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REPORT

Survey report from the joint Norwegian/Russian Ecosystem Survey in the Barents Sea and the adjacent waters August-December 2022

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Survey report from the joint Norwegian/Russian Ecosystem Survey in the Barents Sea and the adjacent waters August-December 2022

Toktrapport fra det norsk/russiske økotoktet i Barentshavet og nærliggende områder

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Summary (English):

The aim of the joint Norwegian/Russian ecosystem survey in the Barents Sea and adjacent waters, August-October (BESS) is to monitor the status and changes in the Barents Sea ecosystem and provide data to support stock advice and research. The survey has since 2004 been conducted annually in the autumn, as a collaboration between the Institute of Marine Research (IMR) in Norway and the Polar branch of the VNIRO (PINRO) in Russia. The general survey plan and tasks were agreed upon at the annual IMR-PINRO Meeting in March 2022. Ship routes and other technical details are agreed on by correspondence between the survey coordinators. BESS aims at covering the entire Barents Sea. Ecosystem stations are distributed in a 35×35 nautical mile regular grid, and the ship tracks follow this design. Exceptions are the area around Svalbard (Spitsbergen), some additional bottom trawl hauls for demersal fish survey indices estimation, and additional acoustic transects for the capelin stock size estimation.

Survey start for the Russian vessel was significantly delayed, resulting in REEZ being covered two-three months later than NEEZ. This resulted in reduced area coverage, decrease in the numbers of trawl hauls, and lack of standard pelagic trawl sampling. In NEEZ, RV “Kronprins Haakon” was cancelled due to difficult economic situation, making it necessary to allocate one of the two remaining vessels to the area west and north of Svalbard (Spitsbergen). This resulted in low coverage in this area, and problems with synoptic coverage in north-east of Svalbard (Spitsbergen) and thus increased uncertainty in assessment of demersal fish (e.g. Greenland halibut) and capelin.

The 19-th joint Barents Sea autumn Ecosystem Survey (BESS) was carried out in two periods. The Norwegian research vessels “G.O. Sars” and “Johan Hjort” covered NEEZ in the period 16-th August to 03-th October, providing data to stock assessment, 0-group fish abundance indices, and state and changes descriptions which is comparable with earlier survey years in NEEZ. The Russian research vessel “Vilnyus” covered REEZ in the periods 20-th to 30-th September and 22-th October to 3-rd December. Survey coordinators in 2022 were Dmitry Prozorkevich (PINRO) and Geir Odd Johansen (IMR). Exchange of Russian and Norwegian experts between each country’s respective vessels did not take place in 2022. We would like to express our sincere gratitude to all the crew and scientific personnel onboard RVs “Vilnyus”, “G.O. Sars” and “Johan Hjort” for their dedicated work, as well as all the people involved in planning and reporting of BESS 2022. This report is a summary of observations and status assessment based on the survey data. Even though the survey was not well completed, the data obtained are the main source of knowledge about the ecosystem of the Barents Sea

Content

1 - BACKGROUND

Author(s): Geir Odd Johansen (IMR) and Dmitry Prozorkevich (VNIRO-PINRO)

The aim of the joint Norwegian/Russian ecosystem survey in the Barents Sea and adjacent waters, August-October (BESS) is to monitor the status and changes in the Barents Sea ecosystem and provide data to support stock advice and research. The survey has since 2004 been conducted annually in the autumn, as a collaboration between the IMR in Norway and the Polar Branch of VNIRO (PINRO) in Russia. The general survey plan and tasks are usually agreed at the annual PINRO-IMR Meeting in March, but in 2022, due to external factors making physical meetings between Norwegian and Russian researchers difficult, it was agreed by correspondence. Ship routes and other technical details was agreed on by correspondence between the survey coordinators. Survey coordinators in 2022 was Dmitry Prozorkevich (PINRO) and Geir Odd Johansen (IMR). Exchange of Russian and Norwegian experts between each country’s respective vessels did not take place in 2022.

The 19-th joint Barents Sea autumn Ecosystem Survey (BESS) was carried out in two periods. The Norwegian research vessels “G.O. Sars” and “Johan Hjort” covered NEEZ in the period 16-th August to 03-th October. The Russian research vessel “Vilnyus” covered REEZ in the periods 20-th to 30-th September and 22-th October to 3-rd December.

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

BESS 2022 was conducted during challenging times for joint survey activity and subsequent reporting of the results. Although the survey in 2022 was unsuccessful with respect to coverage in space and time, it was decided to join all the data and present them in this Joint Report for the sake of continuity, history, and to secure scientific knowledge. We would like to express our sincere gratitude to all the crew and scientific personnel onboard RVs “Vilnyus”, “G.O. Sars”, and “Johan Hjort” for their dedicated work, as well as all the people involved in planning and reporting of BESS 2022. This report is a summary of the observations and status assessments based on the survey data. The data obtained in the survey are the main source of knowledge about the ecosystem of the Barents Sea.

Table 1. Vessels and participants (with main expertise) in the Barents Sea Ecosystem Survey 2022.

Research vessel	Participants
"Vilnyus"	(20-30.09, 22.10-03.12)
	Pavel Krivosheya (Cruise leader, pelagic fish), Alexey Amelkin (demersal fish), Natalia Pankova (pelagic fish), Yury Kalashnikov (pelagic fish), Maxim Rybakov (demersal fish), Serafim Bryzgalov (demersal fish), Michael Nosov (instrumentation), Sergey Harlin (Instrumentation), Maksim Gubanishchev (hydrologist), Alexey Kanishchev (hydrologist), Roman Klepikovsky (sea birds and mammals), Marina Kalashnikova (parasitologist) (20-30.09.2022), Alexander Benzik (plankton, benthos), Alexandra Kudryashova (benthos).
"G.O. Sars"	Part 1 (16.08-30.08)
	Irene Huse (Cruise leader), Penny Lee Liebig (benthos), Amalie Valde Berge (demersal fish), Hege Haraldsen (demersal fish), Lea Marie Hellenbrecht (pelagic fish), Frøydis Tousgaard Rist (pelagic fish), Jon Rønning (plankton), Anne Kari Sveistrup (benthos), Celina Eriksson Bjånes (demersal fish), Erlend Langhelle (demersal fish), Thomas André Sivertsen (sea mammals), Lars Kleivane (sea mammals), Jörn Patrick Meyer (instrumentation), Egil Frøyen (instrumentation), Monica Martinussen (plankton), Gary Elton (sea birds), Njord Svendsen (Crono - journalist).
"G.O. Sars"	Part 2 (30.08-13.9)
	Harald Gjøsæter (Cruise leader), Penny Lee Liebig (benthos), Anne Kari Sveistrup benthos), Celina Eriksson Bjånes (demersal fish), Erlend Langhelle (demersal fish), Thomas André Sivertsen (sea mammals), Lars Kleivane (sea mammals), Jörn Patrick Meyer (instrumentation), Egil Frøyen (instrumentation), Monica Martinussen (plankton), Irene Huse (demersal fish), Eirik Odland (demersal fish), Stine Karlson (pelagic fish), Justine Diaz (pelagic fish), Hege Skaar (plankton), Gary Elton (sea birds).
"Johan Hjort"	Part 1 (18.08-12.09)
	Tore Johannessen (Cruise leader), Mette Strand (benthos), Grethe Thorsheim (demersal fish), Sigmund Grønnevik (demersal fish), Runar Smestad (demersal fish), Anne Sæverud (demersal fish), Jan Frode Wilhelmsen (instrumentation), Hege Rognaldsen (instrumentation), Jessica Anne Hough (pelagic fish), Erling Boge (pelagic fish), Eli Gustad (plankton), Gaston Ezequiel Aguirre (plankton), Guri Nesje (chemical contaminants), Sonnich Meier (chemical contaminants), Andrey Voronkov (benthos), Yasmin Hunt (sea mammals), George McCallum (sea mammals), Jon Ford (sea birds).
"Johan Hjort"	Part 2 (12.09-06.10)
	Georg Skaret (Cruise leader), Andrey Voronkov (benthos), Yasmin Hunt (sea mammals), George McCallum (sea mammals), Felicia Keulder-Stenevik (benthos), Hildegunn Mjanger (demersal fish), Vidar Fauskanger (demersal fish), Amalie Valde Berge (demersal fish), John Nesheim (instrumentation), Magnar Mjanger (instrumentation), Eilert Hermansen (pelagic fish), Timo Meissner (pelagic fish), Tommy Gorm-Hansen Tøsdal (pelagic fish), Terje Berge (plankton), Jane Strømstad Møgster (plankton), Jon Ford (sea birds), Sonnich Meier (chemical contaminants).

2 - SURVEY EXECUTION 2022

Author(s): Geir Odd Johansen (IMR) and Dmitry Prozorkevich (VNIRO-PINRO)

BESS aims at covering the entire the Barents Sea progressing from south to north. Ecosystem stations are distributed in a 35×35 nautical mile regular grid, and the ship tracks follow this design. Exceptions are the area around Svalbard (Spitsbergen), where the tracks follow a zig-zag design with additional depth stratified bottom trawl hauls for demersal fish survey indices estimation along the tracks. There are also additional acoustic transects for the capelin stock size estimation east of Svalbard (Spitsbergen).

The planned vessel tracks for BESS 2022 are given in figure 2.1, but the survey was not executed according to this plan. The Russian RV “Vilnyus” covered the eastern and south-eastern of the Barents Sea within the REEZ and Loophole (bottom trawls) but missed coverage in parts of the central REEZ and in the north. Norwegian RVs covered the western part of the Barents Sea and an area around Svalbard (Spitsbergen) within the NEEZ, but the planned vessel RV “Kronprins Haakon” did not take part in the survey due to a difficult economic situation. As a result of this, RV “G.O. Sars” had to cover the southern and south-eastern part of NEEZ, and additionally the area west and north of Svalbard (Spitsbergen) to compensate for the absence of RV “Kronprins Haakon”. RV “Johan Hjort” covered the central-western part of this area and the Loophole (pelagic trawls), as well as the capelin area east of Svalbard. In addition to standard sampling at BESS, the standard oceanography sections “Vardø Nord extended” and the “Hinlopen”, were sampled in the Norwegian survey area, and the standard sections “Kola” and “Kanin” in the Russian survey area (Fig. 2.3). The realized research vessel tracks with sampling for the BESS 2022 are shown in Figure 2.2 and 2.3. Summarized, the exceptions to the planned spatial coverage were lack of coverage in the north-eastern part of the Barents Sea, thin coverage around of Svalbard (Spitsbergen), and in a central part of REEZ.

The planned time schedule for BESS 2022 was 152 consecutive days, resulting in 134 planned effective vessel days (time between first and last sample in the vessel logs). The difference between these two is as expected, as the vessels need time to prepare before sampling (e.g. testing of sampling gear and calibration), crew and personnel changes, and sail back and forth between survey area and ports related to these changes and at the end of the survey. BESS 2022 was not conducted according to the planned time schedule. Cancellation of R/V Kronprins Haakon after the cruise had started, reduced the planned effective days further to 121. Further, due to external factors, Russian vessel “Vilnius” had not received the ordered engine parts in time, resulting in delayed start of the survey part in REEZ. In addition, for various unfortunate reasons, the ship vessel to return to port several times. In total, this caused late and reduced area coverage, cancelled standard pelagic sampling in the eastern Barents Sea, and decreased number of trawl hauls in northwestern Barents Sea.

The total progression of the survey in time and space in 2022 can be characterized as being of low quality (Figure 2.4).

The consequences of the insufficient coverage in space and time of BESS 2022 is that the main ecosystem components were not well monitored. Data to stock assessment, 0-group fish abundance indices, and state and change descriptions is comparable with earlier survey years in NEEZ only. This has severe consequences for the data quality related to several ecosystem components, including assessment of several commercial species, and conclusions made based on these data must be viewed as highly uncertain.

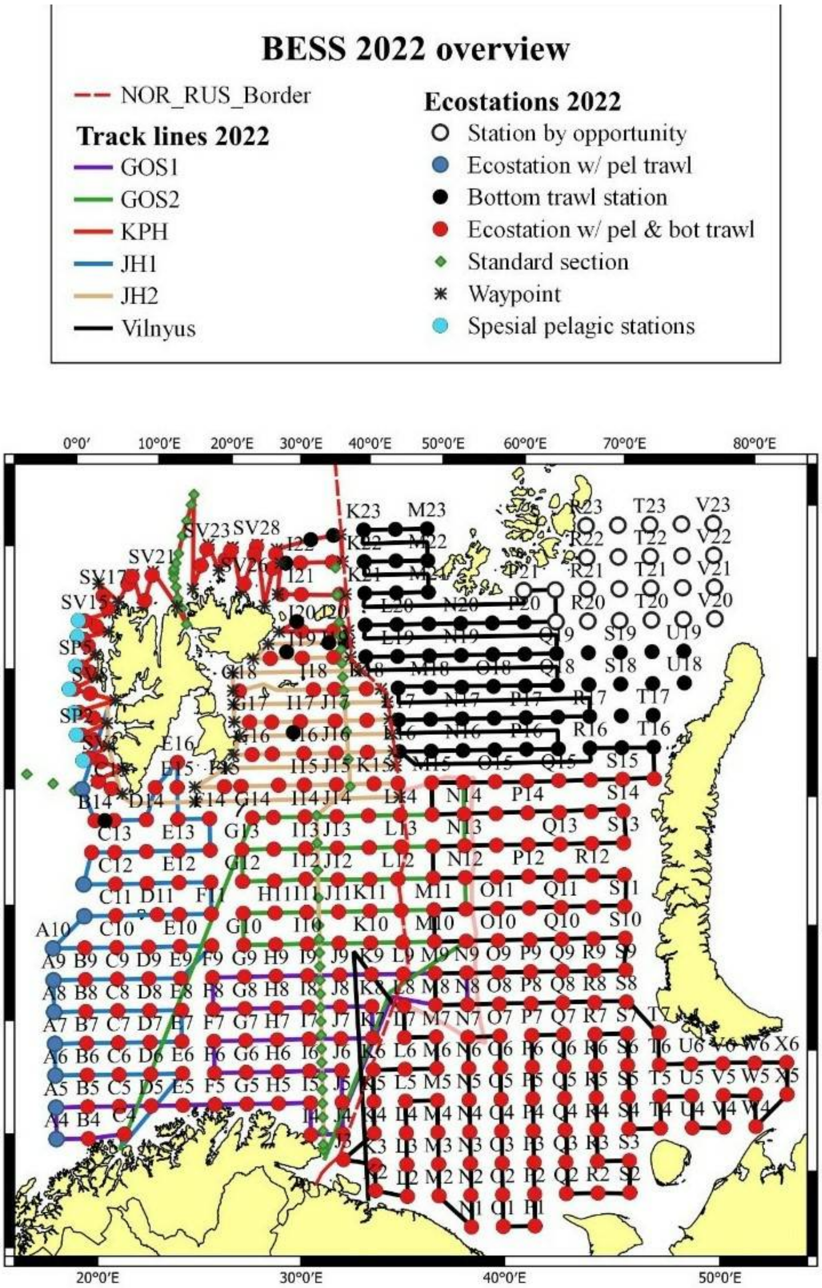

Figure 2.1. *BESS 2022, planned survey map with ecosystem stations and vessel tracks.*

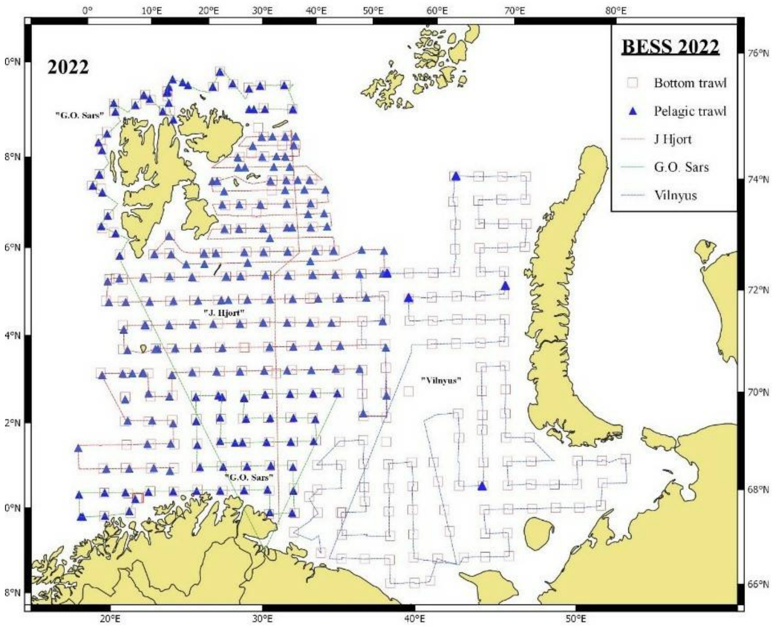

Figure 2.2. *BESS 2022 Realized vessel tracks with pelagic and bottom trawl sampling stations, note that some trawl stations are taken in addition to the regular ecosystem stations.*

