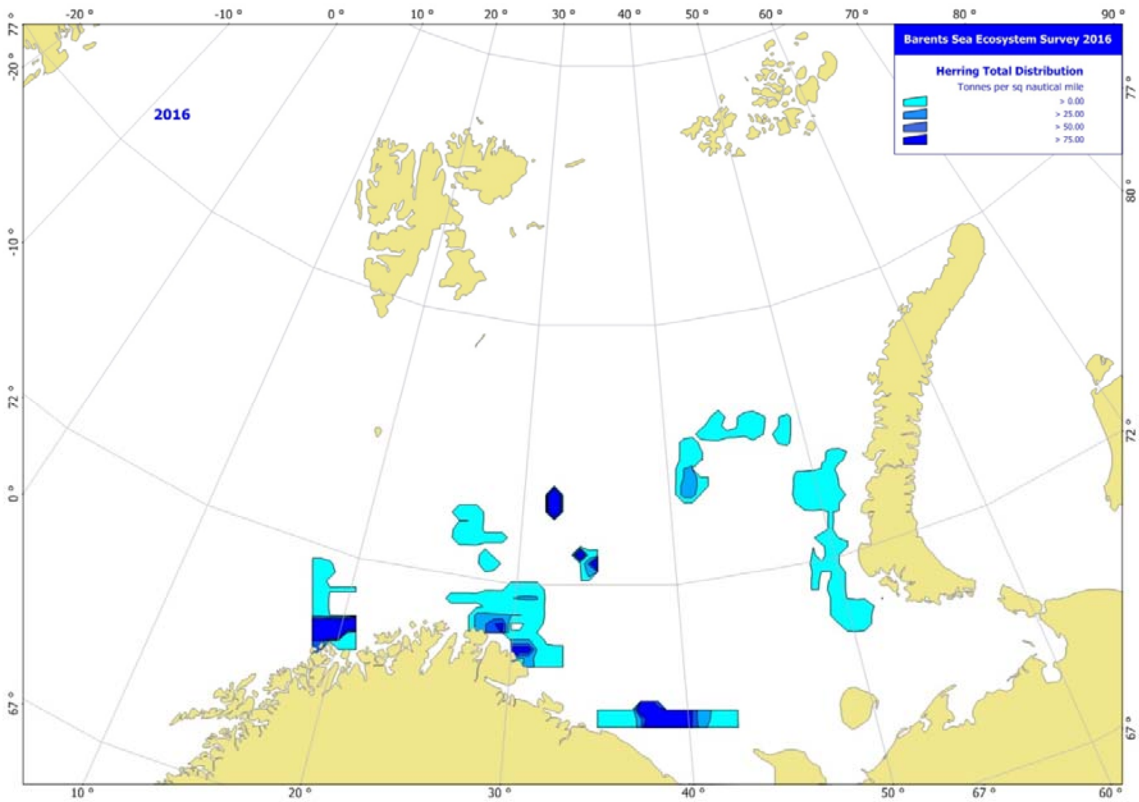


Figure 5.2.2.1 Estimated total density distribution of herring (t/nautical mile^2). August-October 2016. Note that the survey coverage in the central south was limited.

Abundance estimation

There has recently 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 2012-2014 biomass of young herring increased, but decreased a little bit in 2015 to 845 000 tonnes and further in 2016 to 652 000 tonnes. It must be noted that the survey coverage in the central south was not complete this year and the limited recordings that were done from this area indicated high concentrations of herring.

The number of herring recorded in 2016 was similar as the three previous years but the number of 1-year-olds was the highest since 2005. Estimated abundance of herring based on acoustics is shown in Table 5.2.2.1.

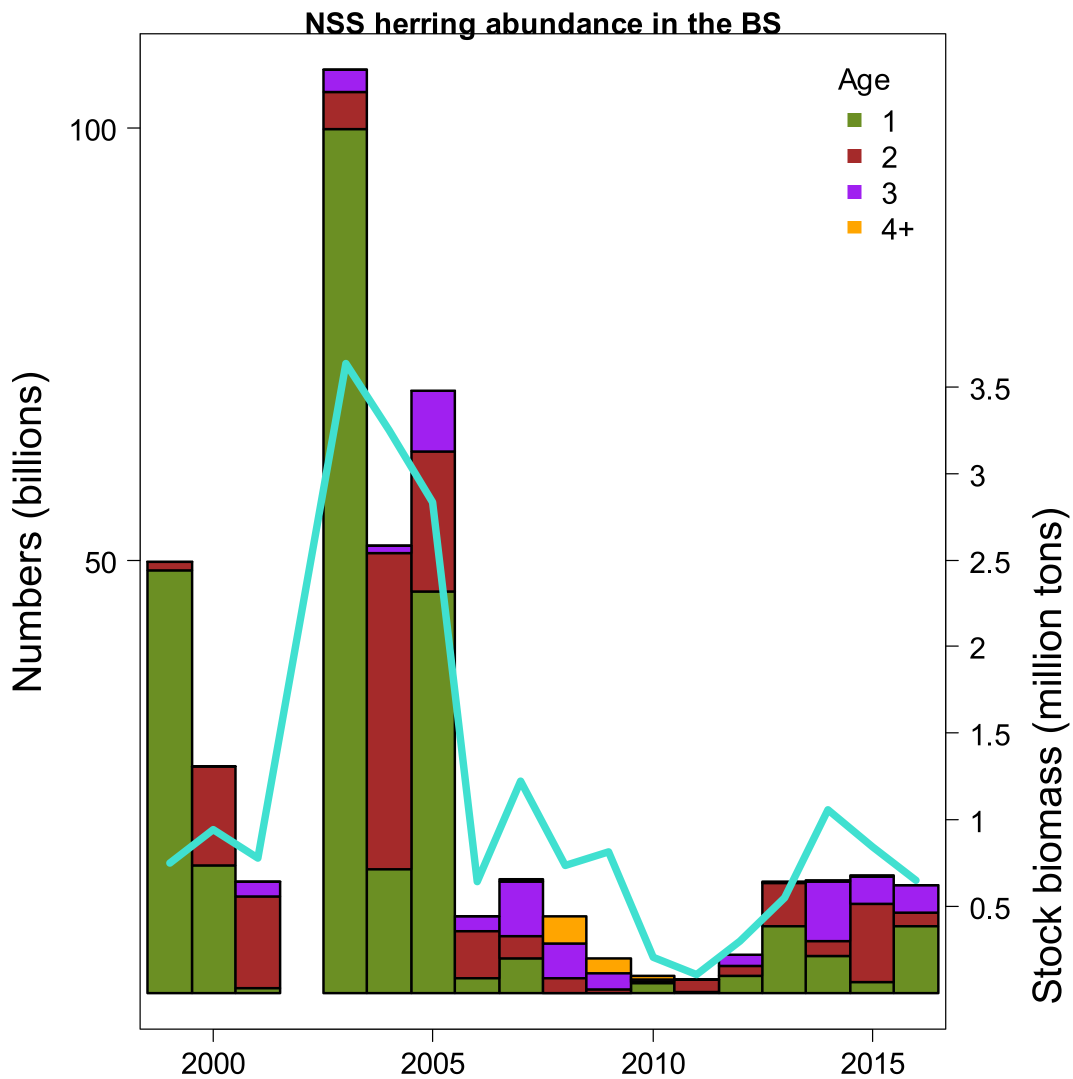


Fig. 5.2.2.2. Total abundance in billions (coloured bars and left axis), and biomass (turquoise line and right axis) of NSS-herring in the Barents sea (BESS data).

Table 5.2.2.1 Norwegian spring spawning herring. Acoustic estimate in the Barents Sea in August-October 2016

Length (cm)	Age group / year class					Sum (10^6)	Biomass (10^3 t)	Mean weight (g)
	1 2015	2 2014	3 2013	4 2012	5+ 2011			
11 - 12	3411					3411	34.1	10.0
12 - 13	564					564	6.8	12.1
13 - 14	226					226	3.6	16.1
14 - 15	2271					2271	47.4	20.9
15 - 16	468					468	11.7	24.9
16 - 17	390					390	11.6	29.7
17 - 18	368					368	13.3	36.0
18 - 19	47	12				59	2.6	44.2
19 - 20		208				208	11.1	53.0
20 - 21		170				170	9.6	56.4
21 - 22		191				191	12.6	65.6
22 - 23		436				436	35.7	81.9
23 - 24		343	486			829	80.3	96.8
24 - 25		181	891			1072	114.3	106.6
25 - 26		32	493			525	63.5	121.0
26 - 27			605			605	86.3	142.7
27 - 28			609			609	100.9	165.6
28 - 29			4	0.2	26	31	5.8	186.0
29 - 30			1	0.2	1	2	0.5	205.0
30 - 31					1	1	0.3	234.0
31 - 32					0.2	0.2	0.1	308.0
32 - 33								
33 - 34								
34 - 35								
35 - 36								
36 - 37					0.2	0.2	0.1	
37 - 38								
38 - 39					0.2	0.2	0.1	479.0
TSN (10^6)	7746	1574	3089	0.4	29	12452		
TSB (10^3 t)	130.5	126.2	389.5	0.1	5.2		652.0	
Mean length (cm)	13.2	22.1	25.3	28.5	30.2	31.5		
Mean weight (g)	16.9	80.2	126.1	192.1	223.7			52.4

The total number of herring in the Barents Sea (ages 1-4+) in 2015 was estimated at 12.5 billion individuals. which is lower than the long term level and similar to the three previous years. Comparative estimates of abundance and biomass of herring are shown in Table 5.2.2.2.

Number of 1-year-olds was estimated at 7.7 billion individuals. which is below the long-term average (14.5 billion individuals) but still the highest since 2005.

There was an estimated 1.5 billion 2-year-olds observed which is well below the long term mean. The average length of the 2-year group (22.1 cm) is higher than last year and average weight more than 20 g higher (80.2 g in 2016 versus 59.7 g in 2015).

The abundance of 3-year-olds in numbers was lower than last year but the biomass was higher; 3.1 billion individuals and 389 000 tonnes. The average weight of the 3-year-olds (126 g) was much higher than in 2015 (89 g) and also average length had increased (25.3 cm compared to 22 cm).

Table 5.2.2.2 Norwegian spring spawning herring. Acoustic estimates by age in autumn 1999-2016. 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	48759	716	986	31	51	2	0	0	49795	749
2000	14731	383	11499	560	0	0	0	0	26230	943
2001	525	12	10544	604	1714	160	0	0	12783	776
2002	**No data**	–	–	–	–	–	–	–	–	–
2003	99786	3090	4336	220	2476	326	0	0	106597	3636
2004	14265	406	36495	2725	901	107	0	0	51717	3252
2005	46380	984	16167	1055	6973	795	0	0	69520	2833
2006	1618	34	5535	398	1620	211	0	0	8773	643
2007	3941	148	2595	218	6378	810	250	46	13164	1221
2008	30	1	1626	77	3987**	287**	3223**	373**	8866**	738**
2009	2	48	433	52	1807	287	1686	393	5577	815
2010	1047	35	215	34	234	37	428	104	2025	207
2011	95	3	1504	106	6	1	0	0	1605	109
2012	2031	36	1078	66	1285	195	0	0	4394	296
2013	7657	202	5029	322	92	13	57	9	12835	546
2014	4188	62	1822	126	6825	842	162	25	13011	1058
2015	1183	6	9023	530	3214	285	149	24	13569	845
2016	7760	131	1573	126	3089	389	29	6	12452	652
Average	14485	363	6498	426	2391	279	352	58	24289	1136

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

5.2.3 Blue whiting *(Micromesistius poutassou)*

The old formula for estimating target strength (TS) used for blue whiting during the BESS differ from the new formula 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 formula 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.

<u>Distribution</u>

As in previous years, blue whiting was observed in the western part of the Barents Sea. in particular along the continental shelf edge (Figure 5.2.3.1).

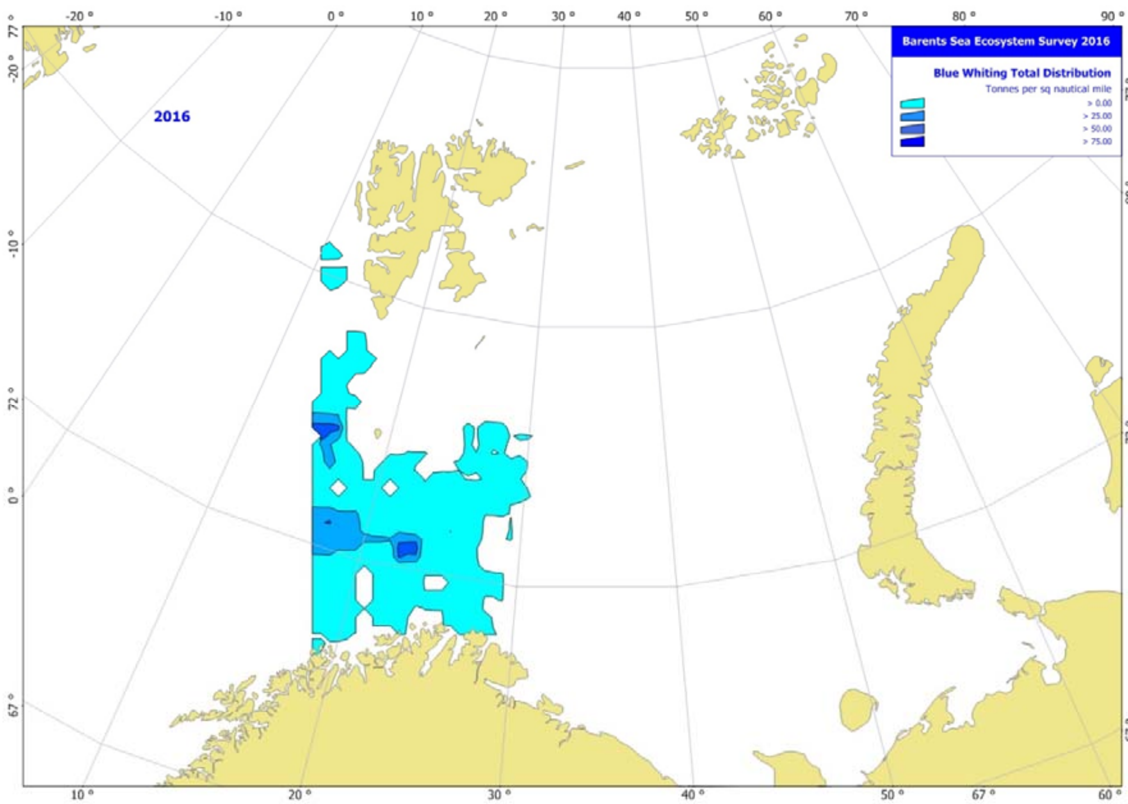


Figure 5.2.3.1. Estimated distribution of blue whiting (t/nautical mile^2) based on acoustic recordings. August-October 2016.

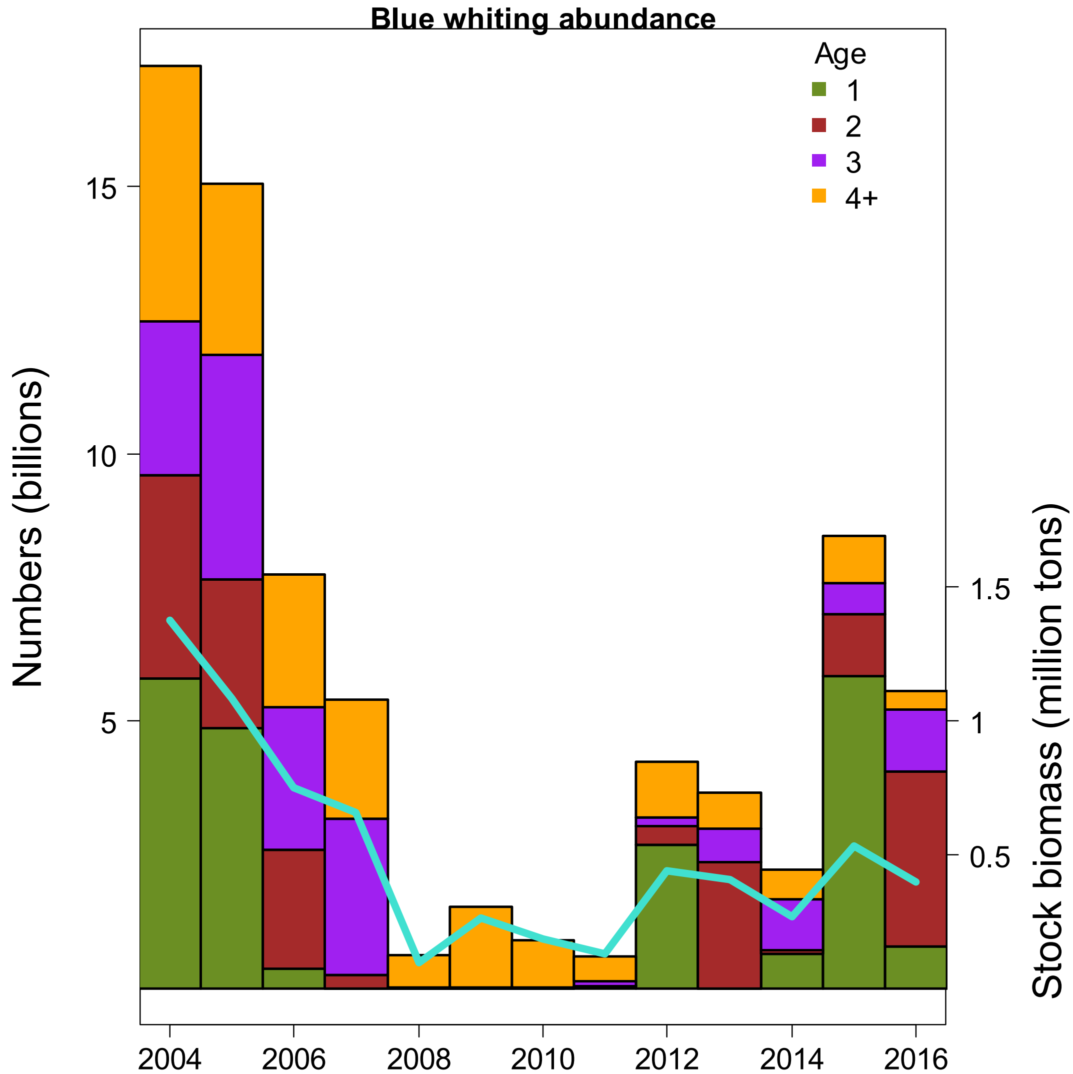


Figure 5.2.3.2. Total abundance in billions (coloured bars and left axis), and biomass (turquoise line and right axis) of blue whiting in the Barents sea (BESS data).

Abundance estimation

In 2004-2005 estimated biomass of blue whiting in the Barents Sea was above 1 million tonnes (Table 5.2.3.1). In 2008 the estimated biomass dropped abruptly to only about 13% of the estimated biomass in the previous year. Since 2007 it has been lower than the 2004-2016 average except last year. This year, blue whiting biomass was about 397 000 tonnes which is a drop from last year and a little bit below the long term mean (Figure 5.2.3.2).

The 2-year olds (2014 year class) dominated in terms of both number and biomass as expected based on the high abundance of 1-year-olds last year (Table 5.2.3.2).

Table 5.2.3.1 Blue whiting. Acoustic estimate in the Barents Sea in August-October 2016.

Length (cm)	Age group / year class											Sum	Biomass	Mean,
	1	2	3	4	5	6	7	9	10	11	12+	(10^6)	(10^3 t)	weight (g)
	2015	2014	2013	2012	2011	2010	2009	2007	2006	2005	2004-			
18-19	14.3	19.4										33.8	1.2	34.5
19-20	283.2	13.2										296.5	12.1	41.0
20-21	258.4	329.2	121.9									709.6	33.5	47.2
21-22	218.9	837.9	130.0									1186.8	64.7	54.6
22-23		986.1	164.2									1150.3	72.5	63.1
23-24		700.5	106.2									806.7	57.6	71.5
24-25		232.4	212.0									444.4	36.7	82.7
25-26		98.9	73.7	47.3	32.5							252.5	24.0	95.2
26-27		32.2	92.8		39.5							164.4	18.3	111.3
27-28		10.5	56.6	20.2		27.9						115.1	14.2	123.2
28-29			23.9	67.6	6.0							97.5	13.5	138.0
29-30			166.0									166.0	26.0	156.4
30-31			1.8	20.2	26.9							48.9	8.1	165.5
31-32			2.6		14.5						4.0	21.1	3.9	184.7
32-33						1.6				13.4		15.0	3.1	209.4
33-34					7.2							7.2	1.5	203.8
34-35				6.1								6.1	1.4	223.2
35-36						0.8		1.2	3.5			5.4	1.3	237.9
36-37						2.8			0.1		2.3	5.2	1.3	242.6
37-38							2.8					2.8	0.8	297.7
38-39									0.9			0.9	0.3	317.5
39-40											1.0	1.0	0.4	357.0
40-41										0.2		0.2	0.1	341.0
42-43											0.04	0.04	0.02	443.0
TSN (10^6)	774.9	3260.4	1151.8	161.4	126.6	33.0	2.8	1.2	4.5	13.5	7.4	5537.4		
TSB (10^3 t)	36.3	207.6	103.4	20.7	16.9	4.8	0.8	0.3	1.1	2.8	1.9		396.4	
Mean length (cm)	20.2	22.3	24.3	27.7	27.9	28.4	37.3	35.3	35.8	32.3	36.7			
Mean weight (g)	46.9	63.7	89.8	128.3	133.7	144.3	297.7	217.5	256.5	205.6	259.8			71.6

Target strength estimation based on formula: TS=21.8 log(L) - 72.7

Table 5.2.3.2 Blue whiting. Acoustic estimates by age in autumn 2004-2016. TSN and TSB are total stock numbers (10^6) and total stock biomass (10^3)

Age	1		2		3		4+		Sum	
Year	TSN	TSB	TSN	TSB	TSN	TSB	TSN	TSB	TSN	TSB
2004	5787	219	3801	286	2878	265	4780	607	17268	1377
2005	4871	132	2770	180	4205	363	3213	410	15058	1084
2006	371	21	2227	159	2665	238	2491	331	7754	749
2007	3	0	245	23	2934	292	2221	315	5666	658
2008	3	0	2	0	11	1	604	95	620	97
2009	2	0	2	0	2	0	1513	261	1519	261
2010	0	0	0	0	13	3	884	179	897	183
2011	30	2	16	2	79	15	462	109	587	129
2012	2685	125	355	43	158	26	1046	248	4244	441
2013	5	0	2364	188	609	62	676	155	3654	406
2014	639	28	83	8	932	104	575	126	2229	267
2015	5836	229	1159	100	596	68	872	137	8463	534
2016	793	37	3260	208	1152	103	350	49	5557	397
Average	1617.3	61.0	1252.6	92.1	1248.8	118.5	1514.4	232.5	5655.1	506.4

TS = 21.8 log (L) 72.7. corresponding to $\sigma = 6.7 \cdot 10^7 \cdot L^{2.18}$

5.2.4 Polar cod (*Boreogadus saida*)

Distribution

High concentrations of polar cod were found in the northeastern parts of the Barents Sea north of 77° and between 35 and 50 degrees east (Figure 5.2.4.1). Low abundances of polar cod were found along the south coast of Novaya Zemlya.

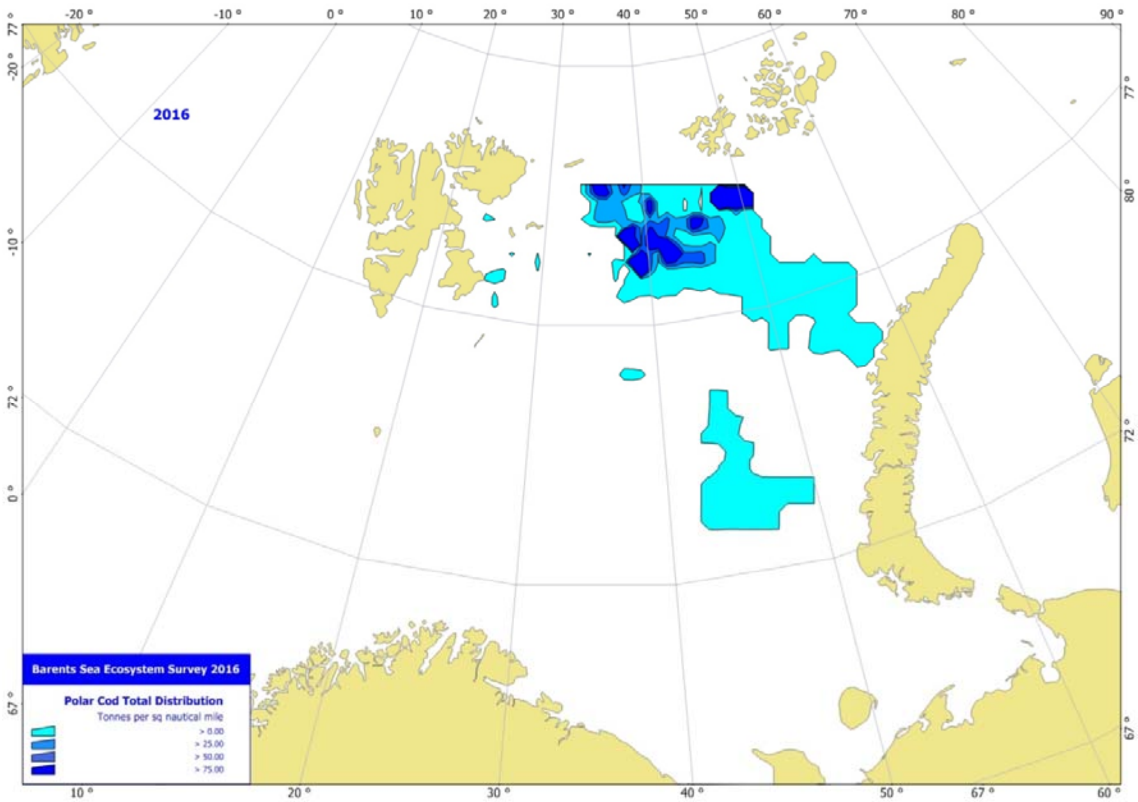


Figure 5.2.4.1 Estimated total density distribution of polar cod (t/sq nautical mile). August-October 2016. Note that the distribution map is not directly comparable with maps for previous years since the kriging is done based on 1 nmi resolution of the data compared to 2 degrees east-west and 1 degree north-south squares used previously.

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 2016 are summarized in table 5.2.4.3.

In 2016, the second highest number of 1-group polar cod on record was recorded, and the highest biomass of 1-year-olds ever recorded. The 1-year-olds totally dominated the total biomass (84 %) which was estimated at 939 thousand tons, the first estimate above the long term mean since 2010 (Table 5.2.4.1). Typically the polar cod was distributed in dense pelagic schools in the northern part of the Barents Sea (Figure 5.2.4.2).

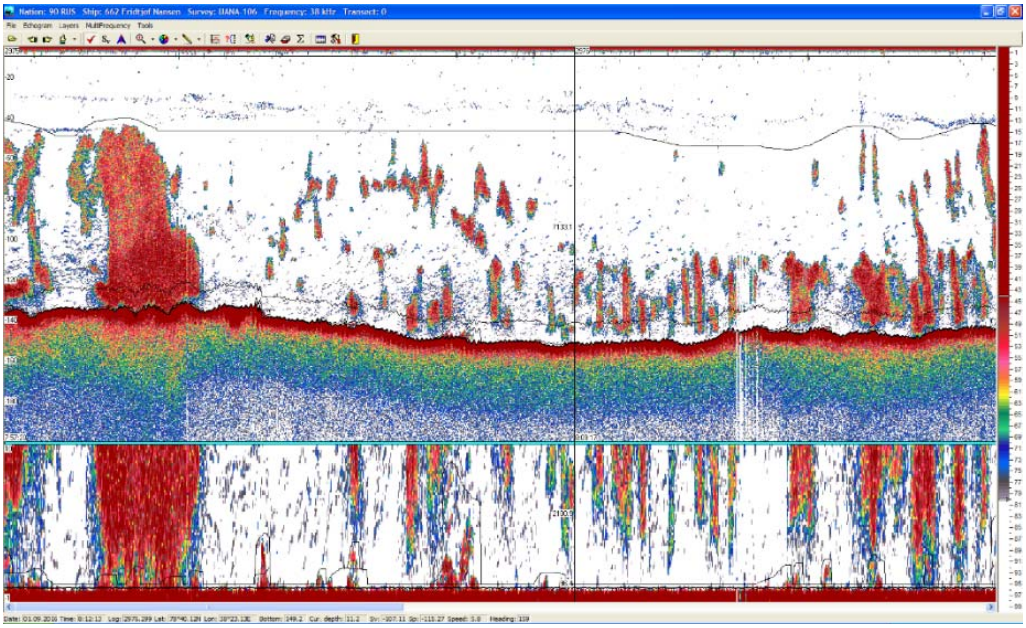


Figure 5.2.4.1 Echorecord of young polar cod to south-west from Frantz Yosef Land (78°40N, 38°23E, 01.09.2016)

Table 5.2.4.4 shows the "survey-mortality rates" of polar cod in the period 1985 to 2016 for each yearclass. Currently the polar cod fishery is negligible so the total mortality is close to the natural mortality. The mortality estimates are very variable for the entire period, and for some years the estimated stock size does most likely not reflect actual stock size, so the estimated mortality is wrong. The main sources of errors in the survey estimation is changes in distributions and hence a variable amount of the stock distributed in the Kara sea waters and Arctic Ocean which are not covered in the BESS. In some years polar cod can also be distributed under ice.