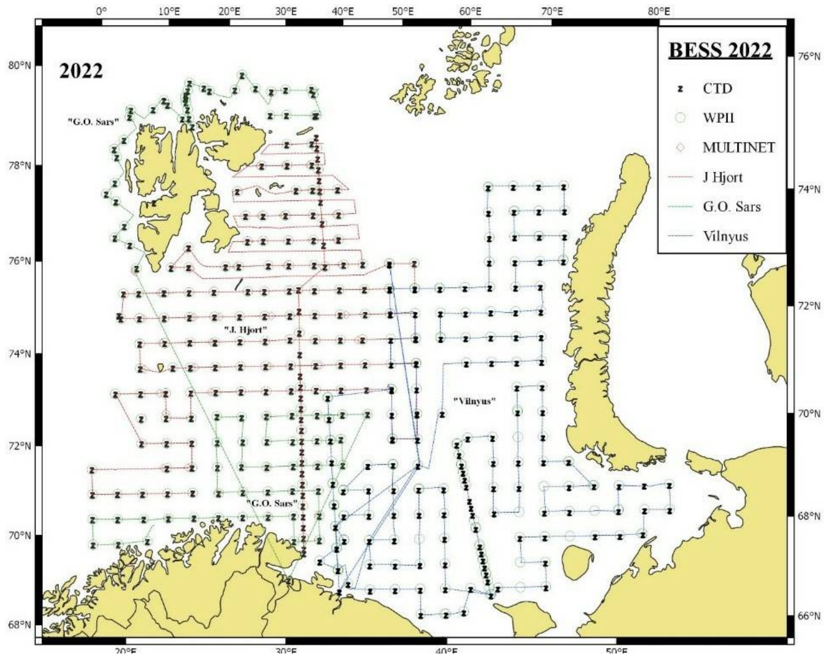

Figure 2.3. *BESS 2022, realized vessel tracks with hydrography and plankton samples at ecosystem stations.*

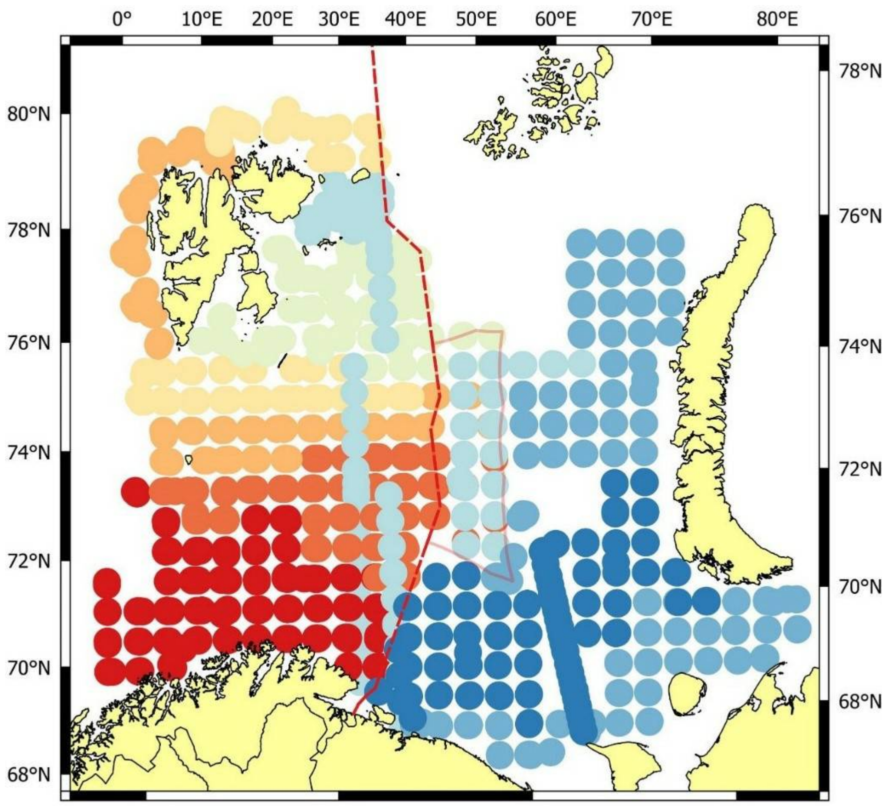

Figure 2.4. *Progression of BESS 2022 in space and time. Points represent samples taken at ecosystem stations during the survey. The colour of the points represents days after 1-st August 2022 in the period of the survey, 16-th August to 1-rst December. The colours scale from red (early in the survey) to blue (late in the survey).*

2.1 Sampling methods

Some adjustments of sampling gear were done in 2022 compared to 2021. At Norwegian vessels, the rigging of the 0- group trawl (Harstad trawl) was changed by using new lining. Special net for juvenile shrimp were taken out as standard at bottom trawl hauls. Manta trawl was included as standard equipment for monitoring microplastic at BESS from 2021 and microplastic samples were also collected in 2022. A new length stratified individual sampling of haddock was tested out in 2022 measuring. Monitoring of phytoplankton with algae nets and CTD water samples was removed from the sampling plan at regular stations in 2022 and will in the future only be taken at the hydrographic standard sections Vardø Nord extended and Hinlopen. Some minor changes in the sampling procedures for snow crab was also introduced.

The survey sampling manuals can be obtained by contacting the survey coordinators. These manuals include methodological and technical descriptions of equipment, the trawling and capture procedures by the sampling tools, sampling and registration of the catch in the lab, and the methods that are used for calculating the abundance and biomass of the biota.

2.2 Special investigations

BESS is a useful platform for conducting additional studies in the Barents Sea. These studies can be testing of new methodology, sampling of data additional to the standard monitoring, or sampling of other types of data. It is imperative that the special investigations do not influence the standard monitoring activities at the survey. The special investigations vary from year to year, and below is a list of special investigation conducted on Russian Norwegian vessels at BESS 2022, with contact persons.

2.2.1 Annual monitoring of pollution levels

In 2022 PINRO continued the annual monitoring of pollution levels in the Barents Sea in accordance with a national program. Samples of seawater, sediments, fish and invertebrates was collected and analysed for persistent organic pollutants (POPs) (e.g. PCBs, DDTs, HCHs, HCB) and heavy metals (e.g. lead, cadmium, mercury) and arsenic. The samples were collected at RV "Vilnyus" during BESS in the southern and eastern parts of the Barents Sea. The results from chemical analyses will be reported in 2023.

Contact: Mikhail Novikov, PINRO (mnovik@pinro.ru)

2.2.2 Collection of samples for biochemical studies

Frozen samples of commercial and non-commercial fish and invertebrates were collected for biochemical studies (ratio of body parts, chemical composition of nutrients, molecular weight of muscle proteins, amino acids and lipid fractions composition) in accordance with a research program. Samples were frozen at a temperature not higher than minus 18° C immediately after catching before rigor mortis.

Contact: Kira Rysakova, PINRO (rysakova@pinro.ru)

2.2.3 Fish pathology research

PINRO undertakes yearly investigations of fish and crabs diseases and parasites in the Barents Sea (mainly in REEZ). This investigation was started by PINRO in 1999. The main purpose of the pathology research is annual estimation of epizootic state of commercial fish and crabs species. The observations are entered into a database on pathology named “Pathology of fish in the seas of the Arctic ocean and the North-East Atlantic”.

Contact: Tatyana Karaseva, PINRO (karaseva@pinro.ru)

Link to more information:

https://www.amazon.com/Barents-Sea-Ecosystem-Management-Cooperation/dp/8251925452 (pp. 743-749)

2.2.4 Parasitological study

The purpose of this study is to monitor the infestation of commercial fish species in the Barents Sea with helminths that are hazardous to human health. 200 specimens of six fish species were studied in order to identify of such helminths. Statistical processing of parasitological data consisted in determination of three indicators of the degree of parasite infestation: prevalence – the proportion (%) of fish infested with a parasite of this species of the number of examined fish; abundance – the number of parasites of this species per one examined fish; confidence interval (CI) – the interval that covers the parameter of the prevalence with a designated confidence level. Helminths of two species that are hazardous to human health have been identified (larvae of nematodes *Anisakis simplex* and *Pseudoterranova* spp.). The first of them are mostly found in cod, haddock and long rough dab. Capelin and Arctic cod are infested with them to a lesser extent (Tables 2.2.4.1; 2.2.4.2).

Table 2.2.4.1. Indicators of the total infestation of fish with larvae of the nematode *Anisakis simplex*.

Fish species	Number of examined fish, specimens	Average length (min-max), cm	Infestation rates Prevalence (CI), %	Abundance, specimens
Cod	25	47.1 (27.0-72.0)	92.0 (78.1-99.2)	11,2
Haddock	25	34.8 (21.0-51.0)	96.0 (84.7-100)	25,7
European plaice	25	39.3 (33.0-54.0)	12.0 (2.3-27.7)	0,1
Long rough dab	25	31.0 (21.0-43.0)	76.0 (57.3-90.6)	6,2
Capelin	25	15.7 (13.5-18.0)	40.0 (27.7-59.9)	0,4
Arctic cod	75	18.0 (11.0-27.5)	52.0 (40.5-63.4)	0,9

Table 2.2.4.2. Indicators of the total infestation of fish with larvae of the nematode *Pseudoterranova* spp.

Fish species	Number of examined fish, specimens	Average length (min-max), cm	Infestation rates Prevalence (CI), %	Abundance, specimens
Long rough dab	25	31.0 (21.0-43.0)	4.0 (0.0-15.3)	0,04

The obtained data indicate a consistent high level of invasion of most bottom fish species with the nematode *A. simplex*.

Contact: Yuri Bakay, PINRO (bakay@pinro.ru)

3 - DATA MANAGEMENT

Author(s): Geir Odd Johansen (IMR) and Dmitry Prozorkevich (VNIRO-PINRO)

3.1 Databases

A wide variety of data are collected during the ecosystem surveys. All data collected during the BESS are quality controlled and verified by experts from IMR and PINRO during the survey. The data are stored in IMR and PINRO national databases, with different formats. However, the data are exchanged so that both institutions have access to each other's data in their respective databases (i.e. both institutes use equal joint data).

3.2 Data application

The main aim of the BESS is to cover the whole Barents Sea ecosystem geographically and provide survey data for commercial fish and shellfish stock estimation. Stock estimation is particularly important for capelin, because capelin TAC is based on the survey result, and the Norwegian-Russian Fishery Commission determines TAC immediately after the survey. In addition, a broad spectrum of physical variables, ecosystem components and pollution are monitored and reported.

The survey data will be used by Norway and Russia for the implementation the joint or national projects. In addition, each of the side uses the survey data for participate in their international projects.

This survey report is based on joint data and contains the main results of the monitoring. The survey report is published as part of the IMR/PINRO Joint Report series and assembled into a complete pdf-report when the main components are completed. Some post-survey information not included in the written report (e.g. plankton and fish stomach samples which need longer processing time) will be published as individual parts of the report later. All reports from BESS from 2004 until the latest are available at this web site: https://imr.brage.unit.no/imr-xmlui/handle/11250/2658167. This report is published in the IMR digital report series IMR-PINRO.

3.3 Time series of distribution maps

The redesigned IMR web site for the joint Norwegian/Russian Barents Sea Ecosystem Surveys is still not finished. The maps from this report series are to be made public in this map site when ready.

4 - MARINE ENVIRONMENT

Author(s): Alexander Trofimov (VNIRO-PINRO), Randi Ingvaldsen (IMR), Tatiana Prokhorova (VNIRO-PINRO), Bjørn Einar Grøsvik (IMR) and Pavel Krivosheya (VNIRO-PINRO)

4.1 Hydrography

Text by: Alexander Trofimov and Randi Ingvaldsen

Figures by: A. Trofimov

4.1.1 Geographic variation

Horizontal distributions of temperature and salinity are shown for depths of 0, 50, 100 m and near the bottom in Figs 4.1.1.1–4.1.1.8, and anomalies of temperature and salinity at the surface and near the bottom are presented in Figs 4.1.1.9–4.1.1.12. The anomalies have been calculated using the long-term means for the period 1981–2010.

In autumn 2022, surface temperature was on average 1.5°C higher than the long-term mean all over the surveyed area (Fig. 4.1.1.9). Compared to 2021, the surface temperature in 2022 was much higher (by 1.2°C on average) almost all over the surveyed area (94%), with the largest positive differences (>2°C) in the western Barents Sea.

Arctic waters were mainly found, as usual, in the 50–100 m layer north of 77°N (Fig. 4.1.1.3 and 4.1.1.5). Temperatures at depths of 50 and 100 m were higher than the long-term means (on average, by 1.0 and 0.7°C respectively) in most of the surveyed area (89 and 84%), with the largest positive anomalies at 50 m depth in the southeast. Negative anomalies (about −0.3°C on average) were mostly found at 100 m depth in the northern Barents Sea. Compared to 2021, the 50 and 100 m temperatures in 2022 were higher (on average, by 0.6 and 0.5°C respectively) in two thirds of the surveyed area. Negative differences were observed in some separate areas of the Barents Sea. Small differences (both negative and positive, <0.5°C in magnitude) prevailed at 100 m depth.

Bottom temperature was in general 0.7°C above average in most of the surveyed area (83%), with the largest positive anomalies in the southeastern Barents Sea (Fig. 4.1.1.10). Negative anomalies were mainly found in the northernmost part of the sea, between the Spitsbergen and Franz Josef Land archipelagoes. In bottom waters, small temperature differences between 2022 and 2021 (both negative and positive, <0.5°C in magnitude) prevailed (~70% of the surveyed area). In autumn 2022, the area covered by bottom water with temperatures below zero was 37% in the Barents Sea (71–79°N 25–55°E) being close to those in the previous two years.

Surface salinity was on average 0.4 higher than the long-term mean in half of the surveyed area, namely in the northern, easternmost and southwesternmost Barents Sea, with the largest positive anomalies (>0.8) in the north (Fig. 4.1.1.11). Negative anomalies (–0.1 on average) were mainly observed in the southern part of the sea. In autumn 2022, surface waters were on average 0.2 fresher than in 2021 in 62% of the surveyed area; they were saltier (on average, by 0.3) in the northern and southwesternmost Barents Sea as well as in a small area west and north of Kolguev Island.

Salinity at 50 m depth was lower than average (by 0.1 on average) in most of the surveyed area (60%), with the largest negative anomalies in coastal waters in the southwestern Barents Sea. Positive anomalies were mainly observed in the northern (especially east of the Spitsbergen Archipelago) and southeasternmost parts of the sea. In autumn 2022, waters at 50 m were saltier (by 0.1 on average) than in 2021 in half of the surveyed area, with the largest positive differences over the Spitsbergen Bank and west and northwest of Kolguev Island. Significant negative differences (>0.1 in magnitude) in 50 m salinity between 2022 and 2021 were mainly observed in the south and east. At a depth of 50 m, both positive and negative anomalies and differences were larger than at 100 m. At a depth of 100 m, salinity anomalies and differences of <0.1 in magnitude occupied about 90% of the surveyed area.

Bottom salinity was slightly lower than average almost all over the surveyed area (80%), with the largest negative anomalies (>0.1 in magnitude) in some small areas in the southern Barents Sea (Fig. 4.1.1.12). Positive anomalies were mainly found south of the Spitsbergen Archipelago and west of Kolguev Island. In autumn 2022, bottom waters were a bit saltier than in 2021 in two thirds of the surveyed area, with the largest positive differences (>0.1) over the Spitsbergen Bank and west and north of Kolguev Island. As a whole, bottom salinity anomalies and differences were small (<0.1 in magnitude) almost all over the surveyed area (85 and 88% respectively).

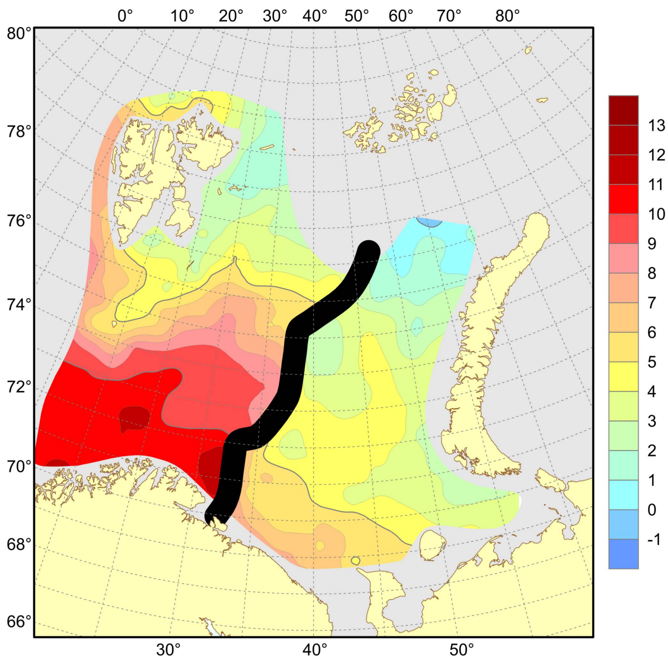

Figure 4.1.1.1. *Distribution of surface temperature (°C), August–November 2022. The thick black line is a line of discontinuity in the survey data.*

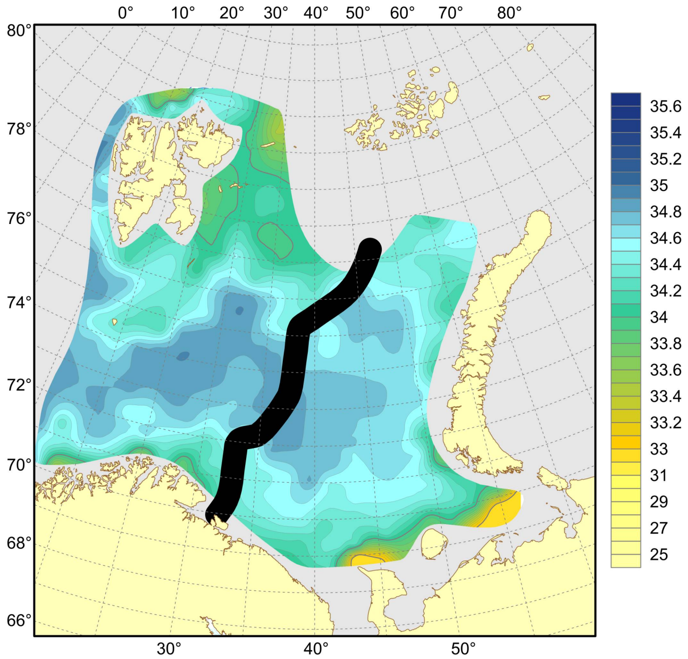

Figure 4.1.1.2. *Distribution of surface salinity, August–November 2022. The thick black line is a line of discontinuity in the survey data.*