Table 5.2.4.1 Barents Sea polar cod. Acoustic estimate in August-October 2016

Length (cm)	Age group / year class				Sum	Biomass	Mean,
	1	2	3	4	(10^9)	(10^3 t)	weight (g)
	2015	2014	2013	2012			
7.5 - 8.0	0.498				0.50	2.0	4.0
8.0 - 8.5	3.064				3.06	12.3	4.0
8.5 - 9.0	6.182				6.18	66.9	10.8
9.0 - 9.5	6.879				6.88	37.6	5.5
9.5 - 10.0	18.552				18.55	113.3	6.1
10.0 - 10.5	18.087				18.09	124.8	6.9
10.5 - 11.0	14.689	0.309	0.004		15.00	129.2	8.6
11.0 - 11.5	12.636	0.214	0.006		12.86	120.6	9.4
11.5 - 12.0	8.261	0.366	0.005		8.63	95.6	11.1
12.0 - 12.5	3.553	0.008	0.004		3.57	45.1	12.7
12.5 - 13.0	2.038	0.209	0.006		2.25	31.7	14.1
13.0 - 13.5	0.984	0.602	0.007		1.59	27.0	16.9
13.5 - 14.0	0.297	0.424			0.72	12.2	16.9
14.0 - 14.5	0.144	0.902	0.001		1.05	19.6	18.8
14.5 - 15.0		0.747	0.002		0.75	15.6	20.9
15.0 - 15.5	0.055	0.635	0.002		0.69	16.1	23.3
15.5 - 16.0		0.417	0.002		0.42	11.2	26.7
16.0 - 16.5		0.478	0.077		0.56	15.3	27.6
16.5 - 17.0		0.353			0.35	11.0	31.3
17.0 - 17.5		0.234	0.002		0.24	7.4	31.1
17.5 - 18.0		0.159			0.16	5.8	36.5
18.0 - 18.5		0.108	+	0.001	0.11	4.2	38.6
18.5 - 19.0		0.145	+		0.15	6.3	43.0
19.0 - 19.5		0.055	0.068		0.12	5.8	47.0
19.5 - 20.0		0.013	0.003		0.02	0.8	52.4
20.0 - 20.5				0.006	0.01	0.3	49.5
20.5 - 21.0			0.012		0.01	0.7	56.0
21.0 - 21.5				0.010	0.01	0.5	51.5
21.5 - 22.0			+		0.00	0.0	59.0
22.0 - 22.5							
23.0 - 23.5			0.005		0.01	0.4	78.4
TSN (10^9)	95.919	6.380	0.207	0.023	102.529		
TSB (10^3 t)	792.6	139.1	6.9	0.7		939.43	
Mean length (cm)	10.18	14.39	16.82	19.02			
Mean weight (g)	8.26	21.8	33.53	47.7			9.2

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*	32804	242.7	3255	59.9	15374	481.2	1739	87.6	53172	871.4
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
2015	10866	97.1	1995	45.1	167	5.3	8	0.5	13036	148.0
2016	95919	792.7	6380	139.1	207	6.9	23	0.7	102529	939.4
Average	31461.8	251.4	14266.0	326.3	4858.9	183.2	513.6	27.9	51133.9	790.6

Target strength estimation based on formula: TS = 21.8 log (L) - 72.7 dB

*-values are based on VPA runs due to survey failure

Table 5.2.4.3 Summary of stock size estimates for polar cod in 2014-2015.

Year class		Age	Number (10^9)		Mean weight (g)		Biomass (10^3 t)	
2015	2014	1	95.9	2.2	8.3	8.2	792.7	18.1
2014	2013	2	6.4	4.3	21.8	23.7	139.1	102.2
2013	2012	3	0.2	5.2	33.5	40.1	6.9	210.3
2012	2011	4	0.02	0.2	47.7	54.9	0.1	9.9
Total stock in								
2016	2015	1-4	102.5	12.0	9.2	28.5	939.4	340.5
Target strength estimation based on formula: TS = 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 1 and age 2.

Year class	In age1	In age 2	Year class	In age1	In age 2
1985	57.8	92.8	2002	30.6	83.7
1986	90.2	83.9	2003	42.6	78.8
1987	58.8	63.4	2004	37.1	92.8
1988	83.6	13.5	2005	-	77.1
1989	-	80.0	2006	38.6	54.4
1990	40.9	78.8	2007	46.7	41.6
1991	17.4	73.3	2008	-	74.1
1992	42.9	82.7	2009	47.0	85.3
1993	76.4	49.4	2010	86.4	-
1994	67.2	68.8	2011	68.1	26.0
1995	60.1	48.9	2012	-	96.2
1996	51.8	-	2013	-	89.6
1997	74.7	35.9	2014	41.3	
1998	66.4	37.5	2015		
1999	53.6	59.5			
2000	54.9	55.9			
2001	61.4	19.3	**Mean**	**55.9**	**64.6**

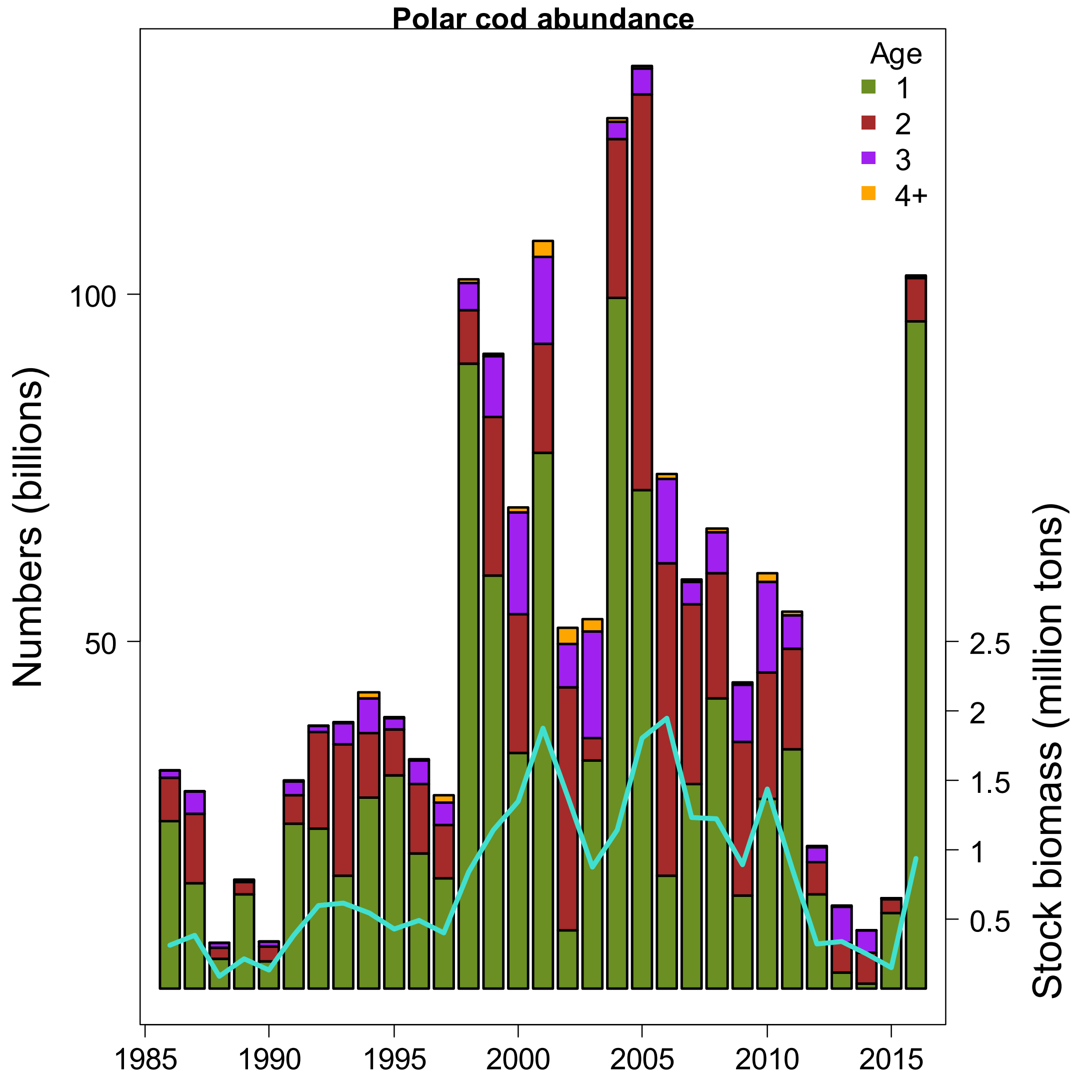


Figure 5.2.4.3. Total abundance in billions (coloured bars and left axis), and biomass (turquoise line and right axis) of polar cod in the Barents sea (BESS data).

6 MONITORING THE DEMERSAL COMMUNITY

6.1 Fish communities

This section provides data on the distribution of commercial and the most abundant non-target demersal fish species. In 2016 the coverage area decreased significantly compared to 2015. In International waters (Loophole) demersal trawl hauls were missing as in 2015, also the south-west part of Russian zone was not covered since these areas was closed for shipping. No attempts to adjust for reduced area coverage have been made. Thus, estimates in 2016 were lower than last year for almost all demersal fish species. As in previous years, the most abundant species by number was the long rough dab, while cod and haddock have the highest biomass.

6.1.1. Cod (*Gadus morhua*)

At the time of survey cod usually reaches the northern and eastern limits of its feeding area. In 2016 the zero-line for cod distribution was not found in the north-eastern Barents Sea, however, cod catches in the north-east areas did not exceed 46 kg/nautical mile. In general, the cod was distributed almost in all survey areas (Fig. 6.1.1.1), and the distribution pattern was similar to last year. The highest catches were observed to the east and southeast of Svalbard between 30 and 40° E in the same areas as capelin were found. The maximum catch was 539.5 kg/nautical mile, average catches about 45 kg/nautical mile. The abundance of cod in 2016 is slightly higher than in 2015, but the biomass still lower than in previous years (Table 6.1.1). Except for the lack of coverage of the Loophole and southwest Russian zone, the coverage of the cod stock in the 2016 survey was generally reasonable.

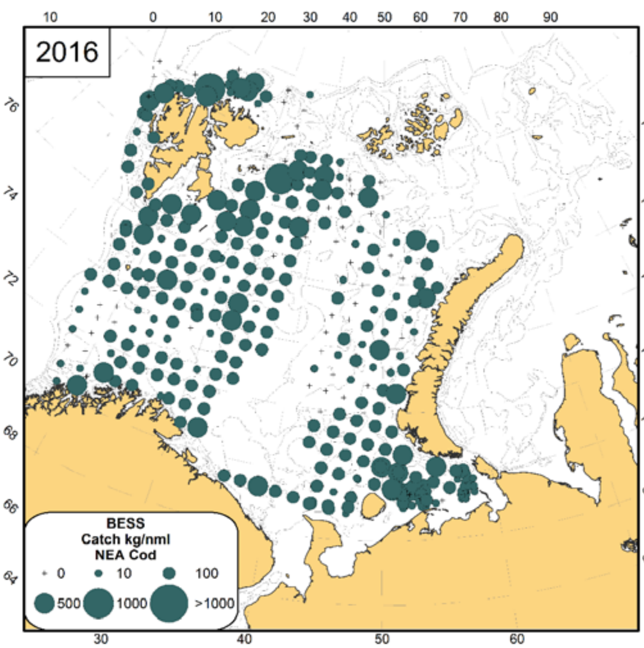


Figure 6.1.1.1 Distribution of cod (*Gadus morhua*), August-October 2016.

6.1.2 Haddock (*Melanogrammus aeglefinus*)

The distribution area of haddock in Barents Sea was not completely covered fully. Lack of coverage near the Murman coast led to underestimation of the stock of haddock. As last year, in 2016 haddock was widely distributed in the southern and western parts of the Barents Sea (Fig. 6.1.2.1). In the western areas the highest catches of haddock were observed south of the Spitsbergen, in the south-east areas of Barents Sea maximum catches were observed near the Kanin peninsula and Kolguev. Average catches of haddock in the shallow waters of the Pechora Sea increased slightly. Compared to last year the average catches of haddock in the survey area was almost twice as high; 41 kg/nautical mile, the maximum catch also was higher – 1441 kg/nautical mile. Abundance and biomass of haddock increased in comparison with 2015 despite the incomplete coverage of the stock distribution area (Table 6.1.1).

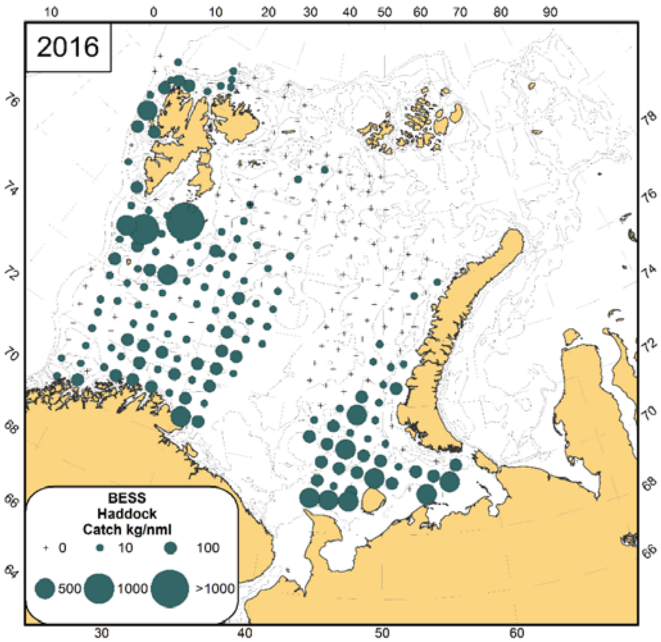


Figure 6.1.2.1 Distribution of haddock (*Melanogrammus aeglefinus*), August-October 2016.

6.1.3 Saithe (*Pollachius virens*)

This survey covers only a small part of saithe stock. As in previous years, the main concentrations of saithe were distributed along of Norway coast. Compared with last year, the area where saithe was observed increased despite the absence of trawling in the western part of Russian zone (Fig. 6.1.3.1). In 2016 saithe was distributed to the west of 35°E. In general, catches along the Norwegian coast have decreased, however, catches in the eastern part increased. The maximum catch was 425 kg/nautical mile. The indices of abundance and biomass of saithe decreased significantly from 2015 to 2016, but still remained above the level of previous years (Table 6.1.1).

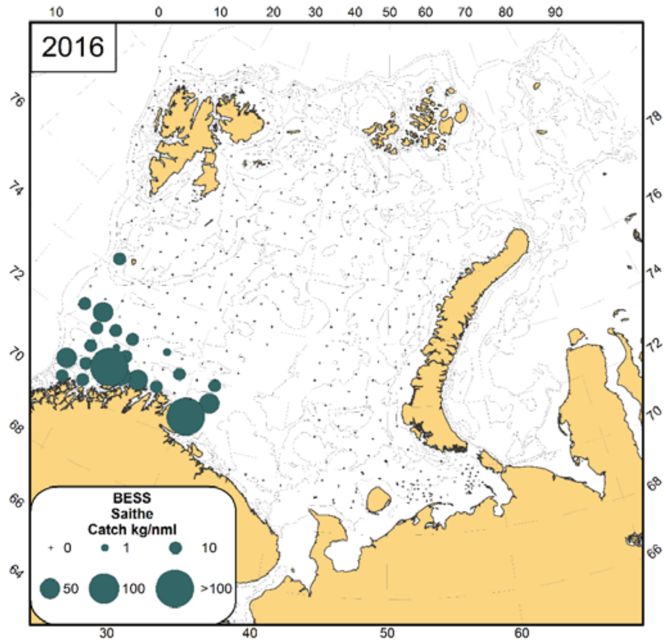


Figure 6.1.3.1 Distribution of saithe (*Pollachius virens*), August-October 2016.

6.1.4 Greenland halibut (*Reinhardtius hippoglossoides*)

Compared to the previous year, in 2016 the coverage of the north-east areas of the Barents Sea was slightly worse, but this was of minor importance for the survey estimate. Missing demersal trawls in the Loophole has significant impact on the estimate of the stock size. As in previous years, the Greenland halibut was observed in almost all catches in the deep areas of the Barents Sea (Fig. 6.1.4.1). Compared with last year the distribution pattern has not changed. In 2016 catches in the northern part of Barents Sea slightly increased. The main concentration of G. halibut was observed south and east of Spitsbergen and in the central part of the Barents Sea. Maximum catch was 30.7 kg/nautical mile. In 2016 the abundance of Greenland halibut grew to 82 million individuals, in the same time the biomass of halibut dropped to 40 thousand tons (Table 6.1.1). It is the minimum biomass level observed over the past 10 years.

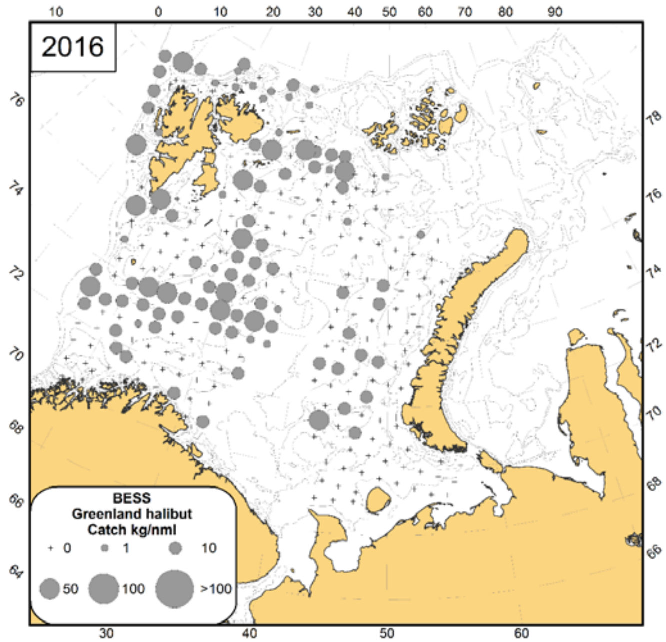


Figure 6.1.4.1 Distribution of Greenland halibut (*Reinhardtius hippoglossoides*), August-October 2016.

6.1.5 Golden redfish (*Sebastes norvegicus*)

In 2016 catches of golden redfish in the survey area decreased compared to 2015. In 2016 redfish was observed along Norway coast and to the west of Bear Island, where catches increased. However, golden redfish was not observed in the Russian zone (Fig. 6.1.5.1). In 2016 the maximum catch of golden redfish was 61 kg/nautical mile observed near the Norway coast around 20°E. The average catch of *S. norvegicus* increased to 7.4 kg/nautical mile. In 2016 biomass of golden redfish was highest observed in the last 10 years.

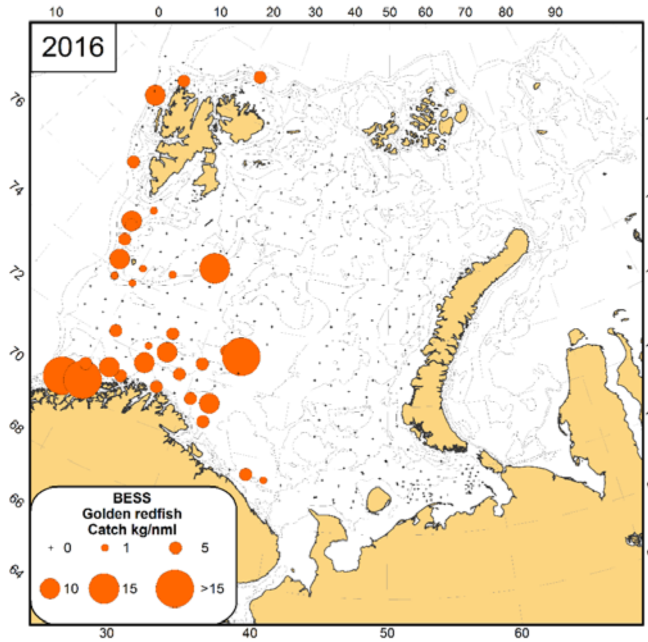


Figure 6.1.5.1 Distribution of golden redfish (*Sebastes norvegicus*), August-October 2016.

6.1.6 Deep-water redfish (*Sebastes mentella*)

Deep-water redfish was widely distributed in almost the entire survey area, except for the south-eastern and eastern parts of the Barents Sea (Fig. 6.1.6.1). In the Russian zone (eastern and northern areas), as in the last year, mostly juvenile redfish were observed. Highest catches of redfish were found in the western areas of Barents Sea to the south and east of the Bear Island. The average catch in survey area increased, compared to 2015, and amounted to 32.7 kg/nautical mile. The maximum catch was registered south of Bear Island and reached 496.1 kg/nautical mile. In 2016 abundance and biomass of deep-water redfish increased to 1.5 billion individuals and 319 thousand tons (Table 6.1.1).

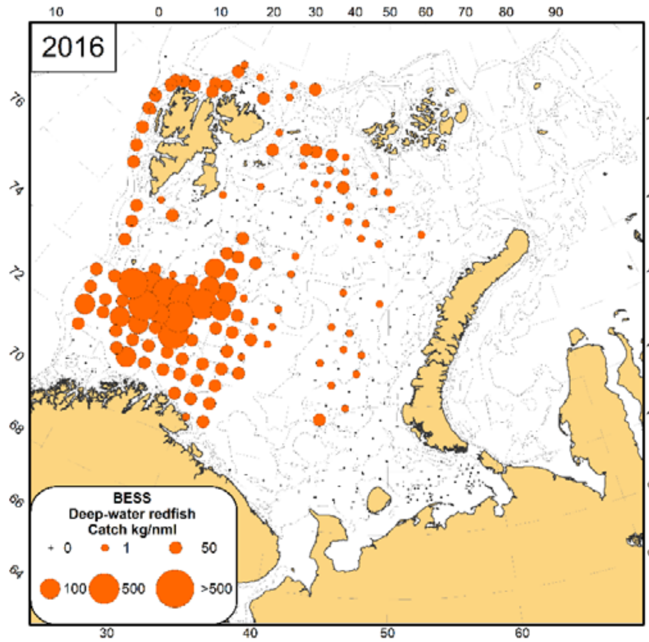


Figure 6.1.6.1 Distribution of deep-water redfish (*Sebastes mentella*), August-October 2016.

6.1.7 Norway redfish (*Sebastes viviparus*)

As last year, Norway redfish were mainly observed in the western areas of the survey along the Norwegian coast (Fig. 6.1.7.1). Several redfish individuals were, however, in the Upland Perseus area and the northern slope of Goose Sandbank. The maximum catch of *S. viviparus* was 213.5 kg/nautical mile, and the average catch in the research area decreased and amounted to 9.9 kg/nautical mile. Abundance and biomass indices in 2016 decreased to 125 million individuals and 13 thousand tons respectively (Table 6.1.1).

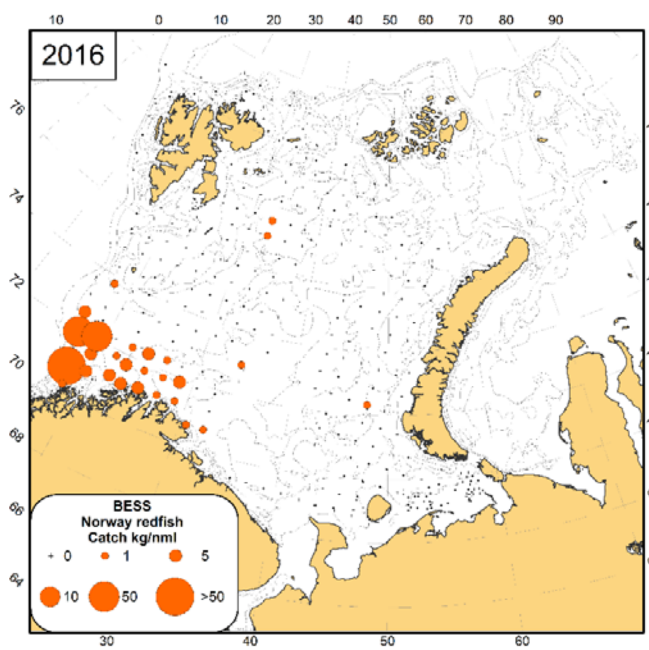


Figure 6.1.7.1 Distribution of Norway redfish (*Sebastes viviparus*), August-October 2016.

6.1.8 Long rough dab (*Hippoglossoides platessoides*)

As usual, long rough dab were found in all survey areas (Fig. 6.1.8.1). Relatively low catches were observed only in south-western areas of Barents Sea. The average catch of long rough dab increased and amounted to 15.7 kg/nautical mile. The maximum catch was observed south of Hopen Island with 142.2 kg/nautical mile. Main concentrations of long rough dab were found in the north and central parts of Barents Sea and to the south and west along the coast of the Novaya Zemlya. In comparison to last year the abundance and biomass indices have decreased and amounted to 3.4 billion individuals and 402 thousand tons respectively (Table 6.1.1). Nevertheless, long rough dab is the most numerous species in the Barents Sea.

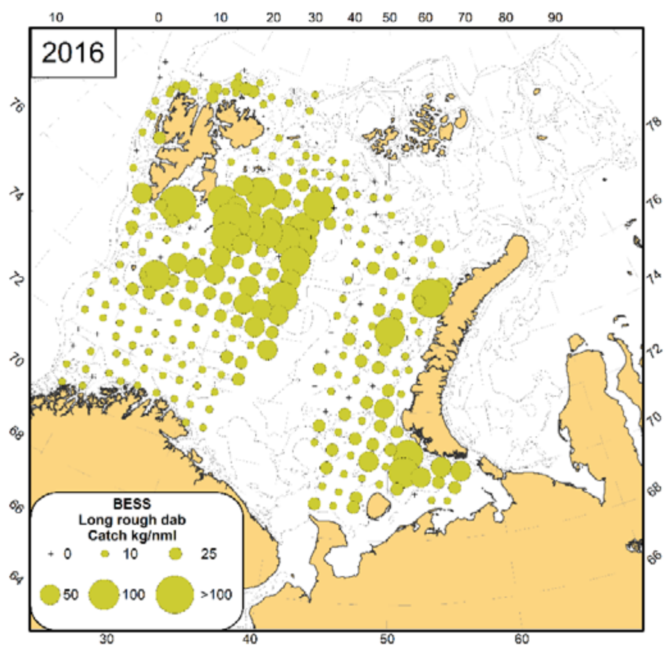


Figure 6.1.8.1 Distribution of long rough dab (*Hippoglossoides platessoides*), August-October 2016.

6.1.9 Atlantic wolffish (*Anarhichas lupus*)

Distribution of Atlantic wolffish was generally similar to last year. In 2016 wolffish catches increased west of Bear Island. On the opposite, catches in the south-eastern areas of Barents Sea decreased (Fig. 6.1.9.1). The main catches were found around Bear Island and to the south of Spitsbergen. The maximum catch of Atlantic wolffish decreased compared to the previous year and was 46.1 kg/nautical mile, while the average catch also declined to 6.3 kg/nautical mile. In comparison with 2015 the abundance of Atlantic wolffish increased by 7 million individuals 40 million, while the biomass dropped to 24 thousand tons (Table 6.1.1).

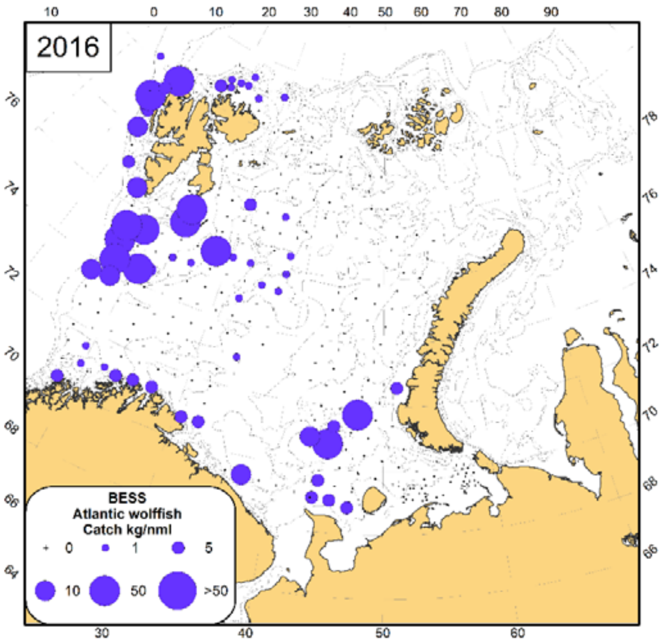


Figure 6.1.9.1 Distribution of atlantic wolffish (*Anarhichas lupus*), Augest-October 2016.

6.1.10 Spotted wolffish (*Anarhichas minor*)

In 2016 the distribution spotted wolffish was almost the same as in previous years. Spotted wolffish catches increased in the western and central parts of the Barents Sea and to the south-west of Novaya Zemlya coast. Overall in 2016 a more eastern distribution of spotted wolffish compared with 2015 (Fig. 6.1.10.1).

In 2016 the maximum catch wolffish was taken in Kanino-Kolguev shallow waters and was 88.5 kg/nautical mile, the average catch of *A. minor* reached 13.5 kg/nautical mile. The number of fish have increased, but biomass of spotted wolffish have decreased in comparison to last year (Table 6.1.1).

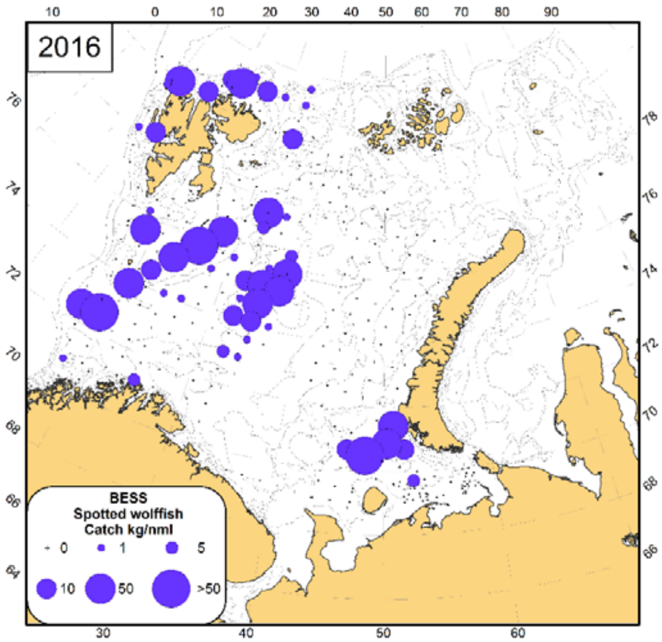


Figure 6.1.10.1 Distribution of spotted wolffish (*Anarhichas minor*), Augest-October 2016.