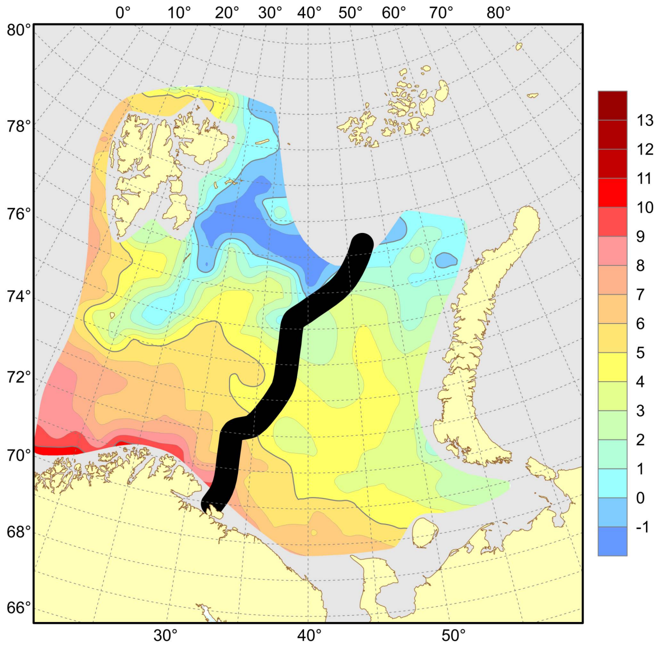

Figure 4.1.1.3. *Distribution of temperature (°C) at the 50 m depth, August–November 2022. The thick black line is a line of discontinuity in the survey data.*

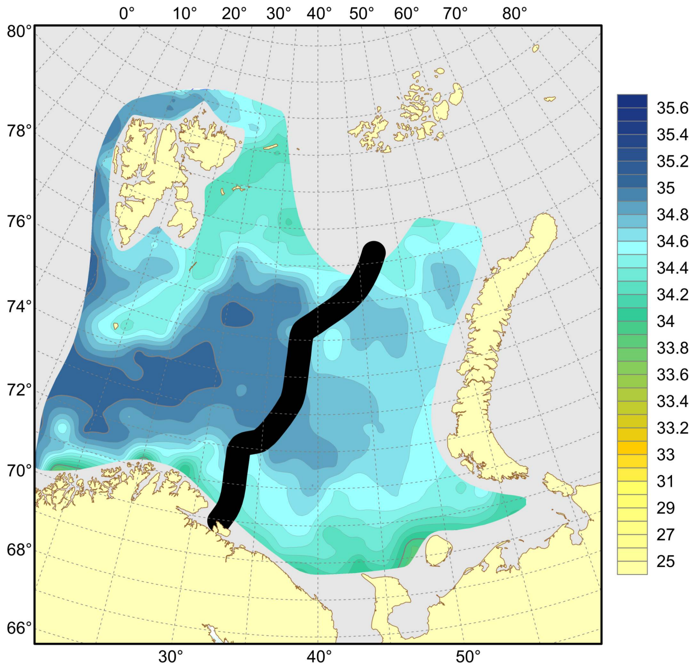

Figure 4.1.1.4. *Distribution of salinity at the 50 m depth, August–November 2022. The thick black line is a line of discontinuity in the survey data.*

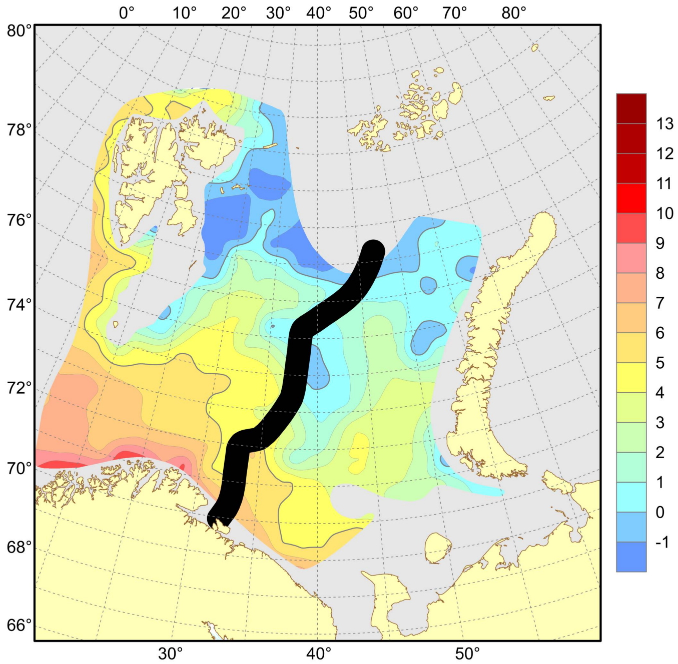

Figure 4.1.1.5. *Distribution of temperature (°C) at the 100 m depth, August–November 2022. The thick black line is a line of discontinuity in the survey data.*

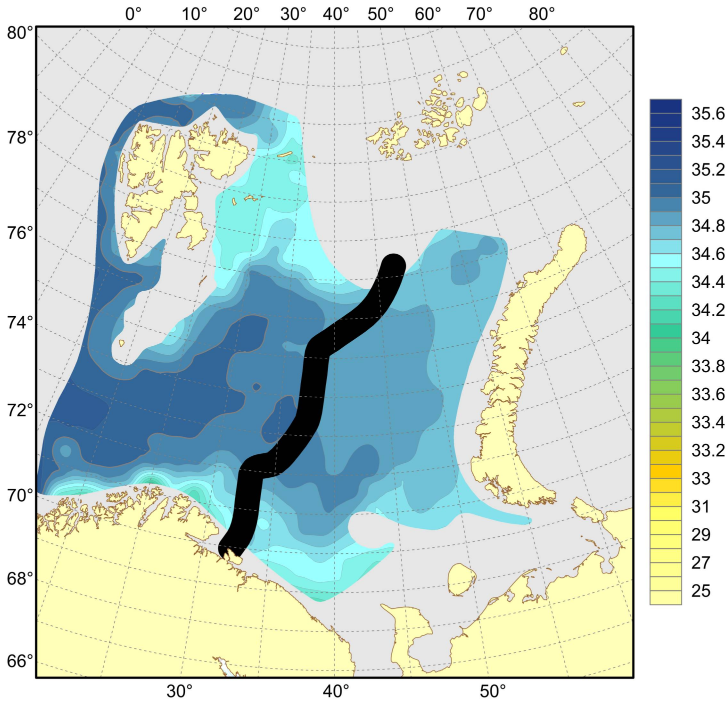

Figure 4.1.1.6. *Distribution of salinity at the 100 m depth, August–November 2022. The thick black line is a line of discontinuity in the survey data.*

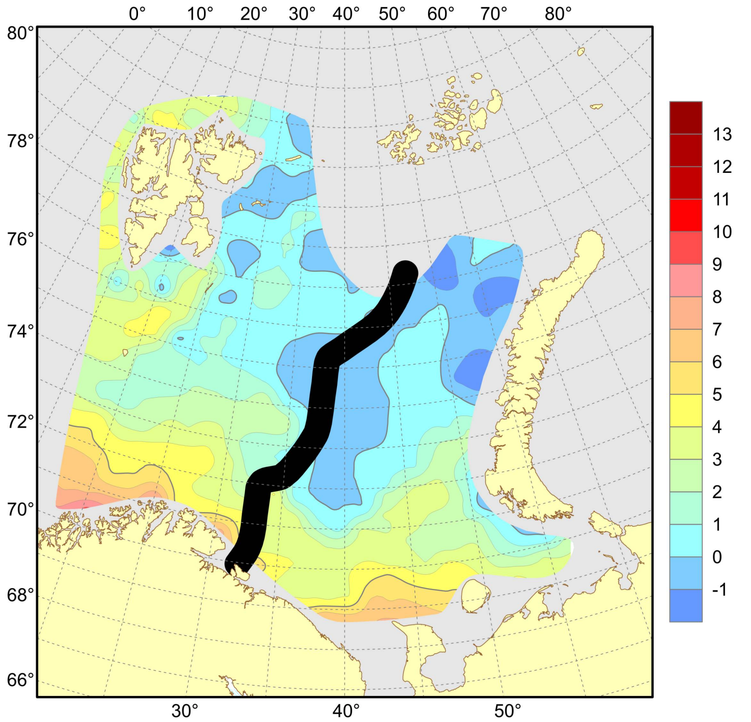

Figure 4.1.1.7. *Distribution of temperature (°C) at the bottom, August–November 2022. The thick black line is a line of discontinuity in the survey data.*

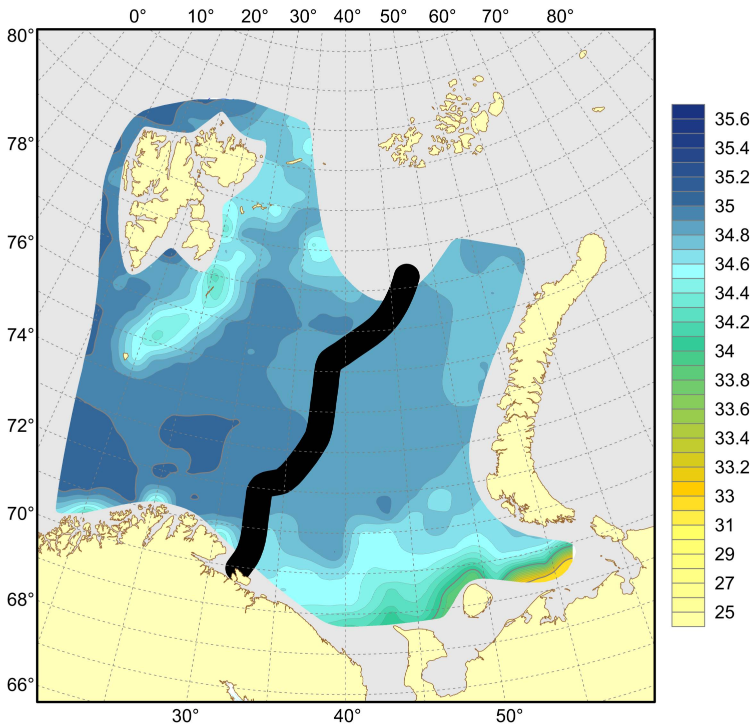

Figure 4.1.1.8. *Distribution of salinity at the bottom, August–November 2022. The thick black line is a line of discontinuity in the survey data.*

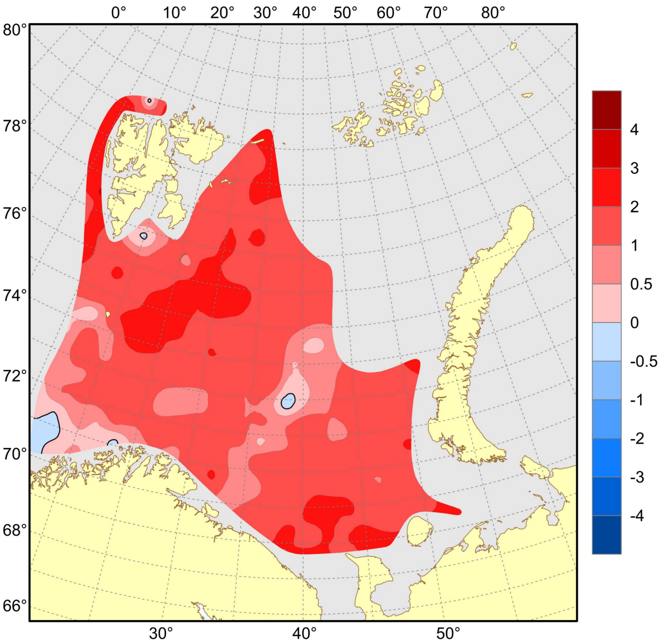

Figure 4.1.1.9. *Surface temperature anomalies (°C), August–November 2022.*

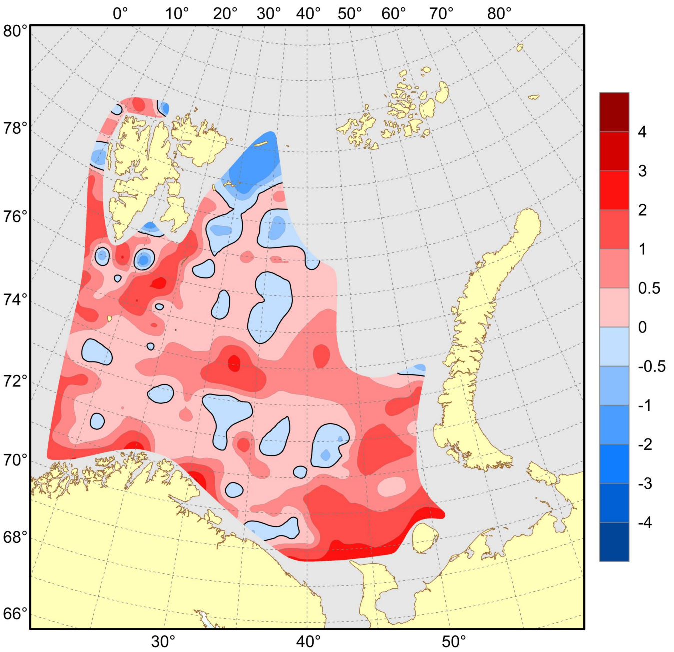

Figure 4.1.1.10. *Bottom temperature anomalies (°C), August–November 2022.*

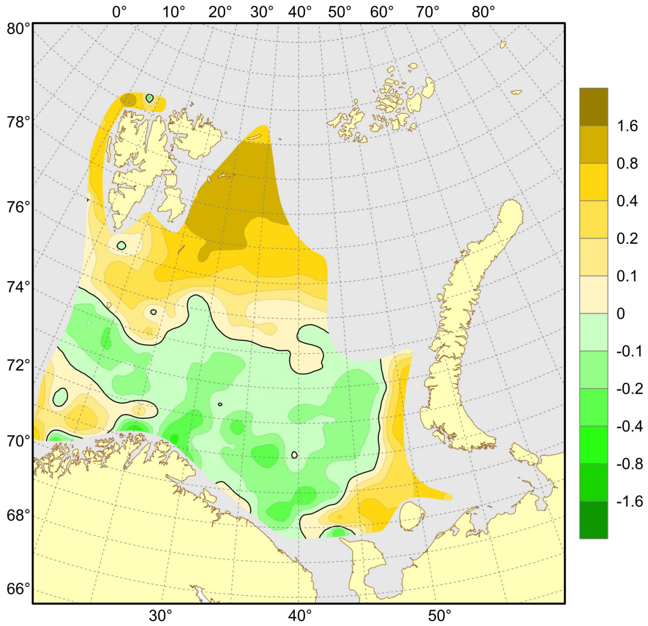

Figure 4.1.1.11. *Surface salinity anomalies, August–November 2022.*

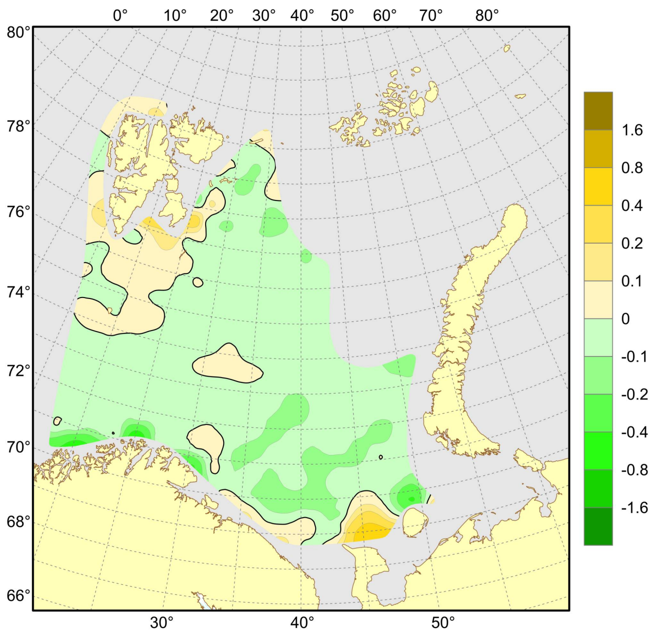

Figure 4.1.1.12. *Salinity anomalies at the bottom, August–November 2022.*

4.1.2 Standard sections

Table 4.1.2.1 shows mean temperatures in the main parts of standard oceanographic sections of the Barents Sea, 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. The mean Atlantic Water (50–200 m) temperature in the inflow region to the Barents Sea, i.e., at the Fugløya–Bear Island Section, was 0.4°C higher than the long-term mean (1981–2010) and 0.3°C warmer than in 2021 (Table 4.1.2.1). The temperature in the Vardø–North Section was at the same level as in 2021 (Table 4.1.2.1).

The Kola Section covers the flow of coastal and Atlantic waters in the southern Barents Sea. In autumn 2022, the Kola Section was sampled in late October. Temperature anomalies (averaged over 50–200 m, relative to 1981–2010) were decreasing from +0.8°C in coastal waters in the inner part of the Kola Section to +0.7 and +0.4°C in Atlantic waters in the central and outer parts respectively, that was typical of warm years. The anomalies were also decreasing with depth: from +1.4 and +0.8°C (0–50 m) to +0.3°C (150–200 m) in the central and outer parts of the section. Compared to 2021, the upper 50 m layer along the Kola Section in October 2022 was 0.7–1.0°C warmer; the 50–200 m layer was 0.1–0.4°C warmer; and temperature in the 150–200 m layer was close to that in 2021.