6.1.11 Northern wolffish (*Anarhichas denticulatus*)

In general, in 2016 distribution of Northern wolffish was similar to last year (Fig. 6.1.11.1). In Russian zone the number of hauls with wolffish catches decreased. The largest catches were registered south of Spitsbergen and near Bear island. In the northern and north-eastern regions northern wolffish as usual was not found.

The average catch of *A. denticulatus* slightly decreased and amounted to 16.3 kg/nautical mile. Maximum catch of northern wolffish also decreased to 74.5 kg/nautical mile. In connection with the general decline in catches of wolffish as well as a reduction of survey area the abundance and biomass of northern wolffish decreased in comparison with the previous year by 1 million individuals and 12 thousand tons respectively (Table 6.1.1).

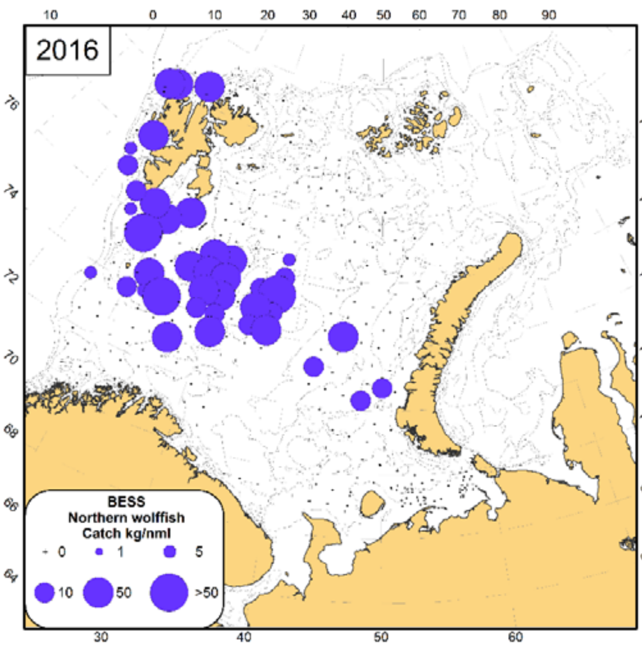


Figure 6.1.11.1 Distribution of northern wolffish (*Anarhichas denticulatus*), Augest-October 2016.

6.1.12 Plaice (*Pleuronectes platessa*)

In 2016 plaice was mainly found in the region between 43° and 56°E (Fig. 6.1.12.1). Several individuals were however caught near Norway coast at 30° and 20°E. Average catch decreased compared to the previous year and amounted to 4.5 kg/nautical mile while maximum catch was 21.2 kg/nautical mile. It should be noted that there were no trawls of the coast of Murman, where in 2015 maximum catches were observed. Thus in 2016 the indices of abundance and biomass decreased (Table 6.1.1).

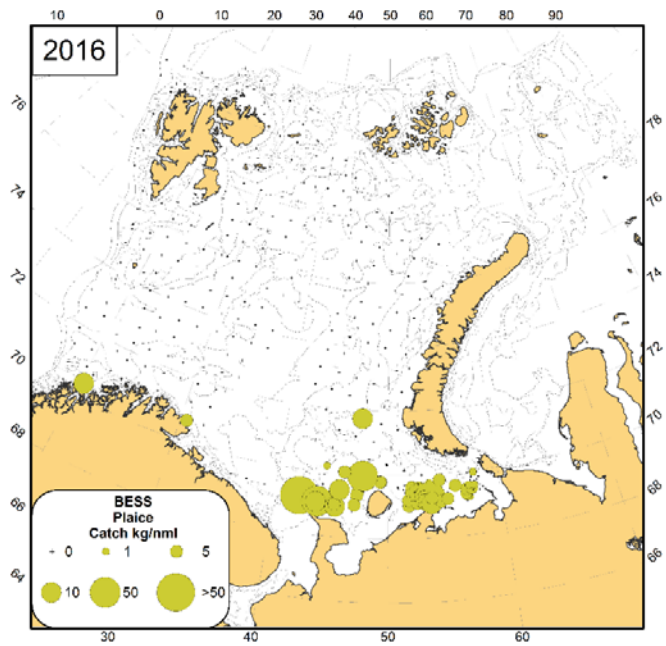


Figure 6.1.12.1 Distribution of plaice (*Pleuronectes platessa*), August-October 2016.

6.1.13 Norway pout (*Trisopterus esmarkii*)

The distribution of Norway pout was similar to last year. Main concentrations were found in the southwestern part of Barents Sea along the Norway coast (Fig. 6.1.13.1). Overall, in the surveyed area the average catch of Norway pout increased compared to 2015 and amounted to 10.0 kg/nautical mile. However, due to the reduction of survey area the indices of abundance and biomass of Norway pout fell to 797 million individuals and 28 thousand tons (Table 6.1.1).

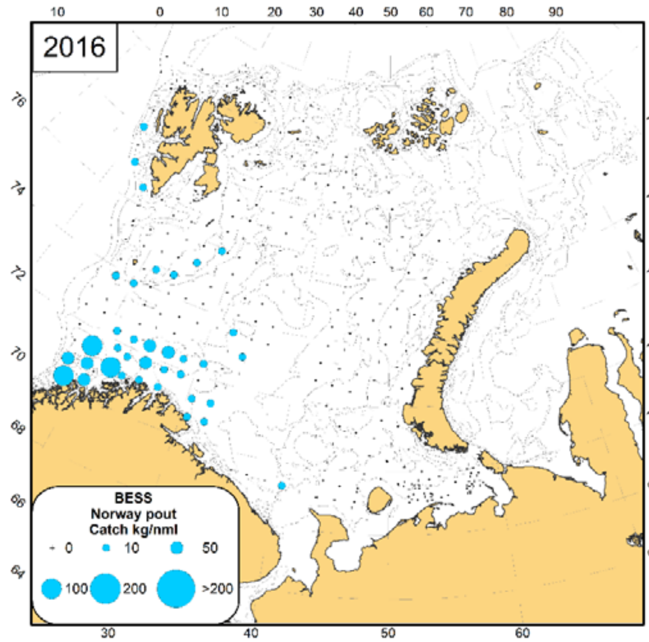


Figure 6.1.13.1 Distribution of Norway pout (*Trisopterus esmarkii*), August-October 2016.

6.1.14 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 6.1.1. Estimates by age/length group for cod, haddock, redfish, and Greenland halibut will be presented in the ICES AFWG report in 2017.

In 2016, the abundance and biomass of almost all species decreased compared to 2015. The reduction of the survey area significantly affected our stock assessments of demersal fish in Barents Sea.

As seen in Table 6.1.1, numbers and biomass of demersal fish species varies annually. This changes are significant for some species, and negligible for others. However, abundance indices allow for investigations of total fish quantity dynamics in the Barents Sea. Some noncommercial species can be indicators of the ecosystem state since their numbers are changing for natural reasons only. Fluctuation in abundance numbers for different fish species indicates not only stock changes, but also changes in ecosystem conditions.

Table 6.1.1. Abundance (N, million individuals) and biomass (B, thousand tonnes) of the main demersal fish species in the Barents Sea (not including 0-group).

Species		Year										
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Atlantic wolffish	N	26	42	25	20	17	20	22	27	12	33	↑40
	B	11	11	14	8	17	13	9	30	12	37	↓24
Spotted wolffish	N	12	12	13	9	7	9	13	13	8	12	↑13
	B	46	42	51	47	37	47	83	84	51	86	↓40
Northern wolffish	N	2	3	3	3	3	6	8	12	6	9	↓8
	B	19	25	22	31	25	42	45	52	34	63	↓51
Long rough dab	N	3705	5327	3942	2600	2520	2507	4563	4932	3046	3624	↓3369
	B	378	505	477	299	356	322	584	565	413	438	↓402
Plaice	N	36	120	57	21	34	36	21	36	170	107	↓37
	B	19	55	29	13	21	26	13	29	121	79	↓29
Norway redfish	N	219	64	24	17	26	83	114	233	105	168	↓125
	B	19	10	4	2	2	9	12	25	6	20	↓13
Golden redfish	N	16	20	42	12	22	14	32	75	45	9	↑34
	B	16	11	17	11	4	5	8	20	13	5	↑24
Deep-water redfish	N	526	796	864	1003	1076	1271	1587	1608	927	894	↑1527
	B	219	183	96	213	112	105	196	256	208	214	↑319
Greenland halibut	N	430	296	153	191	186	175	209	160	43	79	↑82
	B	77	86	76	90	150	88	86	94	53	52	↓40
Haddock	N	3518	4307	3263	1883	2222	1068	1193	734	1110	1135	↑1604
	B	659	1156	1246	1075	1457	890	697	570	630	505	↑836
Saithe	N	28	70	3	33	5	9	14	18	3	105	↓58
	B	49	98	7	29	9	10	13	33	6	153	↓54
Cod	N	1539	1724	1857	1593	1651	1658	2576	2379	1373	1694	↑1767
	B	810	882	1536	1345	2801	2205	1837	2132	1146	1425	↓1087
Norway pout	N	1838	2065	3579	3841	3530	5976	3089	2267	1254	943	↓797
	B	32	61	97	131	103	68	105	40	37	33	↓28

7 MONITORING OF BIODIVERSITY

7.1 Fish biodiversity

7.1.1 Small non-target fish species

By E. Eriksen, T. Prokhorova and A. Dolgov
Figures by E. Eriksen

Despite the distribution and biology of the non-commercial fish species and their role in the Barents Sea ecosystem being investigated since mid-1990s (e.g. Dolgov, 1995; Wienerrother et al., 2011; Wienerrother et al., 2013 etc), their distribution patterns, abundance and biomass is poorly studied. Since 2012 abundance and biomass of pelagically distributed juveniles of fish species from the families Agonidae, Ammodytidae, Cottidae, Liparidae, Myctophidae and Stichaeidae (called "small fishes" here) were calculated presented in the Survey report.

In 2016, the total biomass of small fishes (7.0 thousand tonnes for all these families) was much higher than than in 2013-2015 and 1.6 times higher than to the long term mean (4.3 thousand tones, Table 7.1.1.1). The average biomass of 0-group fish of the most abundant commercial species (capelin, cod, haddock, herring, redfish and polar cod) for 1993-2016 was 1.8 million tonnes, so the small fishes in 2016 were 257 times lower than the most abundant 0-group fish.

Table 7.1.1.1. Abundance indices (AI) (in millions) and biomass (B) (in tonnes) of pelagically distributed juveniles from families Agonidae, Ammodytidae, Liparidae, Cottidae, Myctophidae and Stichaeidae. LTM means long term mean for the period 1990-2016.

Year	*Agonidae*		*Ammodytidae*		*Cottidae*		*Liparidae*		*Myctophidae*		*Stichaeidae*		Total biomass
	AIc	B	AIc	B	AIc	B	AIc	B	AIc	B	AIc	B	
1990	37	11	2099	1050	195	58	0	0	40	18	830	415	1552
1991	179	54	1733	866	2799	840	404	141	6	3	1565	783	2686
1992	85	25	1367	683	230	69	36	12	293	132	456	228	1150
1993	10	3	3425	1712	71	21	15	5	1536	691	0	0	2433
1994	808	242	33168	16584	3992	1198	11	4	13	6	0	0	18034
1995	39	12	4562	2281	93	28	2	1	40	18	3	2	2341
1996	117	35	7791	3895	310	93	35	12	274	123	0	0	4159
1997	32	9	3393	1697	282	85	184	65	12	5	1591	796	2656
1998	112	33	471	236	289	87	99	35	14	6	805	403	799
1999	388	116	1630	815	2460	738	865	303	12	5	1062	531	2508
2000	336	101	8549	4274	887	266	464	163	219	98	2129	1065	5967
2001	75	23	1052	526	206	62	97	34	153	69	681	340	1053
2002	20	6	3259	1630	37	11	46	16	17	8	0	0	1670
2003	33	10	692	346	795	239	10	4	1	1	56	28	626
2004	186	56	4321	2160	354	106	213	75	102	46	81	41	2484
2005	407	122	14379	7190	859	258	3241	1134	42	19	602	301	9023
2006	542	163	25708	12854	0	0	3004	1051	0	0	2027	1014	15081
2007	312	94	839	419	683	205	2001	700	30	13	272	136	1568
2008	121	36	200	100	9	3	26	9	76	34	382	191	374
2009	458	137	10912	5456	3338	1001	1029	360	438	197	4815	2408	9560
2010	253	76	721	360	170	51	267	93	35	16	4390.2	2195	2792
2011	150	45	1844	922	61	18	938	328	27	12	4227	2113	3439
2012	149	45	8694	4347	211	63	936	327	585	263	7674	3837	8883
2013	7	2	2457	1229	36	11	38	13	281	127	199	100	1481
2014	40	12	2059	1029	15	4	18	6	141	64	1480	740	1855
2015	59	18	2903	1452	216	65	439	154	107	48	4050	2025	3761
2016	113	34	9346	4673	185	56	2081	728	687	309	2440	1220	7020
LTM	**188**	**56**	**5836**	**2918**	**696**	**209**	**611**	**214**	**192**	**86**	**1549**	**774**	**4258**

Agonidae were represented by *Leptagonus decagonus*. *L. decagonus* was distributed in the northern area. Single catch was observed west of the Novaya Zemlya Archipelago (Figure 7.1.1.1). The estimated indices in 2016 showed that abundance (113 million individuals) and biomass (34 tonnes) increased since 2013, but was lower than the long term mean of 188 million individuals and 56 tonnes (Table 7.1.1.1).

Ammodytidae were mostly represented by *Ammodytes marinus* and in 2016 were observed at the same area as in previous years - at the western and south-eastern areas (Figure 7.1.1.1). In 2016 estimated abundance and biomass was almost two times higher than long term mean and was 9.3 billion individuals and 4.7 thousand tonnes, respectively.

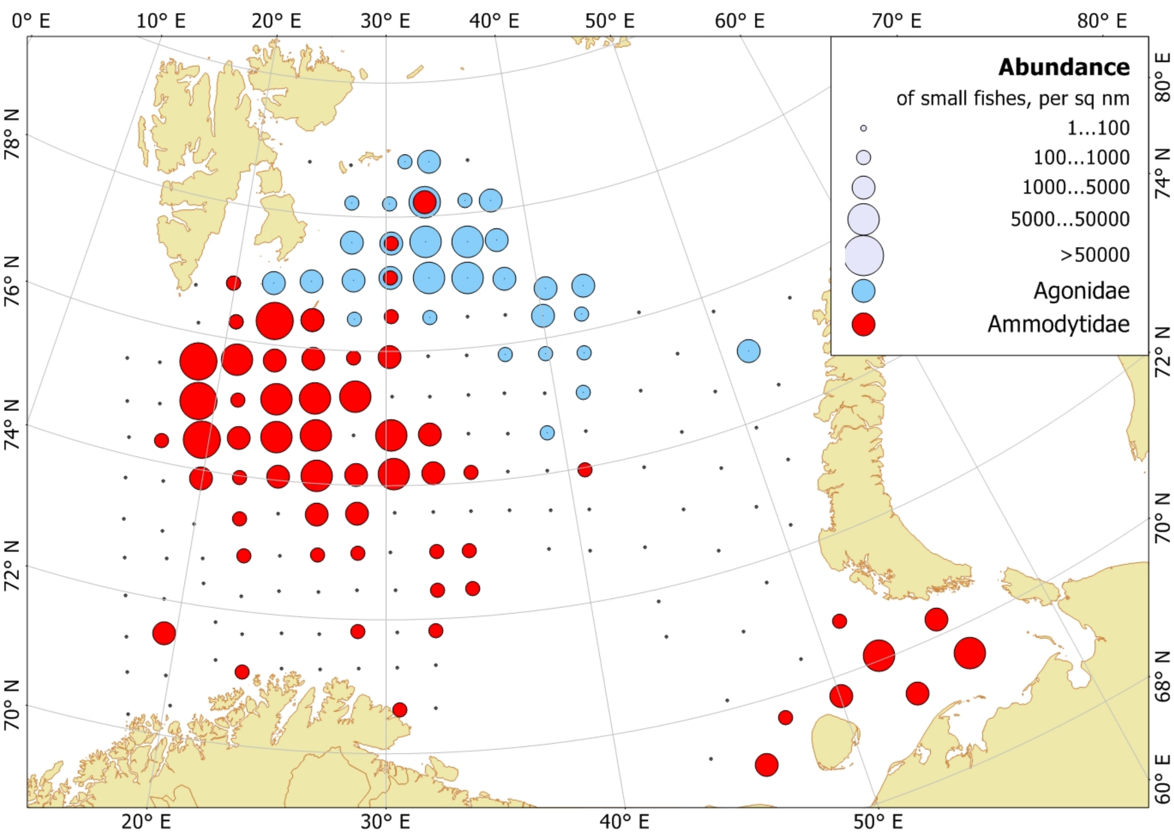


Figure 7.1.1.1. Distribution of *Agonidae and Ammodytidae*, August- September 2016.

Stichaeidae included *Lumpenus lampraetaeformis*, *Leptoclinus maculatus* and *Anisarchus medius*, while *Lumpenus fabricii* is rare in the Barents Sea (Figure 8.2.1.2). The total biomass only presented for the first three species (Table 7.1.1.1). In 2016, Stichaeidae were observed over larger area. In 2016, abundance (2.4 billion) and biomass (1.2 thousand tonnes) of

Stichaeidae was lower than in 2015, but higher than long term mean of 1.5 billion (abundance) and 0.8 thousand tonnes (biomass).

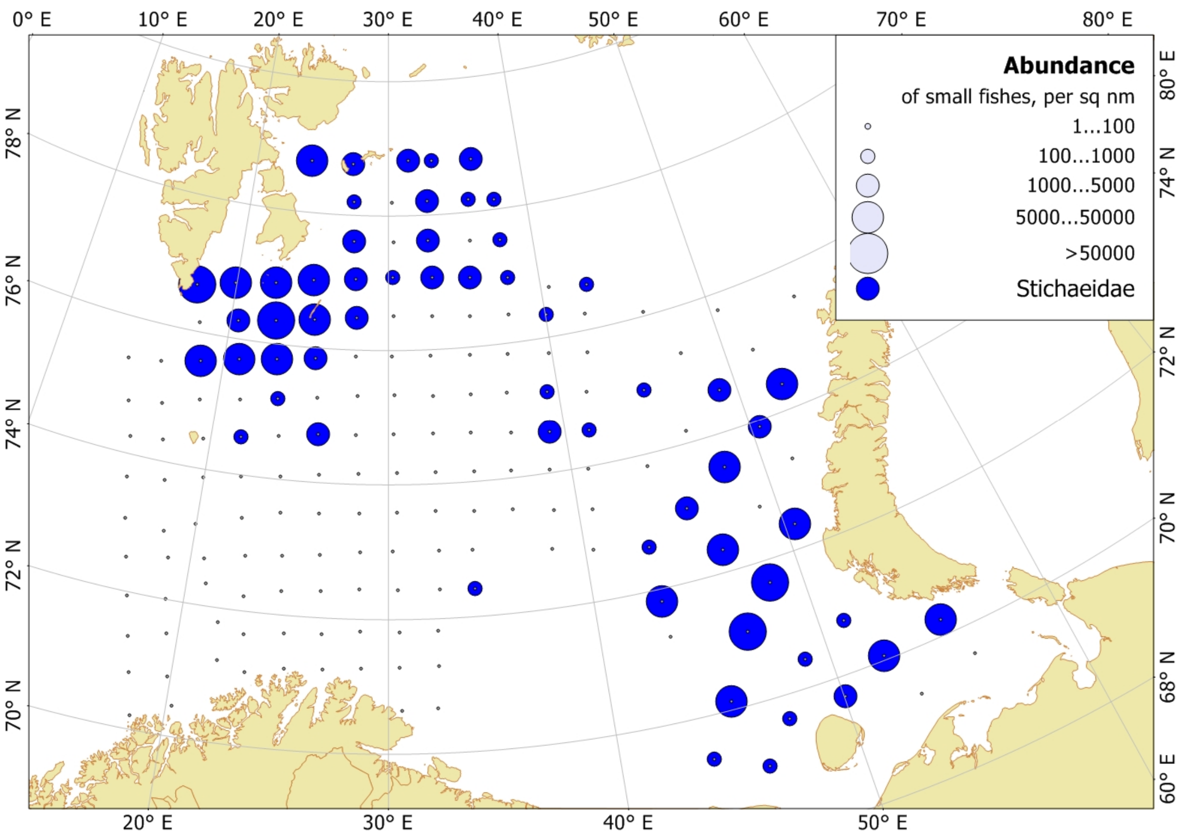


Figure 7.1.1.2. Distribution of *Stichaeidae*, August-September 2016.

Cottidae were mostly represented by *Myoxocephalus scorpius*, *Triglops nybelini*, *Triglops pingelii* and *Triglops murrayi*. In 2016, Cottidae were found in western part only and their distribution was smaller than previous years (Figure 7.1.1.3). Abundance (185 million) and biomass (56 tonnes) was very low, and was almost 3 times lower than long term mean of 696 million (abundance) and 209 tonnes (biomass) (Table 7.1.1.1).

Liparidae were represented by *Liparis fabricii* and *Liparis bathyarcticus.* In 2016, Liparidae distributed east for Svalbard/Spitsbergen (Figure 7.1.1.3). Abundance and biomass was 2 081 million and 728 tonnes, respectively. That is highest since 2007, and higher than the long time mean (611 million and 211 tonnes) (Table 7.1.1.1).

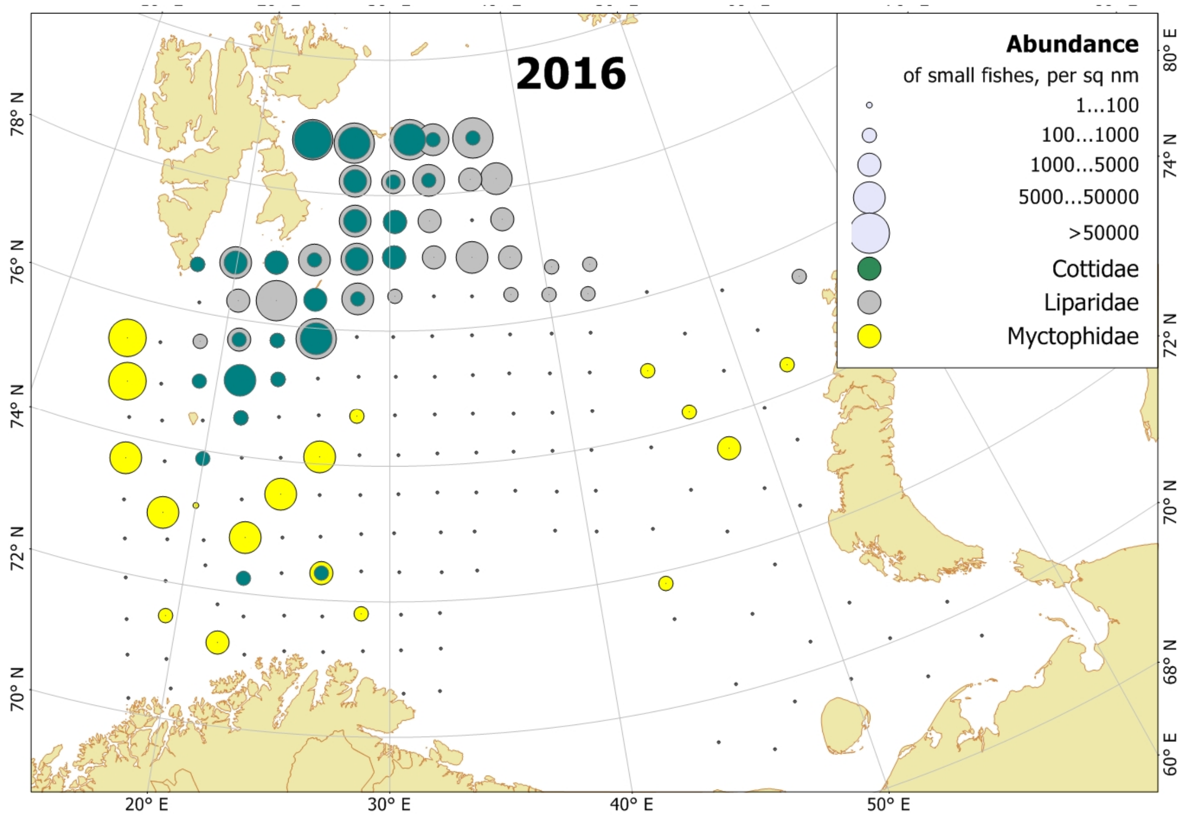


Figure 7.1.1.3. Distribution of Cottidae, Liparidae and Myctophidae, August- September 2016.

Myctophidae are mostly represented by *Benthosema glaciale*, and was observed between 72 °N and 77 °N in the western and eastern part of the survey area (Figure 7.1.1.3). Biomass and abundance of pelagically distributed myctophids in 2016 is highest observed since 1994 and much higher than the long term mean, and was 687 million and 309 tonnes, respectively (Table 8.2.1.1). These indices should be interpreted as minimum indices due to myctophids high trawl avoidance.

7.1.2 Indicator-Species

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 ecologically similar 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.

Thorny skate was distributed in the wide area from the southwest to the northwest where warm Atlantic and Coastal Waters dominates (Figure 7.1.2.1, see Figure 3.1.2.7 in the section 3.1 "Hydrography"). Thorny skate was found roughly in the same area as in 2015, and it was observed in 34.8 % of the bottom stations. Thorny skate was distributed within a depth of 25-829 m, and the highest biomass was at depth 50-150 m (36.8 % of total biomass) and 200-300 m (33.4 % of total biomass). The mean catch was somewhat less than in 2015 and 2014 (Table 7.1.2.1). The estimated total biomass and abundance of thorny skate in 2016 was slightly less than 2015 and 2014 (Table 7.1.2.1). The mean weight of this species in 2016 was the same as in 2015, but higher than in 2014 (Table 7.1.2.1).

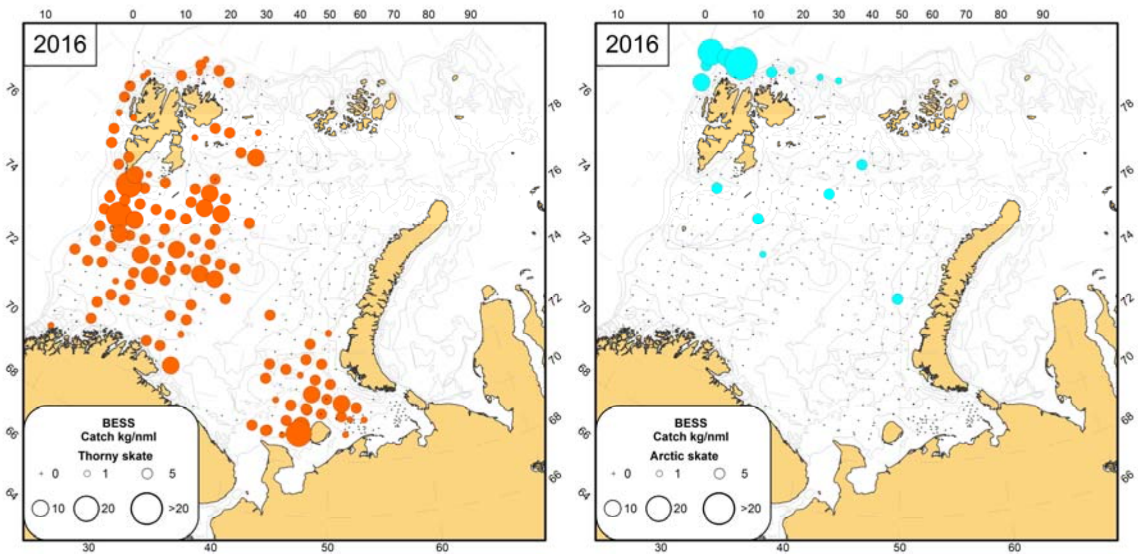


Figure 7.1.2.1 Distribution of thorny skate (*Amblyraja radiata*) and Arctic skate (*Amblyraja hyperborea*), August-October 2016

Table 7.1.2.1 Mean abundance (N, individuals per nautical mile) and biomass (B, kg per nautical male), total abundance (N, million individuals) and biomass (thousand tonnes) and mean weight (kg) of thorny skate during BESS 2016

	2014		2015		2016	
	N	B	N	B	N	B
Mean catch	1.4	1.2	1.1	1.0	1.0↓	0.9↓
Total	34.4	30.0	31.8	30.5	30.7↓	28.2↓
Mean weight		0.82		0.97		0.97

Arctic skate was mainly found in deep trenches in the northwest and central Barents Sea (Figure 7.1.2.1, see also Figure 3.1.2.7 in the section 3.1 "Hydrography"). This species was not found in the southwest Barents Sea, as it was in 2015. Arctic skate was found in the 4.6 % of the bottom stations, and it was distributed within a depth of 164-1092 m and the highest biomass was observed at 750-1092 m (71.7 %). The mean biomass of Arctic skate in 2016 was higher than in 2015, but less than in 2014 (Table 7.1.2.2). The mean abundance in 2016 was higher than in 2015, but the same as in 2014 (Table 7.1.2.2). The estimated total biomass of Arctic skate in 2016 was higher than in 2015, but less than in 2014 . The total abundance in 2016 was higher than in 2015 and in 2014 (Table 7.1.2.2). Mean weight of this species in 2016 was less than in 2015 and in 2014 (Table 7.1.2.2).

Table 7.1.2.2 Mean abundance (N, individuals per nautical mile) and biomass (B, kg per nautical male), total abundance (N, million individuals) and biomass (thousand tonnes) and mean weight (kg) of Arctic skate during BESS 2016

	2014		2015		2016	
	N	B	N	B	N	B
Mean catch	0.2	0.3	0.07	0.1	0.2↑	0.2↑
Total	3.7	6.7	1.6	1.9	8.6 ↑	4.0↑
Mean weight		1.66		1.44		0.47↓

7.1.3 Zoogeographic groups

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

Figures by P. Krivosheya

During the 2016 ecosystem survey 96 fish species from 33 families were recorded in the catches, and some taxa were only recorded at 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** as defined by Andriashev and Chernova (1994) and Mecklenburg et al. (2010). Table 7.1.3.1 represents median and maximum catches of species from different zoogeographic groups in the survey. While only bottom trawl data were used, and only non-commercial species were included into the analysis, both demersal (including bentho-pelagic) and pelagic (neritopelagic, epipelagic, bathypelagic) species were included (Andriashev and Chernova, 1994, Parin, 1968, 1988).