Table 4.1.2.1. Mean water temperatures in the main parts of standard oceanographic sections in the Barents Sea and adjacent waters in August–September 1965–2022. 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), 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	VN	FBI
	0–50	50–200	0–200	0–bot.	0–bot.	50–200	50–200
1965	6.7	3.9	4.6	4.6	3.7	3.8	5.2
1966	6.7	2.6	3.6	1.9	2.2	3.2	5.3
1967	7.5	4.0	4.9	6.1	3.4	4.4	6.3
1968	6.4	3.7	4.4	4.7	2.8	3.4	5.0
1969	6.7	3.1	4.0	2.6	2.0	3.8	6.3
1970	7.8	3.7	4.7	4.0	3.3	4.1	5.6
1971	7.1	3.2	4.2	4.0	3.2	3.8	5.6
1972	8.7	4.0	5.2	5.1	4.1	4.6	6.1
1973	7.7	4.5	5.3	5.7	4.2	4.9	5.7
1974	8.1	3.9	4.9	4.6	3.5	4.3	5.8
1975	7.0	4.6	5.2	5.6	3.6	4.5	5.7
1976	8.1	4.0	5.0	4.9	4.4	4.4	5.8
1977	6.9	3.4	4.3	4.1	2.9	3.6	4.9
1978	6.6	2.5	3.6	2.4	1.7	3.2	4.9
1979	6.5	2.9	3.8	2.0	1.4	3.6	4.7
1980	7.4	3.5	4.5	3.3	3.0	3.7	5.5
1981	6.6	2.7	3.7	2.7	2.2	3.4	5.3
1982	7.1	4.0	4.8	4.5	2.8	4.1	6.0
1983	8.1	4.8	5.6	5.1	4.2	4.8	6.1
1984	7.7	4.1	5.0	4.5	3.6	4.2	5.7
1985	7.1	3.5	4.4	3.4	3.4	3.7	5.6
1986	7.5	3.5	4.5	3.9	3.2	3.8	5.5
1987	6.2	3.3	4.0	2.7	2.5	3.5	5.1
1988	7.0	3.7	4.5	3.8	2.9	3.8	5.7
1989	8.6	4.8	5.8	6.5	4.3	5.1	6.2
1990	8.1	4.4	5.3	5.0	3.9	5.0	6.3
1991	7.7	4.5	5.3	4.8	4.2	4.8	6.2
1992	7.5	4.6	5.3	5.0	4.0	4.6	6.1
1993	7.5	4.0	4.9	4.4	3.4	4.2	5.8
1994	7.7	3.9	4.8	4.6	3.4	4.8	5.9

1995	7.6	4.9	5.6	5.9	4.3	4.6	6.1
1996	7.6	3.7	4.7	5.2	2.9	3.7	5.7
1997	7.3	3.4	4.4	4.2	2.8	4.0	5.4
1998	8.4	3.4	4.7	2.1	1.9	3.9	5.8
1999	7.4	3.8	4.7	3.8	3.1	4.8	6.1
2000	7.6	4.5	5.3	5.8	4.1	4.2	5.8
2001	6.9	4.0	4.7	5.6	4.0	4.2	5.9
2002	8.6	4.8	5.8	4.0	3.7	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	4.8	6.4
2005	8.0	4.4	5.3	5.2	3.8	5.0	6.2
2006	8.3	5.3	6.1	6.1	4.5	5.3	6.9
2007	8.2	4.6	5.5	4.9	4.3	4.9	6.5
2008	6.9	4.6	5.2	4.2	4.0	4.7	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	-	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	4.9	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	5.5	6.6
2016	8.7	4.7	5.8	-	5.5	5.1	6.5
2017	7.9	4.8	5.6	-	-	5.2	6.4
2018	8.1	4.9	5.7	-	-	-	6.0
2019	7.8	4.4	5.2	5.5	4.1	4.7	5.9
2020	8.2	4.3	5.3	-	-	5.1	6.2
2021	7.9	4.5	5.3	6.0	4.3	5.0	6.1
2022	-	-	-	-	-	5.0	6.4
Average 1981–2010	**7.6**	**4.2**	**5.0**	**4.6**	**3.6**	**4.4**	**6.0**

4.2 Antropogenic pollution

4.2.1 Marine litter

Text by: T. Prokhorova, B. E. Grøsvik, P. Krivosheya

Figures by: P. Krivosheya

Anthropogenic litter floating at the surface was observed from the Norwegian vessels only. Plastics dominated among anthropogenic pollutants on the water surface (81.5 % of observations) (Fig. 4.2.1.1). The maximum surface observation of plastic litter was 12 m^3, and it was a part of fishery trawl. The average surface observation of plastic was 0.005 m^3 (except the single maximum catch of 12 m^3). Due to currents, recorded debris could be dumped directly in some areas and transported from other areas. Wood was recorded in 18.5 % of the observations. The maximum surface observation of wood was 0.6 m^3, while the average was 0.4 m^3. Wood was presented by logs and pallets. Strictly, wood is not a pollution item, but we have presented wood in this report traditionally as litter.

Fishery related litter was recorded in 22.7 % of plastic litter observations at the surface (Fig. 4.2.1.2). Fishery related litter was represented by floats/buoys (OSPAR code 37) and pieces of net (OSPAR code 116). Fishery plastic both maximum and average observations (12 m^3 and 0.01 m^3 (except the single maximum catch of 12 m^3) was larger than non-fishery plastic (0.03 m^3 and 0.003 m^3).

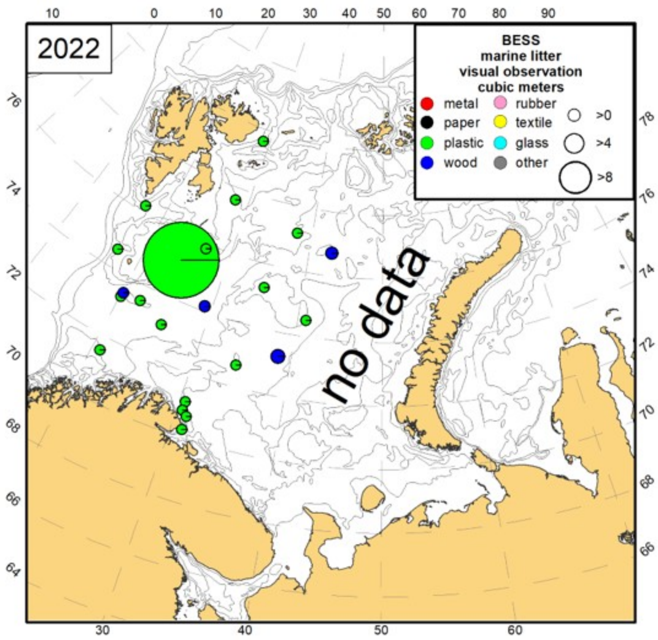

Figure 4.2.1.1. *Type of observed anthropogenic litter (m3) at the surface in the BESS 2022.*

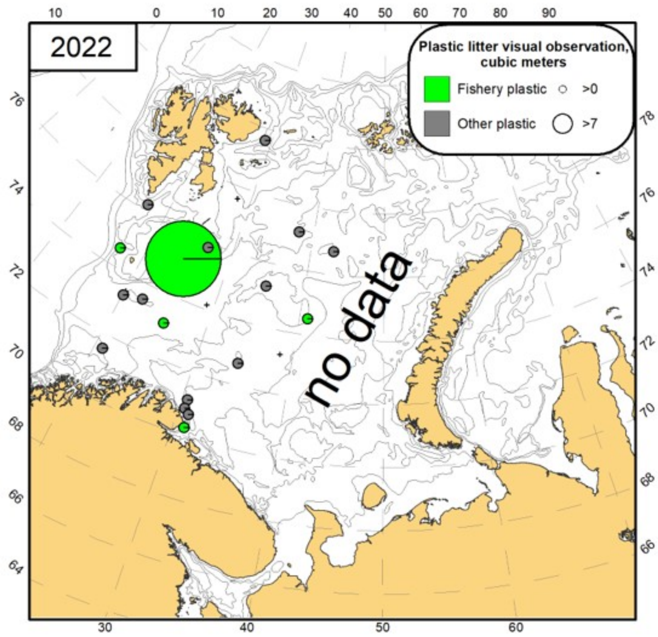

Figure 4.2.1.2. *Litter observations of plastic at the surface indicated as fishery related and other plastic litter in the BESS 2022.*

Anthropogenic litter collected in bottom trawls in 2022 was observed onboard all Norwegian vessels and Russian vessel "Vilnyus", in pelagic trawls – onboard the Norwegian vessels only.
Anthropogenic litter was observed in 17.6 % of pelagic trawl stations (Fig. 4.2.1.3). Only plastic was observed in pelagic trawls with anthropogenic litter in 2022. The minimum catch of plastic by pelagic trawl was 0.0004 kg per n.mile, the maximum catch was 0.04 kg per n.mile, with the average of 0.005 kg per n.mile. Considering the low catchability by pelagic trawl for low-density polymers, the total amount of this matter in the Barents Sea could be much higher.

Litter was observed in 34.9 % of the bottom trawl stations in 2022 (Fig. 4.2.1.4), and it is higher than in 2021 (28.1 % of the bottom trawl stations). The minimum catch of litter by bottom trawl was 0.00002 kg per n.mile. the maximum catch was 602.4 kg per n.mile, with the average of 0.360 kg per n.mile (except the single maximum catch of 500 kg).

Plastic dominated the litter content from the bottom trawls as usual (78.6 % of stations with observed litter). The catch of plastic litter in bottom trawls was from 0.00002 kg per n.mile to 26.5 kg per n.mile with average of 0.4 kg per n.mile. Wood, textile and metal were observed sporadically among the bottom trawl catches.

Litter from fishery was a significant part of plastic litter both in the pelagic and bottom trawls (46.2 % and 65.4 % respectively, Fig. 4.2.1.5).

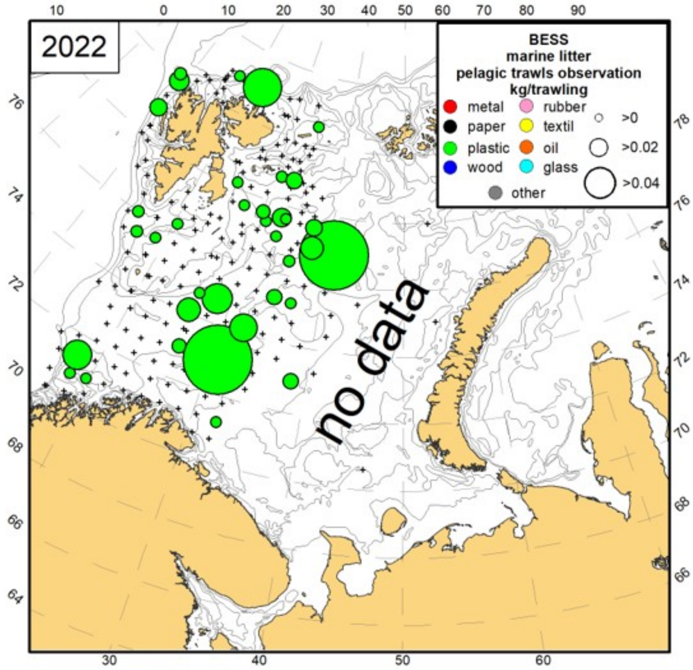

Figure 4.2.1.3.*Type of anthropogenic litter collected in the pelagic trawls (kg) in the BESS 2022 (crosses – pelagic trawl stations).*

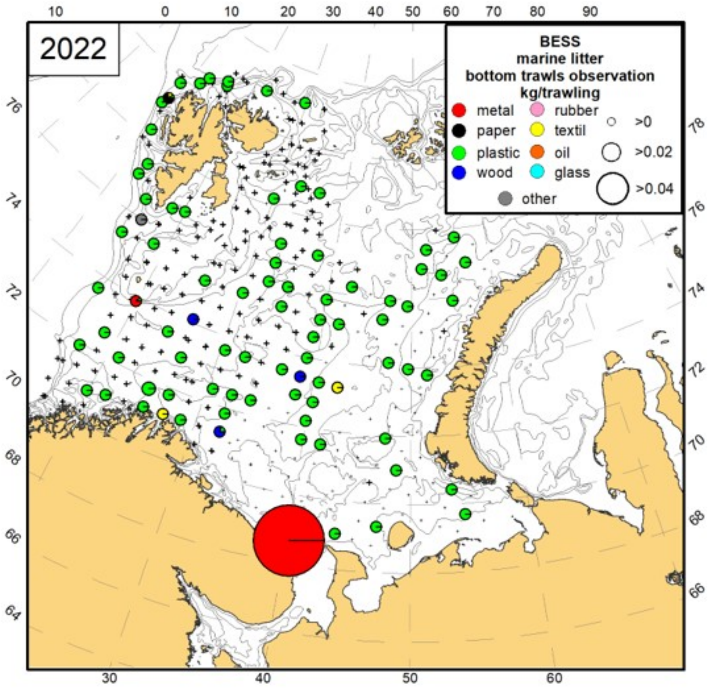

Figure 4.2.1.4. *Type of anthropogenic litter collected in the bottom trawls (kg) in the BESS 2022 (crosses – bottom trawl stations).*

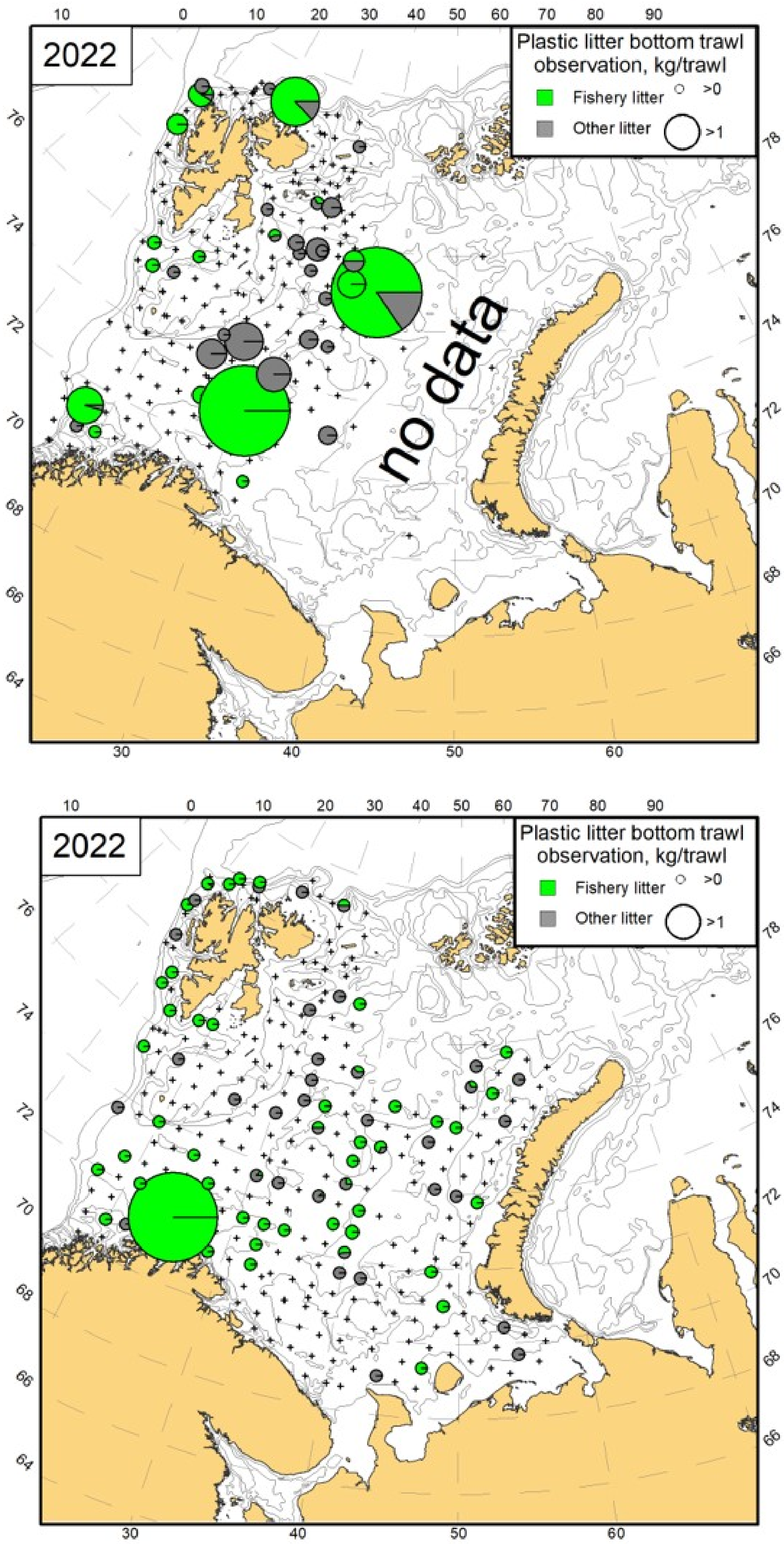

Figure 4.2.1.5. *Fishery plastic proportion among the plastic litter collected in the pelagic (the upper figure) and bottom trawls (the lower figure) in the BESS 2022 (crosses – trawl stations).*

5 - PLANKTON COMMUNITY

Author(s): Sarah Joanne Lerch, Espen Bagøien (IMR) and Irina Prokopchuk (VNIRO-PINRO)

5.1 Phytoplankton, chlorophyll a and nutrients

Text by: Sarah Joanne Lerch

Figures by: Sarah Joanne Lerch

Samples for phytoplankton community composition and abundance were collected from 27 preselected stations along fixed transects in the Barents Sea (Fig. 5.1.1). Samples were collected from Hinlopen and Vardø-N Utvidet during the late summer ecosystem cruise (2022110, 202210), and Fugløya-Bjørnøya during a spring transect cruise (2022207). Phytoplankton samples were collected using two methods, the Algae-net and CTD. Qualitative Algae-net samples were collected using a vertical net tow (10 µm mesh; 0.1 m^2 opening; 30-0 m), fixed with 2 ml 20% formalin and stored for future use. Samples for algal cell counts (100 ml) were taken from 10 m CTD collected water and fixed in Neutral Lugol. Microscope counts were performed following the Utermöhl (1958) method on all CTD samples to quantify community composition and abundance at the Flødevigen Plankton Laboratory.