Widely distributed (only ribbon barracudina *Arctozenus risso* represents this group), **south boreal** (e.g. whiting *Merlangius merlangus*, silvery pout *Gadiculus argenteus*, grey gurnard *Eutrigla gurnardus*) and **boreal** (e.g. round skate *Rajella fyllae*, silvery lightfish *Maurolicus muelleri*, moustache sculpin *Triglops murrayi*) species were mostly found over the south western and western part of the survey area where warm Atlantic and Coastal Waters dominates (Figure 7.1.3.1). The median catch of species from the south boreal group in 2016 (1.4 individuals per nautical mile) was little higher than in 2015 (1.2 individuals per nautical mile), but the maximum catch in 2016 (135.0 individuals per nautical mile) was less than in 2015 (216.3 individuals per nautical mile). The median catch and the maximum catch of species from the boreal group in 2016 (18.3 individuals per nautical mile and 743.8 individuals per nautical mile correspondingly) were higher than in 2015 (8.7 individuals per nautical mile and 660.0 individuals per nautical mile) (Table 7.1.3.1).

Mainly boreal species (e.g. Vahl's eelpout *Lycodes gracilis*, snakeblenny *Lumpenus lampretaeformis*, lesser sandeel *Ammodytes marinus*) were as usual widely distributed over the entire survey area (Figure 7.1.3.1). The south boreal, boreal and mainly boreal species were widely distributed, most likely due to higher temperature near the bottom throughout the Barents Sea in 2016 compared to 2013-2015. The median catch of species from the mainly boreal group in 2016 (32.5 individuals per nautical mile) was somewhat higher than in 2015 (30.0 individuals per nautical mile), but the maximum catch in 2016 (718.1 individuals per nautical mile) was 2.2 times less than in 2015 (1580.0 individuals per nautical mile) (Table 7.1.3.1).

Arctic-boreal (e.g. ribbed sculpin *Triglops pingelii*, Atlantic poacher *Leptagonus decagonus*), **mainly Arctic** (e.g. slender eelblenny *Lumpenus fabricii*, Arctic staghorn sculpin *Gymnocanthus tricuspis*, variegated snailfish *Liparis bathyarcticus*) and **Arctic** (e.g. bigeye sculpin *Triglops nybelini*, Arctic alligatorfish *Aspidophoroides olrikii*, pale eelpout *Lycodes pallidus*) species were distributed west and north off Svalbard/ Spitsbergen, west off Novaya Zemlya Archipelago, in the Pechora Sea area and in the northern part of the survey area (Figure 7.1.3.1). Species of these groups mostly occur in areas influenced by cold Arctic Water, Spitsbergen Bank Water, Novaya Zemlya Coastal Water and Pechora Coastal Water. Median catch and maximum catch of species from mainly Arctic group in 2016 was higher, but from Arctic group was less, than in 2015 (Table 7.1.3.1). Median catch of species from Arctic-boreal group in 2016 was less than in 2015, and maximum catch was higher ((Table 7.1.3.1).

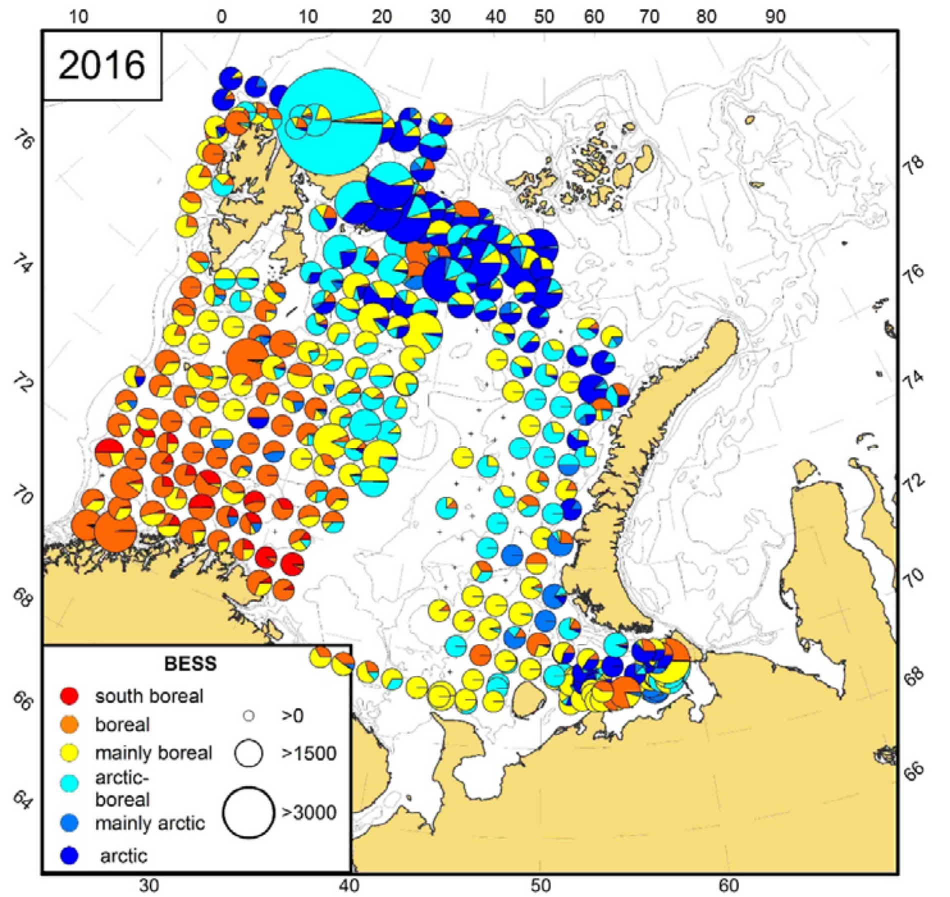


Figure 7.1.3.1 Distribution of non-commercial fish species from different zoogeographic groups during the ecosystem survey 2016. Size of circle corresponds to abundance (individuals per nautical mile, only bottom trawl stations were used, both pelagic and demersal species are included)

Table 7.1.3.1 Median 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	Median catch				Maximum catch			
	2013	2014*	2015	2016**	2013	2014*	2015	2016**
Widely distributed	0.2	0.1	0.09	0.5	17.1	4.3	10.0	36.7
South boreal	0.8	0.9	1.2	1.4	171.5	105.7	216.3	135.0
Boreal	7.1	8.7	8.7	18.3	230.0	478.6	660.0	743.8
Mainly boreal	32.9	19.1	30.0	32.5	981.3	785.7	1580.0	718.1
Arctic-boreal	39.3	24.5	54.4	30.5	3326.9	3077.1	1703.6	2905.0
Mainly arctic	10.2	1.7	1.9	3.3	656.3	60.9	53.8	123.2
Arctic	70.7	7.2	31.4	28.9	3013.8	385.2	832.2	808.6

* – Coverage in the northern Barents Sea was highly restricted

** – The survey started in the north

7.1.4 Uncommon 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 2016 (Figure 7.1.4.1). Most of these species usually occur in adjacent areas of the Barents Sea and were therefore found mainly along the border of the surveyed area. E.g. black seasnail *Paraliparis bathybius* and Adolf's eelpout *Lycodes adolfi* are distributed in the Arctic polar basin. Grey gurnard *Eutrigla gurnardus* and ling *Molva molva* are distributed in the northeastern Atlantic and were caught in the southwest from the Barents Sea. Hooknose *Agonus cataphractus* and ninespine stickleback *Pungitius pungitius* were caught in the southeast of the survey area.

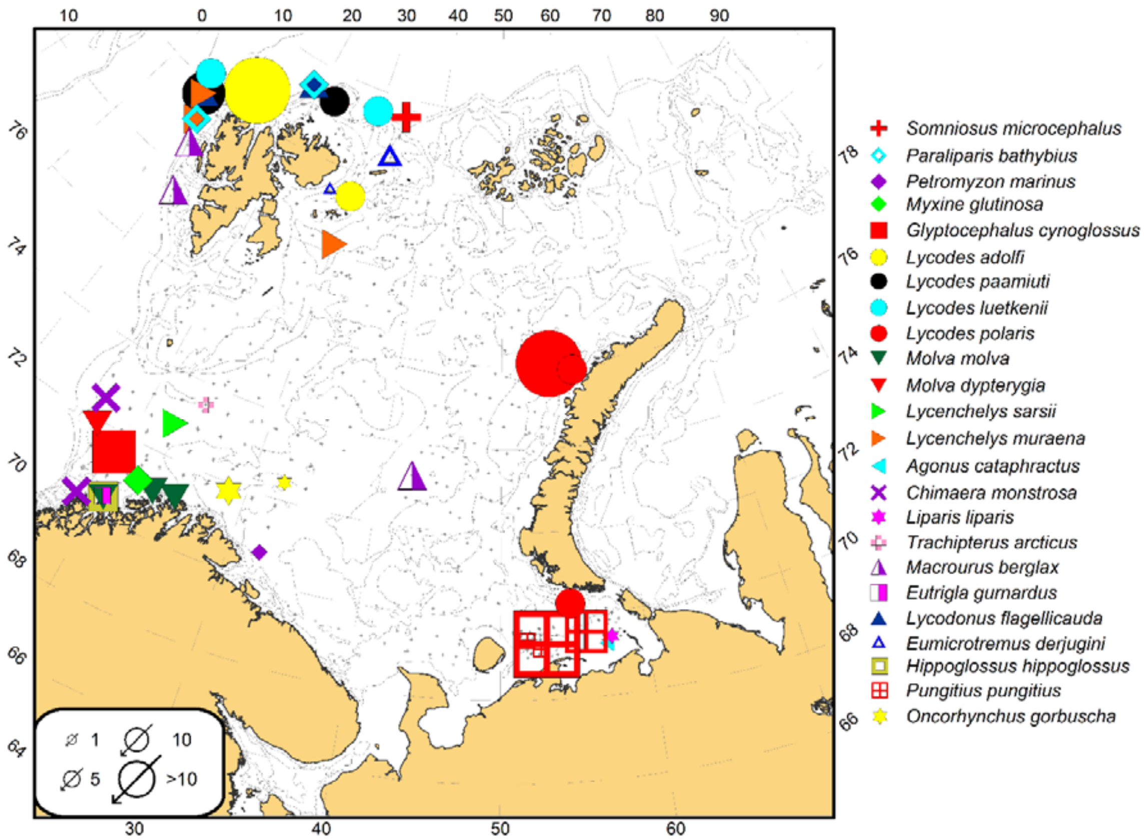


Figure 7.1.4.1 Distribution of species which are rare in the Barents Sea and which were found in the survey area in 2016. Size of circle corresponds to abundance (individuals per nautical mile, both bottom and pelagic trawls were used)

8 MARINE MAMMALS AND SEABIRD MONITORING

8.1 Marine mammals

Text by R. Klepikovskiy

Figures by R. Klepikovskiy

There were not carried out any special marine mammals' research on board Norwegian research vessels (R/V) during ecosystem survey. On board the Russian R/V "Frithjof Nansen" there were done observations of sea mammals as usual. Nevertheless, the Norwegian observers of sea birds on board R/V «Eros», R/V «Johan Hjort», and R/V «Helmer Hansen», as far as possible, in parallel to monitoring of marine mammals also did observations of sea mammals.

8 species of marine mammals were observed during the observation period in the research area, reaching a total of 899 individuals. The results of observations from each vessel are presented in Table 8.1.1 and Fig. 8.1.1-8.1.2.

Table 8.1.1. Quantity of marine mammals individuals observed from the R/V "Johan Hjort", R/V "Helmer Hansen", R/V "Eros", R/V "Frithjof Nansen" during the ecosystem survey in 2016.

Order/ suborder	Name of species (english)	F.Nansen	Eros	J. Hjort	H. Hansen	Total	%
Cetacea/	Fin whale	2	111	17	1	131	14.6
Baleen	Humpback whale	6	58	5	-	69	7.7
whales	Minke whale	29	25	1	1	56	6.2
	Unidentified (unid.) whale	-	5	-	2	7	0.8
Cetacea/	White-beaked dolphin	255	302	53	5	615	68.4
Toothed	White-sided dolphin	-	6	-	-	6	0.7
whales	Harbour porpoise	-	2	-	-	2	0.2
	Killer whale	-	-	-	1	1	0.1
Pinnipedia	Walrus	3		-	-	3	0.3
	Unid. marine mammals	-	9	-	-	9	1.0
Total sum		295	518	76	10	899	100

The most often observed species was white-beaked dolphin (*Lagenorhynchus albirostris*) (68,4% of all recordings). This species had a wide distribution in the research area. The most frequent observations of this dolphins was in areas close to observations of capelin, polar cod and Atlantic cod aggregations with different densities, and this was in the western, central and eastern parts of the Barents Sea between 74º-80º N. The largest group of these animals (15-30 individuals) were seen in the south of Spitsbergen and the northern part of Novaya Zemlya. Some groups of these dolphins were also observed off the Kola Peninsula.

Toothed whales, besides white-beaked dolphin, consisted of observation of two groups of Atlantic white-sided dolphin (*Lagenorhynchus acutus*) (2 and 4 individuals in each) to the south of Spitsbergen. Previously years, this dolphin in the Barents Sea was not recorded during the research period. Also, one killer whale (*Orcinus orca*) and two harbour porpoise (*Phocoena phocoena*) were observed.

Of the baleen whales minke whale (*Balaenoptera acutorostrata*), humpback whale (*Megaptera novaeangliae*) and fin whale (*Balaenoptera physalus*) (in total about 28,5% of all animals) were observed. Minke whale were recorded mainly in the western, northern and southeastern parts of the research area. The densest concentrations of this species was seen off the southern island of Novaya Zemlya Archipelago, in the herring aggregations that were observed, as well as off the southern tip of Spitsbergen and in the Great Bank area, also were capelin aggregations were recorded. In the northeastern parts of the Barents Sea minke whale were found in aggregations of juvenile polar cod and capelin, and in the southeast part of the Barents Sea it was in aggregations of juvenile cod, herring and other fish.