Microscopy counts include heterotrophic and autotrophic groups, these communities will therefore be referred to as microplankton in the summarized results below.

Nutrient and chlorophyll samples were collected from rosette-mounted water-bottles released at various depths at the CTD stations in the Norwegian sector of the Barents Sea. The nutrient samples (20 ml) were preserved with chloroform (200 ml), 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. Data on nutrient levels (nitrate, nitrite, silicate and phosphate) are not presented in the cruise-report, but are available at IMR.

During the ecosystem cruise, the Barents Sea microplankton community at an average station was numerically dominated by small flagellates (71%, $4.1\times10^5 \pm 6.4\times10^5$ cells ml^{-1}) with smaller contributions from cryptophytes (16%, $9.3\times10^4 \pm 7.3\times10^4$ cells ml^{-1}), diatoms (5%, $2.6\times10^4 \pm 4.7\times10^4$ cells ml^{-1}) and haptophytes (5%, $3.1\times10^4 \pm 5.2\times10^4$ cells ml^{-1}) (Fig. 5.1.2). Small flagellates have consistently comprised at least 42% of the average microplankton community quantified during the ecosystem cruises since 2017. Microplankton community concentration overall has increased since 2020, small flagellates accounted for the majority of this (219% increase) but haptophytes (557%, increase), diatoms (139% increase), and cryptophytes (123% increase) contributed as well. Increasing cell concentrations correspond to increasing average surface chlorophyll concentrations during this period (Fig. 5.1.3). Changes in chlorophyll concentrations since 2020 are also part of a long-term trend of increasing chlorophyll which began in 2010. It should be noted that these patterns are not seen in all ICES sub-regions though, indicating spatial variations in chlorophyll concentrations within the sea.

Spatial and temporal variations were also seen within the 2022 microplankton community. During the ecosystem cruise, the taxa which contributed substantially to community composition (≥ 2%) differed in the most Northern ICES-sub regions (Svalbard N and Fanz Victoria Trough) relative to the southern ones (Great Bank, Hopen Deep, Thor Iverson Bank, South West) (Fig. 5.1.4). Diatoms were substantial contributors in both northern sub-regions and haptophytes in Svalbard North only. Latitudinal changes were also seen in the spring community observed on the Fugløya-Bjørnøya transect, with diatoms and haptophytes more abundant in northern ICES sub-regions. Similar communities, dominated by small flagellates and cryptophytes, were observed in the South West sub-region in both spring and late summer.

The average concentration of all microplankton in the late summer ($5.65×10^5$ ± $6.73×10^5$ cells ml^{-1}) was approximately one third of that measured in the spring ($2.11×10^6$ ± $1.84×10^6$ cells ml^{-1}). During the spring, southern stations were characterized by the highest cell abundance, which was mostly attributed to small flagellates (Fig. 5.1.5). In the late summer, cell concentrations were patchy with both the highest ($3.12×10^6$ cells ml^{-1}) and the lowest ($6.35×10^5$ cells ml^{-1}) concentrations found along the Vardø-N transect.

Within the microplankton these data describe only one purely photosynthetic group at a high taxonomic level, diatoms. During the ecosystem cruise, diatom abundance was greatest in the Hinlopen transect (2.0×104-$1.44×10^5$ cells ml^{-1}) and most northern Vardø-N station ($1.41×10^4$ cells ml^{-1}) (Fig. 5.1.6). These communities were comprised mainly of *Pseudo-nitzschia* and *Leptocylindrus*. During the spring, communities were dominated by *Chaetoceros* and the maximum diatom abundance ($8.63×10^5$ cells ml^{-1}) was found in one of the northern Fugløya-Bjørnøya stations.

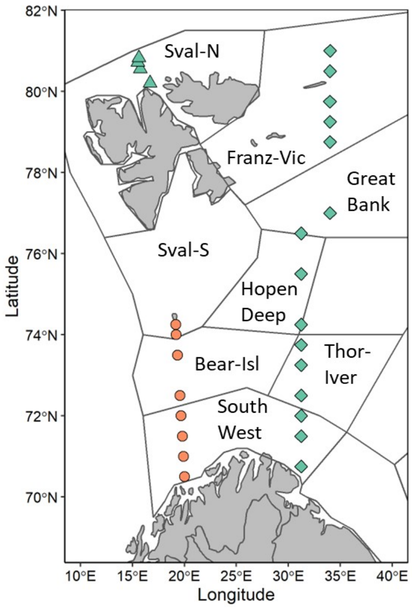

Figure 5.1.1. *Map showing stations where samples were collected and analyzed for phytoplankton community composition using microscopy. Outlined areas indicate ICES sub-regions, sampled sub-regions are labeled. Point shape indicates transect, circle: Fulgøya-Bjørnøya, diamond: Vardø-N Utvidet, triangle: Hinlopen. Colors indicate when samples were collected, green: during the 2022 ecosystem cruise, red: spring transect cruise (May-June). Sval-N: Svalbard North, Franz-Vic: Franz Victoria Trough, Sval-S: Svalbard South, Bear-Isl: Bear Island Trench, Thor-Iver: Thor Iversen Bank.*

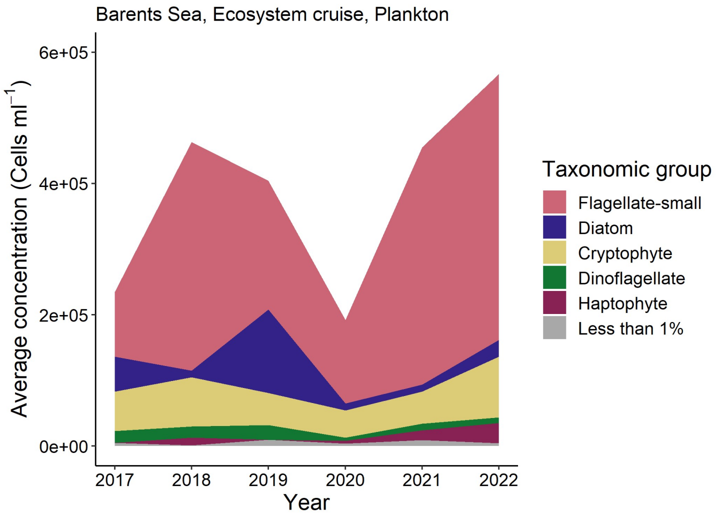

Figure 5.1.2. *Timeseries of Barents Sea microplankton community composition showing the average concentration of cells within broad taxonomic groups during the ecosystem survey. Many groups contain heterotrophic and autotrophic (phytoplankton) members. Cell concentrations derived from light microscopy. All groups which comprised ≤ 1% of the community are summed for ease of visualization.*

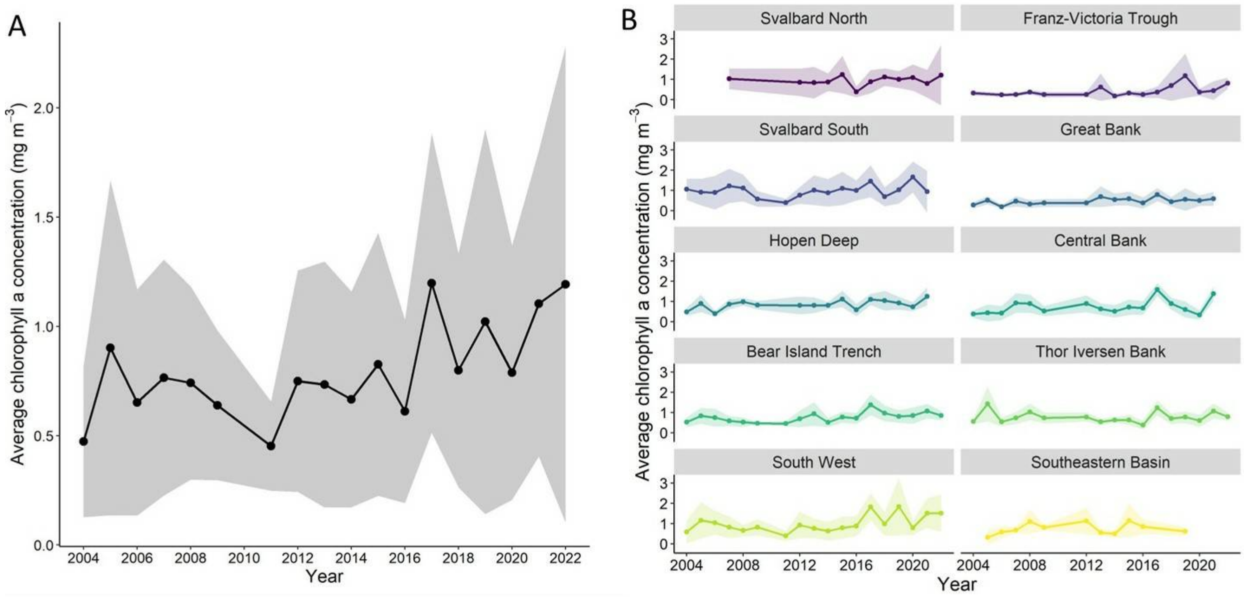

Figure 5.1.3. *Timeseries of Barents Sea surface chlorophyll a concentration measured during the time period of the Ecosystem cruise, August-October. Shading indicates standard deviation. A) Average chlorophyll concentrations across the entire Barents Sea. B) Average chlorophyll concentrations in the subset of ICES sub-regions with relatively consistent temporal sampling. ICES sub-regions are roughly colored and arranged by sub-region location with more northern regions in darker colors at the top and southern in lighter colors at the bottom.*

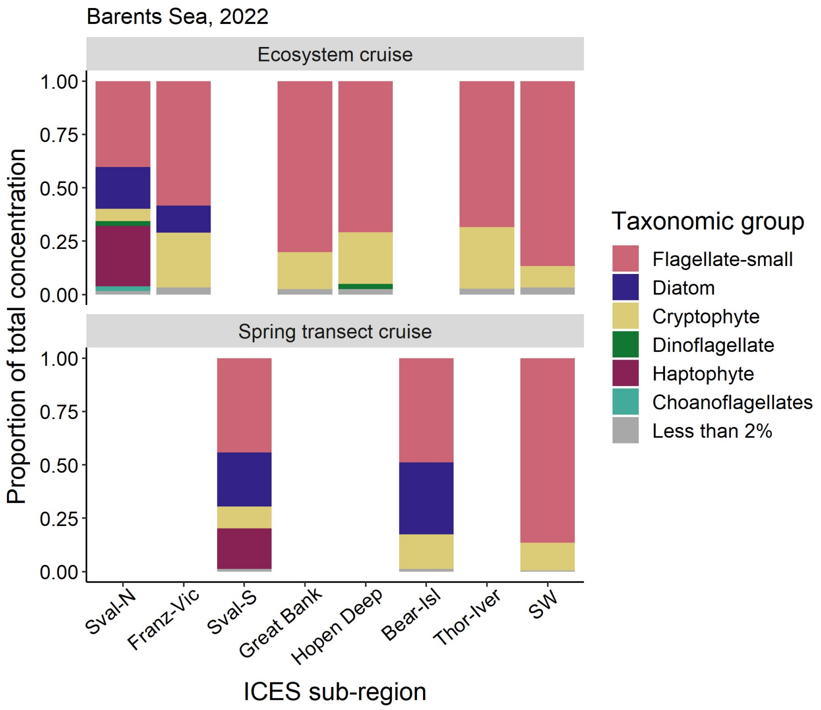

Figure 5.1.4. *Bar plot showing the average microplankton community composition at sampled stations by ICES sub-region during the ecosystem and spring transect cruises. All groups which comprised ≤ 2% of the community at a given station are summed for ease of visualization. Sval-N: Svalbard North, Franz-Vic: Franz Victoria Trough, Sval-S: Svalbard South, Bear-Isl: Bear Island Trench, Thor-Iver: Thor Iversen Bank, SW: South West.*

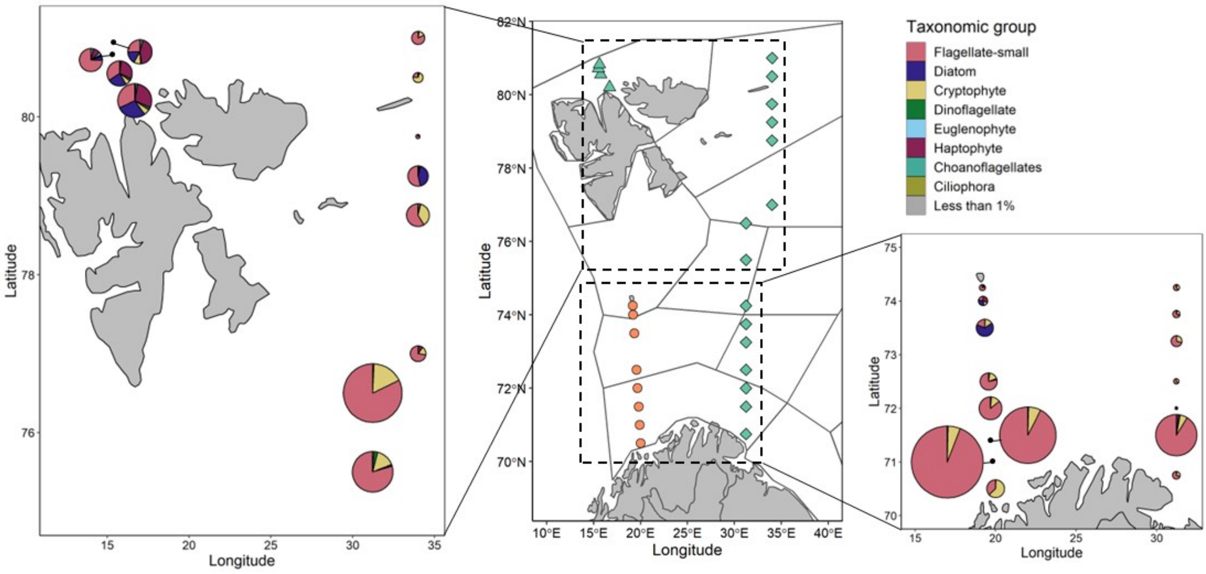

Figure 5.1.5. *Maps showing plankton community composition and abundance at all sampled stations North of 75°N (left) and South of 75°N (right). Pie chart radii scale to average cell concentrations, scaling varies between panels to allow for visualization; maximum radii represent 8.9×10^5 cells ml^{-1} (N of 75°N) and 5.6×10^6 cells ml^{-1} (S of 75°N). Divisions within pie charts show the contributions from broad taxonomic groups. All groups which comprised ≤ 1% of the community at a given station are summed for ease of visualization.*

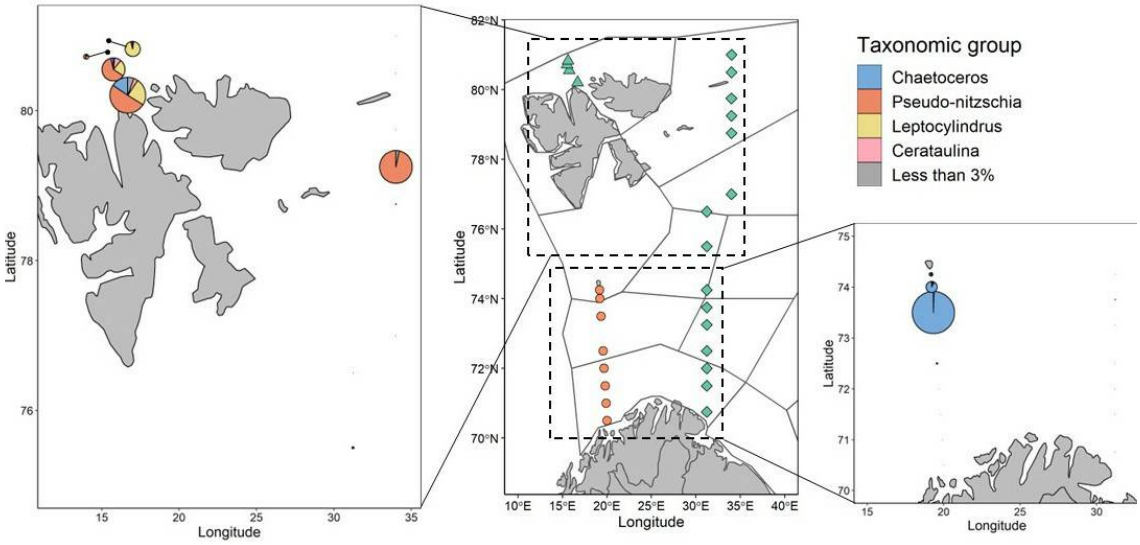

Figure 5.1.6. *Maps showing diatom community composition and abundance at all sampled stations North of 75°N (left) and South of 75°N (right). Pie chart radii scale to average cell concentrations, scaling varies between panels to allow for visualization; maximum radii represent 1.44×10^5 cells ml^{-1} (N of 75°N) and 8.63×10^5 cells ml^{-1} (S of 75°N). Divisions within pie charts show the contributions from broad taxonomic groups. All groups which comprised ≤ 3% of the community at a given station are summed for ease of visualization. If pie charts were shifted for visualization, lines with points indicate original sampling location.*

5.2 Mesozooplankton biomass and geographic distribution

Text by: Espen Bagøien and Irina Prokopchuk

Figure by: E. Bagøien

Mesozooplankton sampling stations during the joint Norwegian-Russian Barents Sea ecosystem cruise in 2022 are shown in Figure 5.2.1. In the Norwegian sector the WP2 net (opening area ~ 0.25 m^2) was applied, while in the Russian sector the Juday net (opening area ~ 0.11 m^2) was used. Both gears were rigged with nets of mesh-size 180 µm and hauled vertically from near the bottom to the surface. The WP2 and Juday nets provide roughly comparable results with respect to mesozooplankton biomass and species composition (Skjoldal et al., 2019). The Norwegian biomass samples are dried before weighing, while the Russian samples are preserved in 4% formalin and their wet-weight determined. Dry-weight is then estimated by dividing the wet-weight with a factor of 5.

The spatial distribution of total mesozooplankton biomass shown in Figure 5.2.1 is based on a total of 291 samples, of which 161 were located in the Norwegian sector and 130 in the Russian sector. Within the Norwegian sector, the average biomass was 6.9 (± 8.9 SD) g dry-weight m^{-2}. The average zooplankton biomass for the samples within the Russian sector was 3.3 (± 3.0 SD) g dry-weight m^{-2}. All stations shown in Figure. 5.2.1 are included in the 2022 biomass averages here presented.

The time of sampling in the Russian sector this year (26. Oct - 1. Dec, 2022) was unusually late in autumn, both compared to the Norwegian sector (17. Aug – 1. Oct, 2022), and the Russian sector in previous years. Hence, the biomass averages for Norwegian and Russian sectors in 2022 are not directly comparable. Likewise, the validity of comparing biomasses within the Russian sector in 2022 with earlier years becomes questionable. Figure 5.2.1 shows horizontally interpolated zooplankton biomasses for the Norwegian and Russian sectors in 2022, but to visualize the issue of differences in sampling time, we have added a line separating the Norwegian and Russian samples. For closely located Norwegian versus Russian stations separated by this line, the difference in sampling-time could vary between ca. 1.5 and 3 months, with the largest differences occurring in the southern area. We note that the lack of synoptic sampling in 2022 may very well be a confounding factor when evaluating zooplankton biomasses in different parts of the Barents Sea.

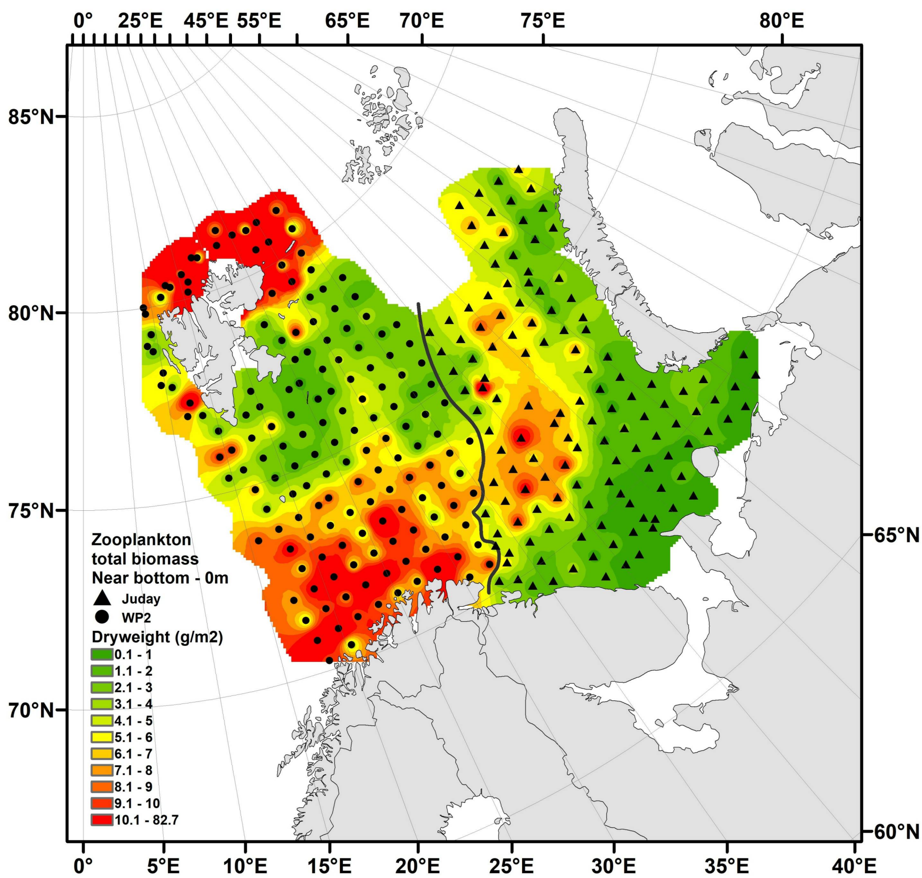

Figure 5.2.1. *Distribution of total zooplankton biomass (g dry-weight m^{-2}) from near-bottom to surface in the Barents Sea during BESS 2022 - based on a total of 291 stations. The data visualized were collected by WP2 and Juday nets with mesh-size 180 mm. Interpolation was made in ArcGIS v.10.8, module Spatial Analyst, using inverse distance weighting (IDW). The black line in the figure separates Norwegian and Russian samples. Note that for closely located Norwegian versus Russian stations separated by this line, the difference in sampling-time could vary between ca. 1.5 and 3 months, with the largest differences occurring in the southern area.*

Comparison of average biomasses across years is also vulnerable to differing area coverages. Challenges in covering the same area over a series of years are inherent in such large-scale monitoring programs, and interannual variation in ice-cover and logistical issues are two of several reasons for this. To improve the regularity of the sampling grid across the survey area in 2022, most stations belonging to the Hinlopen-section north of Svalbard/Spitzbergen and the whole Vardø-North section were omitted when calculating average biomass (excluded from Fig. 5.2.1). Differences in spatial coverage among years, as well as spatial variability in station density within the survey region will impact biomass estimates, and particularly so in an environment characterized by large-scale patterns in biomass distribution. Such challenges fall outside the scope of this cruise-report, but are addressed in other phora, for instance by analysing time-series for spatially consistent sub-areas.

The overall distribution patterns show similarities across years, although some interannual variability is apparent. In 2022 we observed the familiar pattern of comparatively high biomasses in the southwestern region and north of Svalbard/Spitsbergen, as well as the deeper part of the southeastern region. The biomasses were relatively low in the central regions including the bank areas, and very low in the southeastern corner of the Barents Sea and near Novaja Zemlja (Fig. 5.2.1).

Several factors may impact the levels of zooplankton biomass in the Barents Sea;

- Advective supply of zooplankton from the Norwegian Sea
- Local zooplankton production rates – linked to temperature, nutrient conditions and primary production rates
- Predation from carnivorous zooplankters (jellyfish, krill, hyperiids, chaetognaths, etc.)
- Predation from planktivorous fish incl. capelin, young herring, polar cod, juveniles of cod, saithe, haddock, redfish
- Predation from marine mammals and seabirds

References

Skjoldal, H.R., Prokopchuk, I., Bagøien, E., Dalpadado, P., Nesterova, V., Rønning. J., Knutsen, T. 2019. Comparison of Juday and WP2 nets used in joint Norwegian-Russian monitoring of zooplankton in the Barents Sea. Journal of Plankton Research 41:759-769.

5.3 Macrozooplankton

Macrozooplankton will be updated in the IMR-PINRO survey report from the 2023 BESS survey in 2024.

6 - FISH RECRUITEMENT (YOUNG OF THE YEAR)

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Figures by: D. Prozorkevich

Area coverage and estimations

In 2022, coverage of the 0-group fish was limited to the western part of the Barents Sea due to technical challenges with Russian vessel (Fig. 6.1). Based on years of full coverage and the average long-term distribution in 2000-2017, we corrected the 2022 abundance indices for lacking coverage. We present species distribution maps for western polygons only.

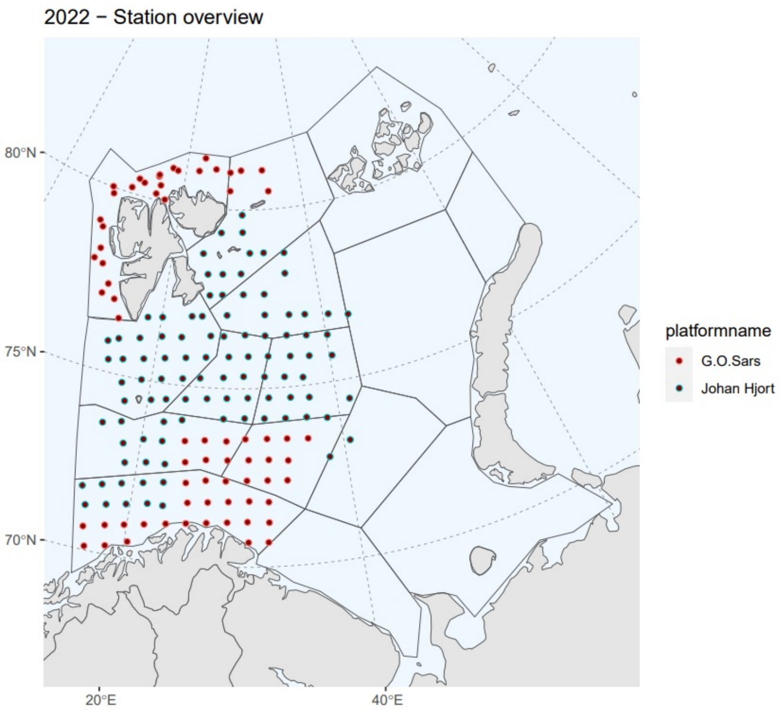

Figure 6.1. *Map showing spatial coverage of the 0-group fish in the Barents Sea in 2022. Colored dots indicated vessel coverage, while grey lines 15 WGIBAR-subareas (regions) used in estimations.*

Total biomass

Zero-group fish are important consumers of plankton and are prey for predators (larger fish, sea birds and marine mammals) and, therefore, are important for transfer of energy between trophic levels in the ecosystem. Estimated total biomass of 0-group fish species (cod, haddock, herring, capelin, polar cod, and redfish) varied from a low of 0.165 million tonnes in 2001 to a peak of 4.5 million tonnes in 2022 with a long-term average of 1.2 million tonnes (1993-2022) (Figure 6.2). In 2022, estimated total biomass of 0-group fish species was record high and was 4.5 million tonnes. In 2022, like in 2012-2013, 0-group fish biomasses were dominated by herring. In 2022, like in 2012-2013, 0-group fish biomasses were dominated by herring. In 2022, observed polar cod and capelin biomasses were especially low due to lack of coverage of their distribution areas. The indices are corrected for incomplete area coverage in Figure 6.2.

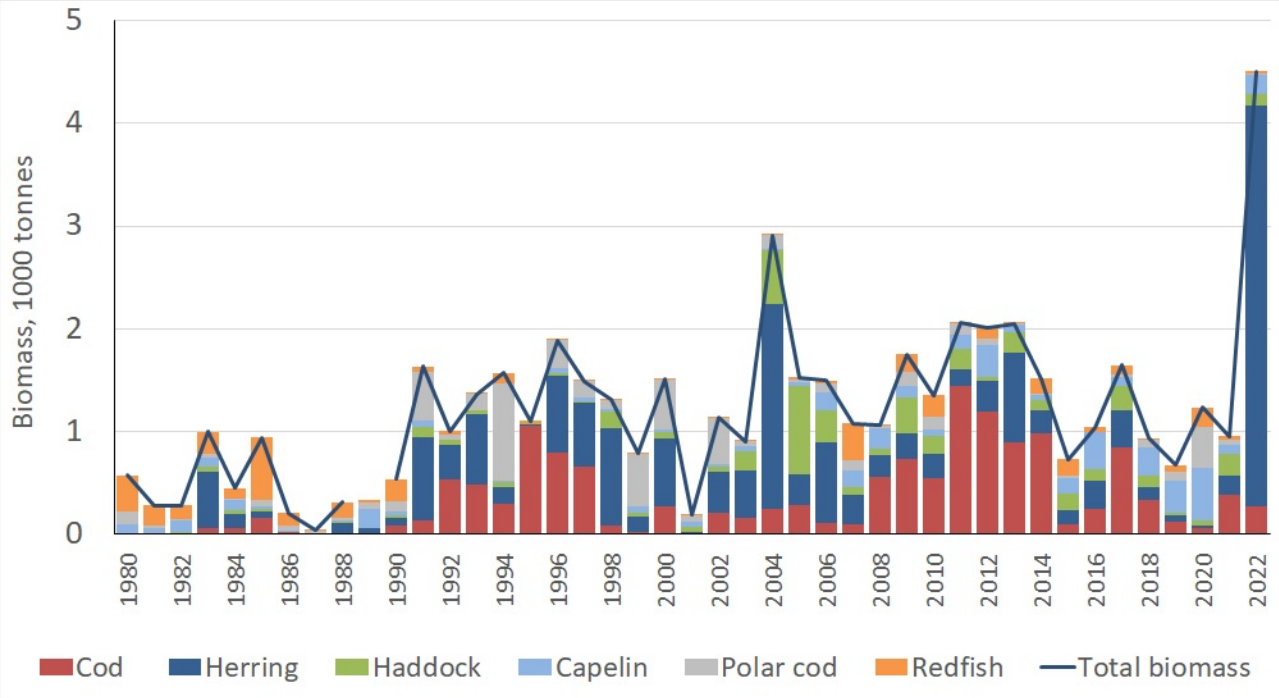

Figure 6.2. *Biomass of 0-group fish species in the Barents Sea, August–October 1980–2022. The biomass of 0-group fishes for the period 1980-1992 were estimated based on abundance indices and mean fish weight, while for later years it is ased on fish biomass. Indices were calculated in SAS for the period 1980-2017 and in R since that. Biomasses in 2018, 2020 and 2022 were corrected for lack of coverage.*

6.1 Capelin (*Mallotus villosus*)

The highest average abundance per strata were found in the Svalbard North (435 billion individuals) and Central Bank (17billion individuals) areas.

The 0-group capelin body length varied from 2 to 7.4 cm in 2022, while most of capelin were medium size with body length of 3.5-5.9 cm in 2022, which is similar to length distribution in 2021. Larger individuals (with an average length above 5 cm) were found mainly in northern areas, that indicated most likely that larvae from early spawning drifted further north. The smallest capelin with average length close to 3 cm were found in the southwestern areas (South West).

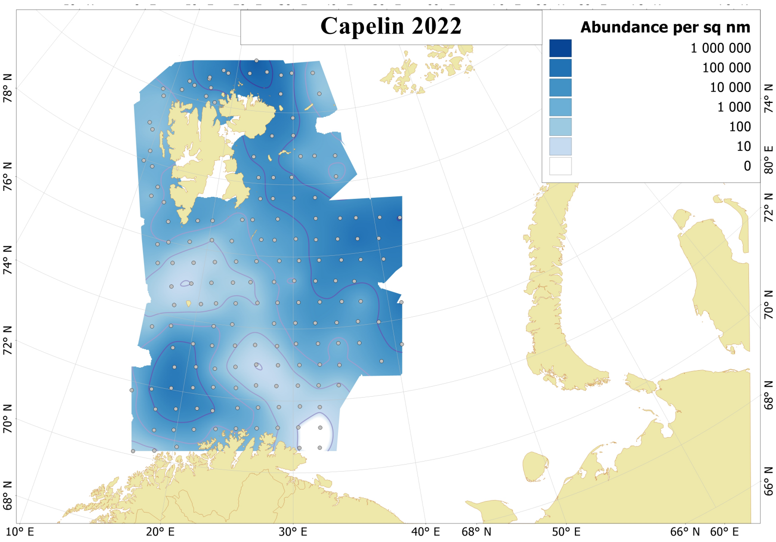

Figure 6.1.1. *Distribution of 0-group capelin, August-September 2022. Abundance is corrected for capture efficiency (Keff). Dots indicate sampling locations.*

A record strong year class of capelin occurred in 2019, followed by medium (2020), weak (2021) and most likely weak 2022-year classes. Estimated abundance of 0-group capelin varied from 1 billion in 1993 to 1. 5 billion individuals in 2019 with a long-term average of 361.6 billion individuals for the 1980-2022 period (Figure 6.1.2). In 2022, the eastern Barents Sea was not covered, where 0-group capelin were often found, and thus abundance and biomass indices were underestimated. Based on the average long-term distribution in 2000-2017, we corrected the 2022 abundance indices for lacking coverage like in 2018 and 2020. In 2022, the total abundance index for 0-group capelin was well below the long term mean and was 164.6 billion individuals (Fig. 6.1.2). Therefore, the 2022 year-class of capelin seemed to be weak.

However, estimated biomass of 0-group capelin was higher than the long term mean and was 186 thousand tonnes.