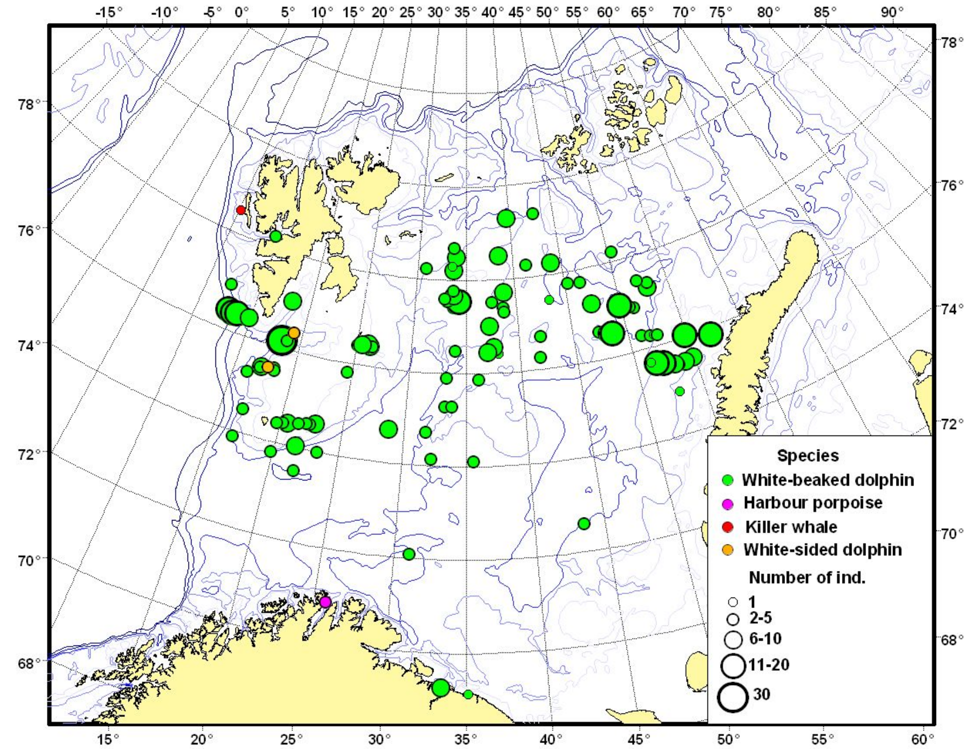


Figure 8.1.1. Distribution of toothed whales observed in August- September 2016.

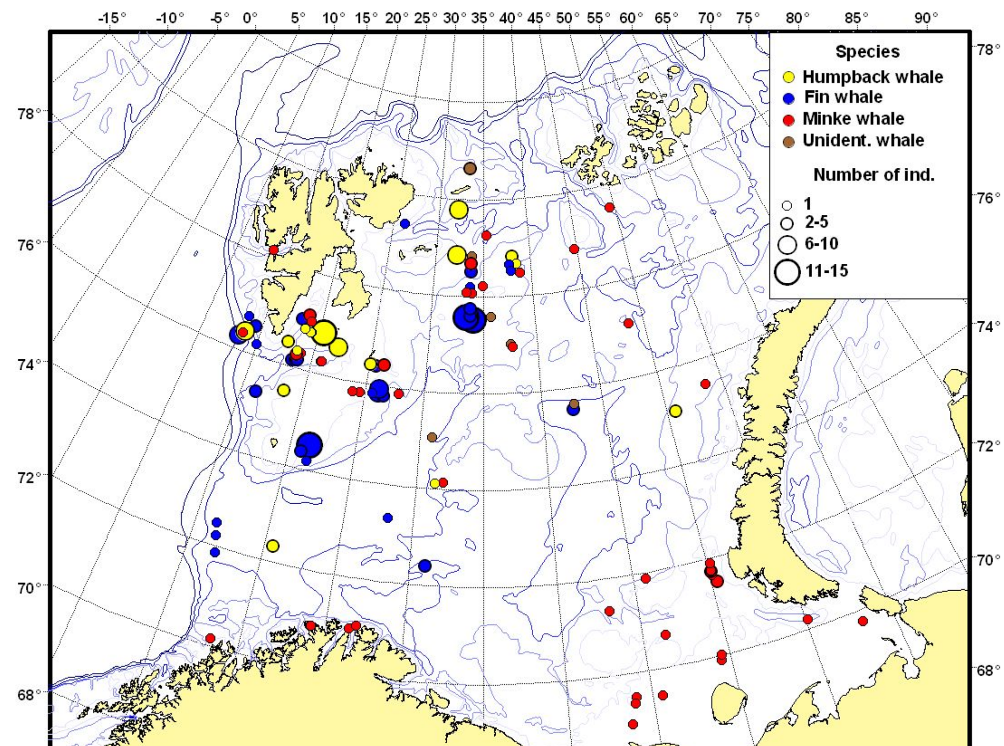


Figure 8.1.2. Distribution of baleen whales observed in August- September 2016.

Recordings of the main groups of humpback whale were in the areas adjacent to the southern tip of Spitsbergen and in the Great Bank area, in capelin aggregations. Fin whale together with humpback whale and minke whale was observed in the northern and western regions of the research area. Here, large groups of fin whale of 13-15 individuals in each were observed.

Only walrus (*Odobenus rosmarus*) was observed from the pinnipeds during research period. This species was observed in the Pechora Sea. This year, the harp seal (*Phoca groenlandica*) summer-autumn concentrations were not recorded. It was probably caused by poor ice condition in the Barents Sea, as ice edge was located far north. Also, due to the removal of the ice edge far to the northern part of research area, polar bears (*Ursus maritimus*) were not observed.

8.2 Seabird observations

Text by P.Fauchald and R. Klepikovskiy

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», «Eros» 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. The ship-followers are attracted to the ship from surrounding areas and individual birds are likely to be counted several times. The numbers of ship-followers are therefore probably grossly over-estimated.

Total transect length covered by the Norwegian vessels: «Helmer Hansen», Eros and «Johan Hjort», was 10 624 km. Total transect length covered by the Russian research vessel: «Fridtjof Nansen», was 5056 km. A total of 89 435 birds belonging to 51 different species were counted (Table 8.2.1). 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*) (Fig. 8.2.1).

Broadly, the distribution of the different species was similar to the distribution in the 2015 survey (Fig. 8.2.1). Alcids were observed throughout the study area but the abundance and species distribution varied geographically. Little auks (*Alle alle*) were found north of Spitsbergen, Brünnich's guillemots were found in the western and northern area, Atlantic puffins (*Fratercula arctica*) were found in the southwest and common guillemots (*Uria aalge*) were found in the south. 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 the southeastern area, kittiwakes were found in high density in the eastern and northern area, while Northern fulmars were encountered in high numbers throughout the study area.

Table 8.2.1 List of species encountered during the survey in 2016. Note that ship-followers were counted differently on the Norwegian and Russian vessels.

English name	Scientific name	Norwegian vessels	Russian vessel
Common sandpiper	*Actitis hypoleucos*	4	0
Razorbill	*Alca torda*	31	2
Little Auk	*Alle alle*	4101	25
Bean goose	*Anser fabalis*	0	1
Red-throated Pipit	*Anthus cervinus*	0	1
Barnacle goose	*Branta leucopsis*	0	240
Rough-legged buzzard	*Buteo lagopus*	1	0
Purple sandpiper	*Calidris maritima*	11	55
Little stint	*Calidris minuta*	0	1
Unident. Knot	*Calidris sp.*	14	22
Common redpoll	*Carduelis flammea*	0	2
Black guillemot	*Cephus grylle*	55	0
Common ringed plover	*Charadrius hiaticula*	8	0
Long-tailed duck	*Clangula hyemalis*	0	54
Little bunting	*Emberiza pusilla*	0	1
Merlin	*Falco columbarius*	1	1
Peregrine falcon	*Falco peregrinus*	0	1
Atlantic puffin	*Fratercula arctica*	524	4
*Northern fulmar	*Fulmarus glacialis*	47561	4960
Common snipe	*Gallinago gallinago*	1	0
Yellow-billed loon	*Gavia adamsii*	1	0
Black-throated loon	*Gavia arctica*	0	11
Unident. Loon	*Gavia sp.*	4	1
Red-throated loon	*Gavia stellata*	9	0
*Herring gull	*Larus argentatus*	955	11
Mew gull	*Larus canus*	6	0
Lesser black-backed gull	*Larus fuscus*	4	0
Heuglin's gull	*Larus heuglini*	0	150
*Glaucous gull	*Larus hyperboreus*	524	271
*Great black-backed gull	*Larus marinus*	487	123
Sabine's gull	*Larus sabini*	0	1
Velvet scoter	*Melanitta fusca*	0	16
Northern gannet	*Morus bassanus*	14	0
White wagtail	*Motacilla alba*	1	0
Ivory gull	*Pagophila eburnea*	81	1
Unident. Sparrow	*Passeridae spp.*	2	0
European shag	*Phalacrocorax aristotelis*	29	0
Great cormorant	*Phalacrocorax carbo*	15	0
Common chiffchaff	*Phylloscopus collybita*	0	1
Snow bunting	*Plectrophenax nivalis*	60	32
Sooty shearwater	*Puffinus griseus*	51	14
Manx shearwater	*Puffinus puffinus*	0	1
Goldcrest	*Regulus regulus*	0	1
Ross's gull	*Rhodostethia rosea*	1	0
*Kittiwake	*Rissa tridactyla*	16158	3647
Common eider	*Somateria mollissima*	0	16
King eider	*Somateria spectabilis*	0	20
Long-tailed skua	*Stercorarius longicaudus*	50	7
Arctic skua	*Stercorarius parasiticus*	97	12
Pomarine skua	*Stercorarius pomarinus*	692	654
Great skua	*Stercorarius skua*	39	1
Unident. Skua	*Stercorarius sp.*	37	0
Arctic tern	*Sterna paradisaea*	585	56
Common guillemot	*Uria aalge*	103	36
Brünnich's guillemot	*Uria lomvia*	5035	1577
Unspec. guillemot	*Uria sp.*	20	33
Total		77372	12063

*Ship-followers

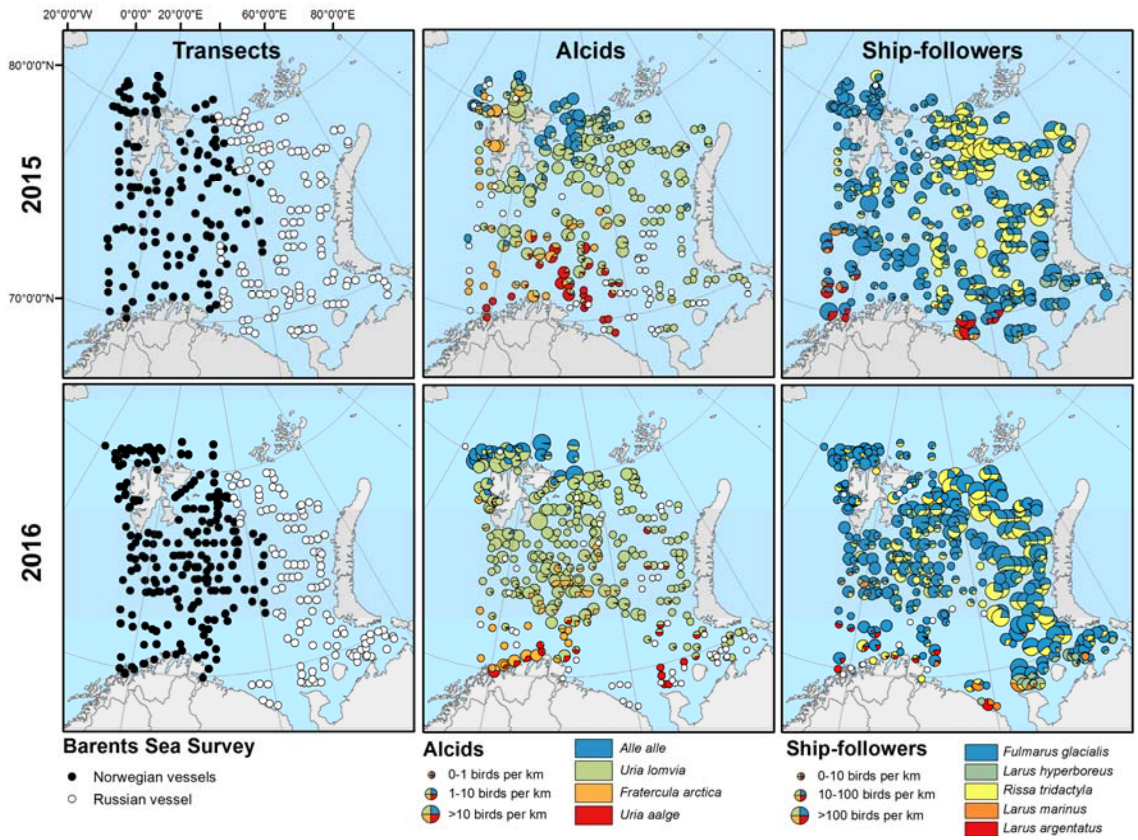


Figure 8.2.1 Seabird observations in 2015 (top) and 2016 (bottom). Left panel; positions of transects, middle panel; distribution of auks, right panel; distribution of ship-followers (gulls and fulmar).

9 APPENDIX 1 – VESSELS AND PARTICIPANTS

Prepared by P. Krivosheya and K. Sunnanå

Research vessel	Participants
”Frithjof Nansen” (09.8–30.09)	P. Krivosheya (cruise leader), A. Amelkin, A. Kluev, A. Bessonov, A. Gordeeva, A. Velikzhanin, U. Firsov, N. Puodzhunas, M. Gubanishev, D. Lazareva, M. Nosov, M. Kalashnikova, R. Klepikovsky, S. Kharlin, T. Nosova, N. Pankova, E. Eveseeva.
”Eros” (17.8 – 20.9)	Part 1 (17.8-7.9) G.Skaret (cruise leader), L. Drivenes, F. Bogetveit, J. Alvarez, V. Anthonyplilay, M. Johannessen, A, Rey, E. Grimsbø, A. Custer, T. Prokhorva, J. Ford Part 2 (7.9-20.9) J. Alvarez (cruise leader), A. Custer, T-W. Kangas, G. Lien, J. Røttingen, S. Karlson, J. Diaz, J H. Simonsen, M. Ring Kleven, T. Prokhorva, J. Ford
”Johan Hjort” (19.8-30.9)	Part 1 (19.8-2.9) E. Eriksen (cruise leader), H. Gabrielsen, J. Vedholm, J.T. Øvredal, A. Engås, C. Irgens, A. Kristiansen, B. Kvinge, M. Mjanger, A.L. Johnsen, R. Grønningsæter, A. Benzik, A. Pavenko Part 2 (2.9-14.9) S. Mehl (cruise leader), C. Irgens, A. Kristiansen, B. Kvinge, M. Mjanger, A.L. Johnsen, E. Langhelle, E. Holm, P. Arneberg, T. Tangstad, S. Murray, A. Benzik, A. Pavenko Part 3 (14.9-30.9) A. Aglen (cruise leader), T. Tangstad, B. Kraft, A. Storaker, H. Myran, E. Odland, S. Kolbeinson, I.M. Beck, L. Drivenes, T. Haugland, Ø. Sørensen, M. Johannessen, S. Murray, A. Benzik, A. Pavenko
“Helmer Hanssen” (24.9-5.10)	K. Sunnanå (cruise leader), T. d L. Wenneck, A. Sæverud, J. Skadal, L. Heggebakken, H. Dybvik, J. Kristiansen, I. Henriksen, J. Rønning, J. Enrices, J. Ford, S. Gundersen, A. Pop, L. Deris, S. Gutemuth, L. S. Hundstad, M. K. R. Jensen, P. Schweizer, C. Bachell, M. K. Mortensen (24.9-25.9) J. Simpson, T. Clark, S. Stanleigh, D. Baker, J. R. Møller, S. Hansson

JOINT REPORT

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