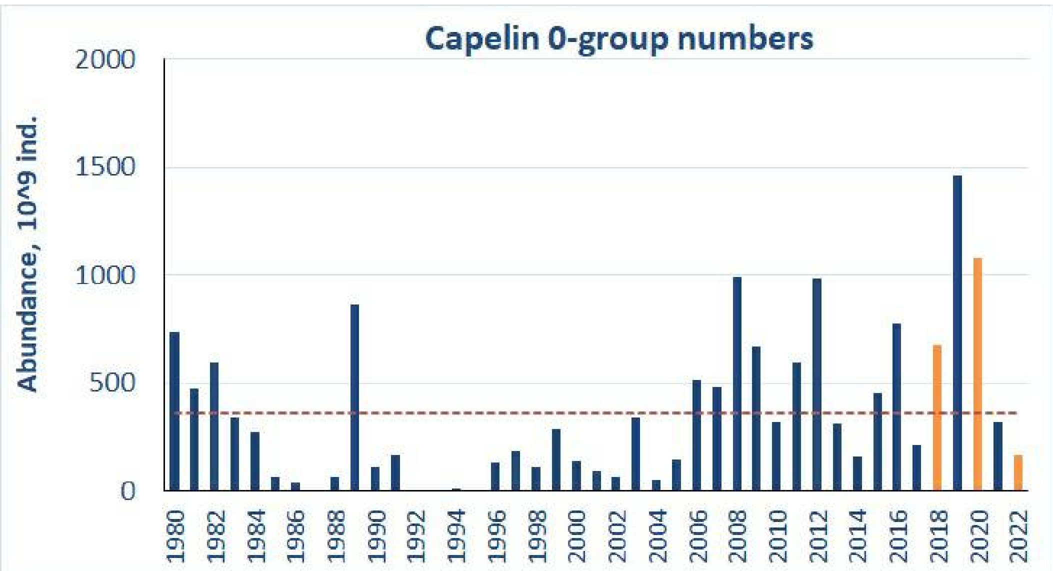

Figure 6.1.2. *0-group capelin abundance estimates corrected for capture efficiency (Keff) for the period 1980-2022. Red line shows the long-term average. Abundance indices for 2018, 2020 and 2022 were corrected for lack of coverage and shown by orange columns.*

6.2 Cod (*Gadus morhua*)

The highest average abundance per polygon were found in the northern area (Svalbard North, 18 billion individuals). In 2022, the eastern Barents Sea was not covered, where 0-group cod were usually found, and thus the first abundance indices were underestimated and represents the covered area only.

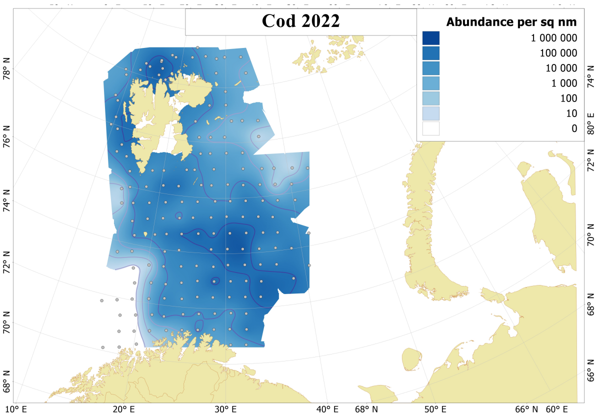

Figure 6.2.1. *Distribution of 0-group cod, August-September 2022. Abundance is corrected for capture efficiency (Keff). Dots indicate sampling locations.*

In 2022, 0-group cod were larger than in 2021 and were dominated by fish of 7.0-8.4 cm length. The largest cod (with an average close to 8,5 cm) were observed in polygons of the Southeastern and Great and Central Banks. Some few specimens of small cod below 1.5 cm were found in the Southeastern, Thor Iversen Bank and Svalbard North polygons.

Estimated abundance of 0-group cod varied from 0.276 billion in 1980 to 464.1 billion individuals in 2014 with a long-term average of 114.4 billion individuals for the 1980-2022 period (Figure 3.6.2). In 2022, the total abundance index for 0-group cod was below the long term mean and was 72.8 billion individuals. Cod estimated biomass in 2022 (277 thousand tonnes) was somewhat lower than in 2021 (385 thousand tonnes) and the long term mean for 2003-2022 (339 thousand tonnes). Therefore, the 2022 year-class of cod seemed to be below average.

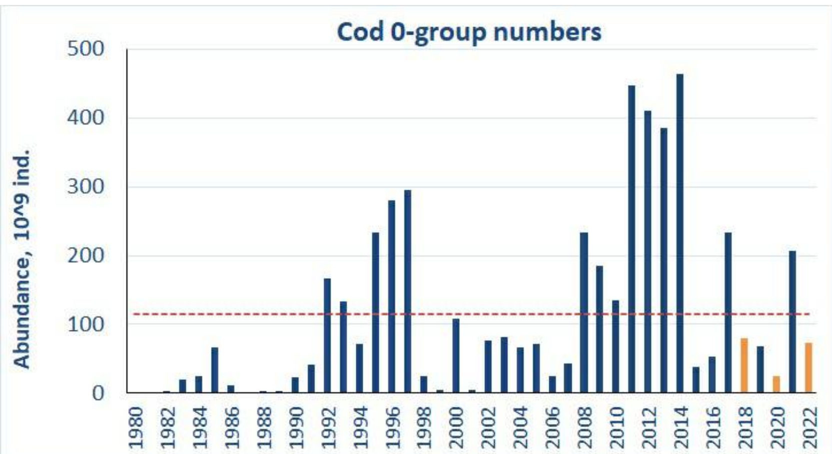

Figure 6.2.2. *0-group cod abundance estimates corrected for capture efficiency (Keff) for the period 1980-2021. Red line shows the long-term average. Abundance indices for 2018, 2020 and 2022 were corrected for lack of coverage and are shown by orange columns.*

6.3 Haddock (*Melanogrammus aeglefinus*)

More than half of the 0-group haddock were found in the Bear Island Trench polygon and the abundance there was as high as 11 billion ind. Haddock were also distributed along the western Svalbard/Spitsbergen archipelago (Fig. 6.3.1.).

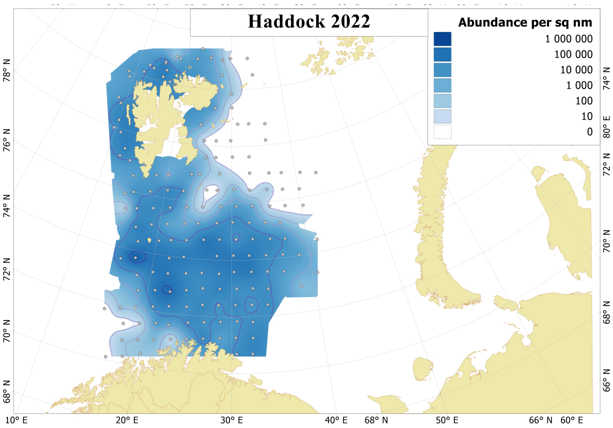

Figure 6.3.1. *Distribution of 0-group haddock, August-September 2022. Abundance are corrected for capture efficiency (Keff). Abundance are corrected for capture efficiency (Keff). Dots indicate sampling locations.*

In 2022, 0-group haddock dominated by fish of 8.0 – 11.4 cm length. The largest haddock (with an average length > 12-13 cm) were observed in the central areas (Great Bank and Southeastern basin), while the smallest haddock were found in the northern areas (with an average length < 6-7 cm).

Estimated abundance of 0-group haddock varied from 0.075 billion in 1982 to 91.6 billion individuals in 2005 with a long-term average of 12.1 billion individuals for the 1980-2022 period (Figure 6.3.2).

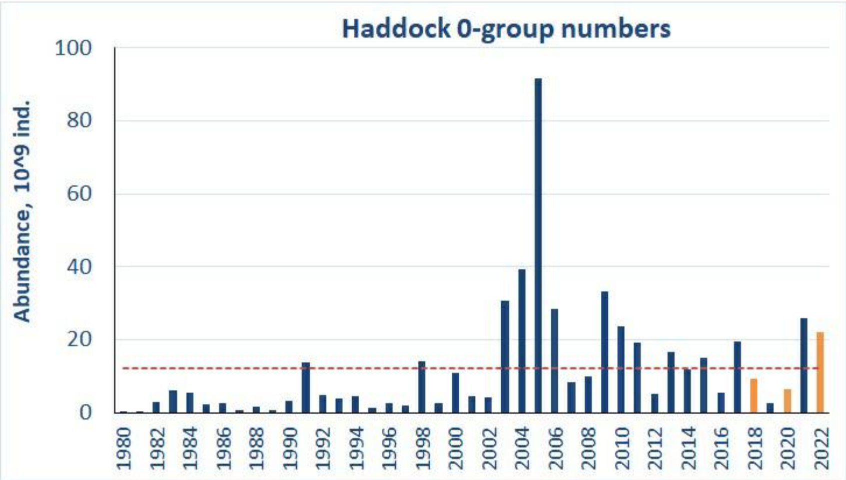

Figure 6.3.2. 0-group haddock estimates corrected for capture efficiency (Keff) for the period 1980-2022. Red line shows the long-term average. Abundance indices for 2018, 2020 and 2022 were corrected for lack of coverage and shown by orange columns.

In 2022, the total abundance estimates for 0-group haddock were higher than the long term mean and was 22.1 billion individuals. Haddock estimated biomass in 2022 (124 thousand tonnes) was lower than in 2021 (216 thousand tonnes) and close to the long term mean for 2003-2022 (115 thousand tonnes). Lack of coverage in the eastern Barents Sea will not influence the level of abundance indices so much due to 0-group haddock usually being distributed in the western and central areas. Thus, the 2022-year class may be characterized as strong.

6.4 Herring (*Clupea harengus*)

0-group herring were widely distributed in the covered area (Fig. 6.4.1). The highest average abundance per polygon were found Svalbard North (1100 billion individuals) and fish of average size (with an average length of 5.6 cm). Relatively high concentrations were also found in the Bear Island Trench, Thor Iversen Bank and Hopen Deep polygons (with an average of 140-160 billions individuals).

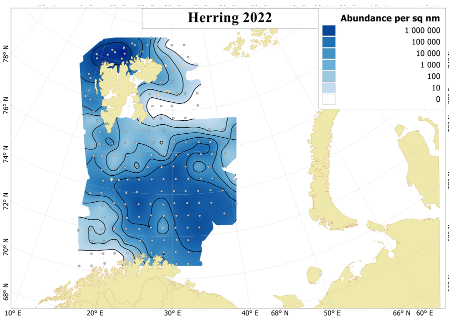

Figure 6.4.1. *Distribution of 0-group herring, August-September 2022. Abundance are corrected for capture efficiency (Keff). Abundance are corrected for capture efficiency (Keff). Dots indicate sampling locations.*

The length of the majority of herring (90%) varied between 4 and 7 cm in 2022. Larger individuals were observed in the central areas with an average length of 6.0 cm, while the smallest herring was found in the southeastern areas and north of Svalbard (Spitzbergen).

Estimated abundance of 0-group herring varied from 0.037 billion in 1982 to774 billion individuals in 2004 (Figure 6.4.2). In 2022, the eastern Barents Sea was not fully covered and zero border of herring distribution were not found in the east, and thus abundance and biomass indices estimates are slightly underestimated. Despite this, in 2022, the total abundance index for 0-group herring was almost 10 times higher than to the long term mean and was close to 2000 billion individuals (Figure 6.4.2).

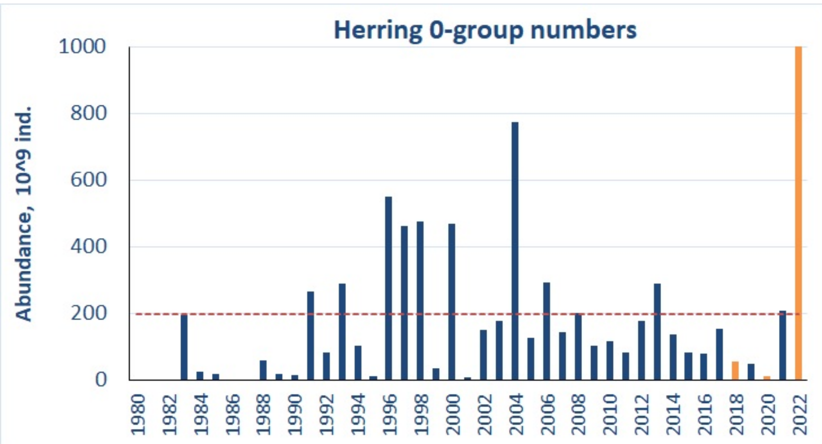

Figure 6.4.2. *0-group herring abundance estimates corrected for capture efficiency (Keff) for the period 1980-2022. Red line shows the long-term average. Abundance indices for 2018, 2020 and 2022 were corrected for lack of coverage and shown by orange columns.*

Estimated biomass of 0-group herring was highest since 2004 and much higher than the long-term mean (411 thousand tonnes) and was close to 4 million tonnes. Therefore, the 2022-year class of herring may be characterized as record strong. Unfortunately, half of the 0-group herring abundance was distributed north of Svalbard and therefore their survival during the first winter is highly unknown.

6.5 Polar cod (*Boreogadus saida*)

Polar cod were found around the Svalbard archipelago in 2022 (Fig. 6.5.1). Coverage of the 0-group polar cod was not complete, especially in the eastern parts of the Barents Sea (Fig. 6.1), and thus the south-eastern component of polar cod could not be presented here.

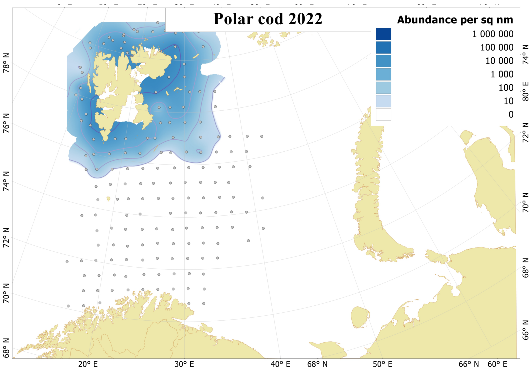

Figure 6.5.1. *Distribution of 0-group polar cod, August-September 2022. Abundance is corrected for capture efficiency (Keff). Dots indicate sampling locations.*

The polar cod length varied between 2.5 and 8.0 cm, while dominated by fish with length of 3.5-5.5 cm. In 2020, the average length was 4.8 cm. Averaged length doesn't vary between polygons.

Estimated abundance of 0-group polar cod varied from 0.201 billion in 1995 to 2400* billion individuals in 1994 with a long-term average of 307.6 billion individuals for the 1980-2022 period (Figure 3.5.4). In 2018, 2020, 2021 and 2022 the eastern part of the Barents Sea was not fully covered, where 0-group polar cod are often found, and thus abundance and biomass indices were underestimated. The eastern component has dominated in abundance and biomass during 1980, 1990 and early 2000s. In 2022, the total abundance index for 0-group polar cod was extremely low and was 5.4 billion individuals (Figure 6.5.2).

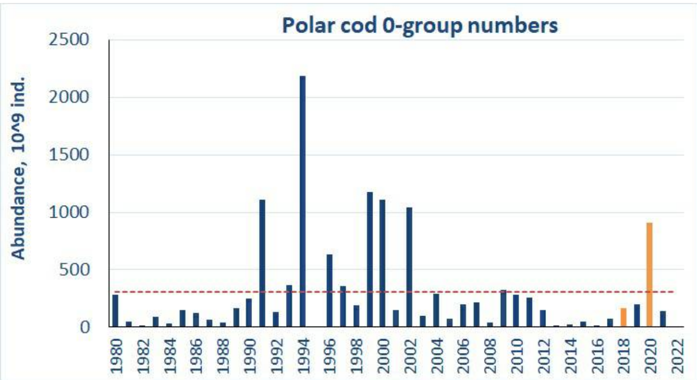

Figure 6.5.2. *0-group polar cod abundance estimates corrected for capture efficiency (Keff) for the period 1980-2022. Red line shows the long-term average. Abundance indices for 2018, 2020 and 2022 were corrected for lack of coverage and shown by orange columns.*

In 2021, estimated biomass of 0-group polar cod was 1/15 of the long term mean (134 thousand tonnes for the period 1993-2022) and was 9 thousand tonnes.

The abundance index of 2022-year class from Svalbard (Spitzbergen) population is very low and may be characterized as weak.

6.6 Saithe (*Pollachius virens*)

Saithe distribution and abundance varied a lot between years. In 2022, 0-group saithe were found in the central Barents Sea such as in 2021 (Fig. 6.6.1).

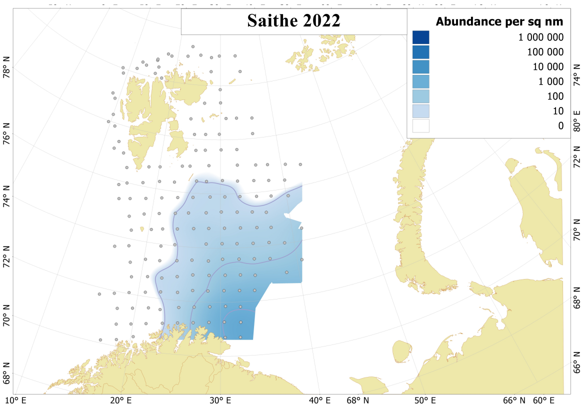

Figure 6.6.1. *Distribution of 0-group saithe in August-September 2022. Abundance was not corrected for capture efficiency. Dots indicate sampling locations.*

Largest saithe with an average of 11-12 cm were observed in the Bear Island Trench and Thor Iversen Bank polygons, fish with an average of 8.5-9.0 cm were found in the northcentral areas.

In 2022, abundance was higher than long term mean (442 million for the period 1980-2022), i.e. 724 million individuals (Fig. 6.6.2).

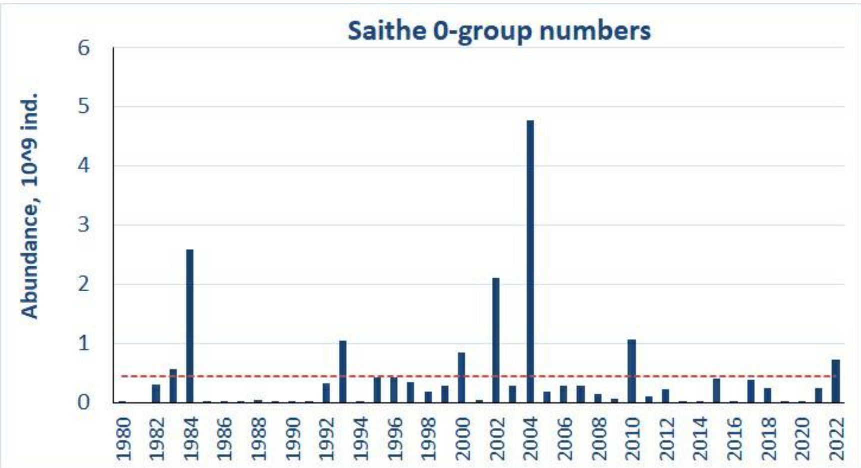

Figure 6.6.2. *0-group saithe abundance estimates were not corrected for capture efficiency for the period 1980-2022. Red line shows the long-term average.*

0-group saithe are generally distributed along the Norwegian coast, while some part of the year class are transported to the Barents Sea. Therefore, abundance indices for saithe may not represent year classes strength but give indication of abundance in the Barents Sea.

6.7 Redfish (mostly *Sebastes mentella*)

0-group redfish was distributed from north of Norwegian coast to the northwest/east of Svalbard (Spitsbergen) archipelago in 2022 (Figure 6.7.1). The densest concentrations and the largest fish with an average length of 4.3 cm were found in the Thor Iversen Bank polygon.

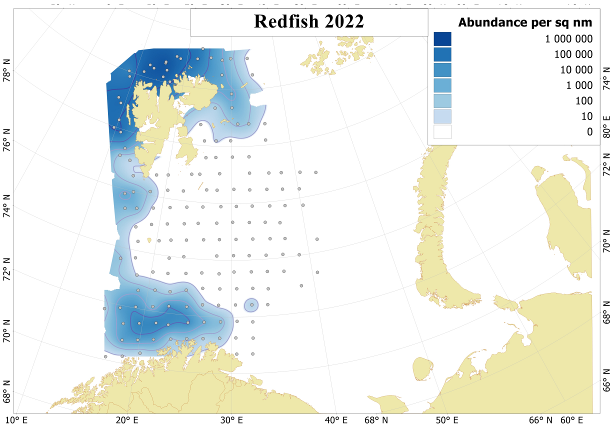

Figure 6.7.1. *Distribution of 0-group redfishes (mostly Sebastes mentella) in August-September 2022. Abundance was not corrected for capture efficiency. Dots indicate sampling locations.).*

Estimated abundance of 0-group deepwater redfish varied from 23 billion individuals in 2001 to 1600 billion individuals in 1985, and long term average abundance was 217 billion individuals for the 1980-2022 period (Figure 6.7.2). In 2022, the total abundance index for 0-group deepwater redfish was very low and was 9.1 billion individuals, which is much lower than the long-term mean. The total biomass was close to 19 thousand tonnes. Thus the 2022-year class may be characterized as weak.

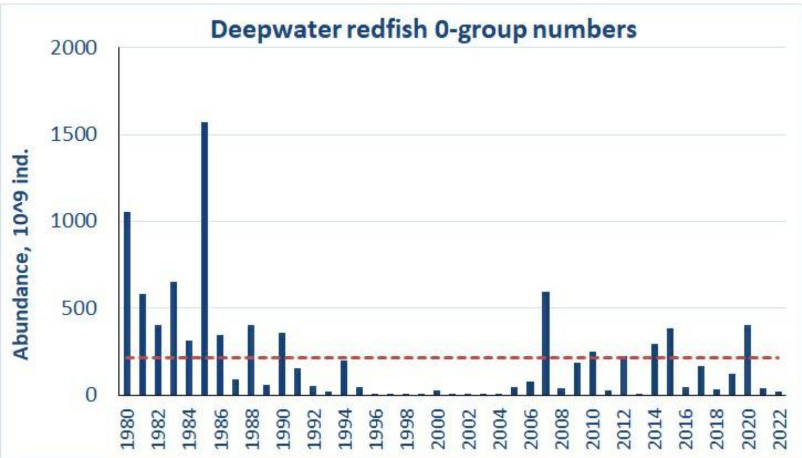

Figure 6.7.2*. 0-group deepwater redfish abundance (corrected for trawl efficiency) in the Barents Sea during 1980-2022. Red line shows the long-term average.*

6.8 Greenland halibut (*Reinhardtius hippoglossoides*)

0-group Greenland halibut were found distributed around the Svalbard (Spitzbergen) in 2022 similar to the distribution in 2018-2021 (Figure 6.8.1).

0-group Greenland halibut length varied from 2.5 to 9.5 cm. Larger fish were found in the Fr.Victoria Trough polygon, and fish length were with an average of 7.3 cm, while smaller fish were found in the Svalbard South and Svalbard North polygons with an average of 6.6 - 6.7 cm.

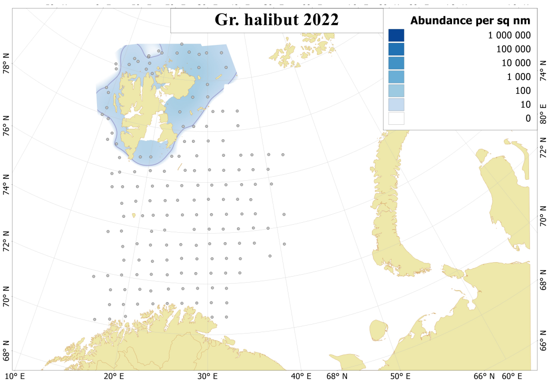

Figure 6.8.1. *Distribution of 0-group Greenland halibut, August-September 2022. Dots indicate sampling locations.*

In 2022, the total abundance index for 0-group fish were 40.5 *106 individuals, that was higher than the long term mean of 30 million individuals. Estimated biomass was also higher than the long term mean (of 82 tonnes) and was 73 tonnes.

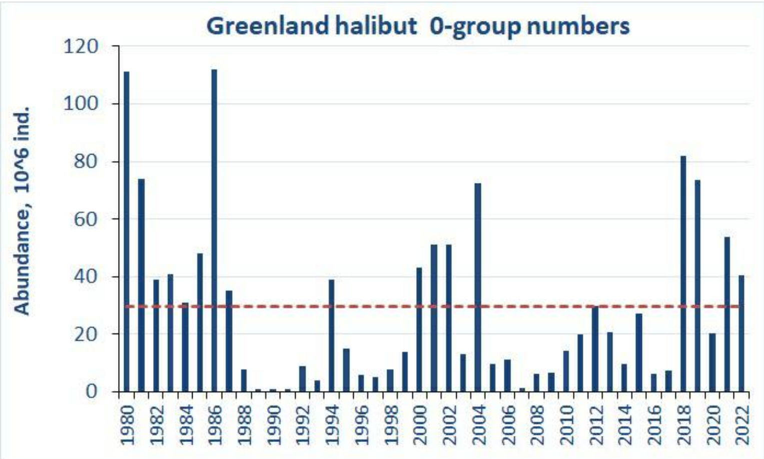

Figure 6.8.2. *0-group Greenland halibut abundance estimates were not corrected for capture efficiency for the period 1980-2022. Red line shows the long-term average.*

6.9 Long rough dab (*Hippoglossoides platessoides*)

In 2022, 0-group long rough dab were mainly distributed in the north of Svalbard (Spitsbergen) (Figure 6.9.1). In 2022, the eastern Barents Sea was not covered, where long rough dab is usually distributed.

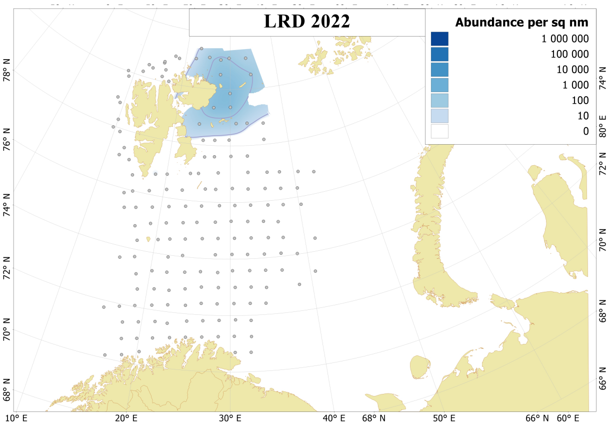

Figure 6.9.1. *Distribution of 0-group long rough dab, August-September 2022. Dots indicate sampling locations.*

The 0-group long rough dab length varied from 0.5 to 6.0 cm with an average of 3.9 cm.

In 2022, the total abundance index for 0-group fish were 69.3 million individuals that was lowest since 2014. Estimated biomass was also lower than long term mean of 287 tonnes and was 48 tonnes.

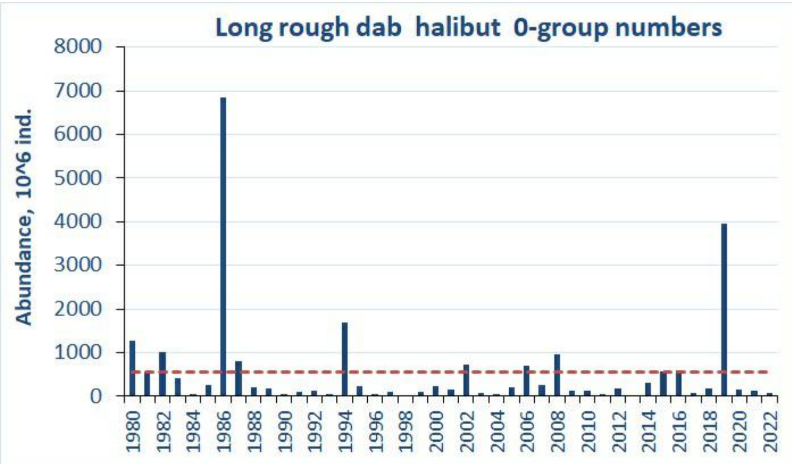

Figure 6.9.2. *0-group long rough dab abundance estimates were not corrected for capture efficiency for the period 1980-2022. Red line shows the long-term average.*

Thus the 2022-year class of long rough dab is difficult to characterize because lack of coverage in traditional area.

7 - COMMERCIAL PELAGIC FISH

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Figures by S. Karlson, G. Skaret

In 2022, the Russian survey sector was surveyed with a significant delay (see chapter 2). Thus, initially the calculations of numbers and biomass were made for the Norwegian part only.

7.1 Capelin (*Mallotus villosus*)

Only the Norwegian side of the Barents Sea was covered synoptically, the eastern part of the feeding area for capelin was covered late (see Figure 7.1.1.1). It is highly variable between years how much capelin is present in the eastern part of the distribution area (see: Advice on fishing opportunities for Barents Sea capelin in 2023 | Havforskningsinstituttet). Assesment in October-November cannot be combined with assesment in August-September, since there are no reliable data on capelin migration within 2 months. Therefore, the estimates given in the table 7.1.2.1b can only be used as additional information.

7.1.1 Geographical distribution

The Norwegian (western) side of the Barents Sea was covered during BESS in August-September 2022, and the geographical distribution of capelin recorded acoustically is shown in Figure 7.1.1.1 (marked in gray colour). The capelin was distributed further north than in recent years. Significant recordings of capelin were made north of Kvitøya already in early September by ‘GO Sars’. A similar northerly distribution has not been observed since 2013. The Russian (eastern) part was covered in October-November. Capelin was distributed far to the northeast up to 78°N and 60°E (see Figure 7.1.1.1, marked in red). The main densities were found at the border of the surveyed area, which shows that the capelin distribution was even further north and east.

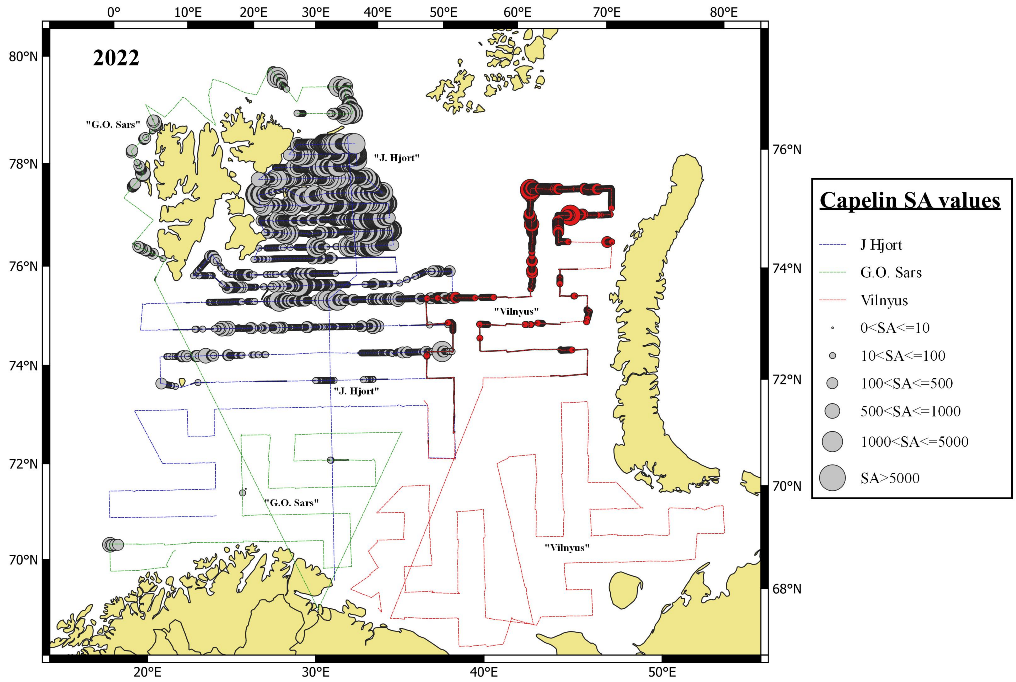

Figure. 7.1.1.1. *Geographical distribution of capelin in autumn 2022 based on acoustic recordings. Circle sizes correspond to s_A values (m^2/nmi^2) per nautical mile. The circles and transect marked with red colour are recordings from Vilnyus made later than the other vessels (see text for details).*

7.1.2 Abundance by size and age

A detailed summary of the acoustic stock estimate is given in Table 7.1.2.1a, and the time series of abundance estimates is summarized in Table 7.1.2.2. A comparison between the estimates in 2022 and 2021 is given in the table 7.1.2.3 with the 2021 estimate shown on a shaded background.

The total stock in the covered area was estimated to about 2.17 million tons, which is below the long-term average level (2.8 million tons). About 38 % (0.82 million tons) of the 2022 stock had length above 14 cm and was therefore considered to be maturing. The 2-year-olds and 3-year-olds (2020 and 2019 year-classes) dominated in the capelin stock in terms of both abundance and biomass. Late estimation in October-November in the northeastern part showed a SSB in this area of about 244 thousand tons. There was a significant dominance of age 3+ (70%). Average weight at age (based on the western survey area) was the lowest since the 1970s for the 2-year-olds and the lowest since the mid-eighties for 3-year-olds (figure 7.1.2.1).

The work concerning assessment and quota advice for capelin is dealt with in a separate report published here: [Advice on fishing opportunities for Barents Sea capelin in 2023 | Havforskningsinstituttet].

Table 7.1.2.1a Barents Sea capelin. Summary of results from the acoustic estimate in August-September 2022 (western part).

Length (cm)	**Age/year class**					**Sum (10^9)**	**Biomass (10^3 t)**	**Mean weight (g)**
	1	**2**	**3**	**4**	**5**			
	2021	**2020**	**2019**	**2018**	**2017**			
7.0-7.5	0.275					0.275	0.347	1.26
7.5-8.0	0.448					0.448	0.982	2.19
8.0-8.5	1.851					1.851	4.324	2.34
8.5-9.0	3.240					3.240	9.512	2.94
9.0-9.5	11.849	0.367				12.216	41.061	3.36
9.5-10.0	16.198	0.643				16.841	64.576	3.83
10.0-10.5	18.004	3.259	0.234			21.498	92.273	4.29
10.5-11.0	15.478	22.005	0.997			38.481	191.589	4.98
11.0-11.5	4.450	28.864	1.244			34.558	193.871	5.61
11.5-12.0	2.061	28.342	2.699			33.102	211.645	6.39
12.0-12.5	1.194	20.241	4.766			26.201	190.108	7.26
12.5-13.0	0.270	11.627	3.362	0.016		15.275	128.200	8.39
13.0-13.5	0.141	8.034	4.325	0.081		12.581	122.333	9.72
13.5-14.0		4.171	5.232	0.068		9.470	105.374	11.13
14.0-14.5		2.936	5.955	0.040		8.932	114.229	12.79
14.5-15.0		1.788	5.060	0.046		6.894	101.479	14.72
15.0-15.5		1.294	5.544	0.262		7.100	119.397	16.82
15.5-16.0		0.832	5.340	0.184		6.356	122.091	19.21
16.0-16.5		0.933	5.625	0.447		7.006	148.635	21.22
16.5-17.0		0.290	3.518	0.005		3.814	91.257	23.93
17.0-17.5		0.079	1.988	0.077		2.143	59.219	27.63
17.5-18.0		0.078	1.019	0.025	0.008	1.129	34.809	30.82
18.0-18.5		0.004	0.679			0.683	22.707	33.24
18.5-19.0			0.103			0.103	3.620	35.20
19.0-19.5			0.001			0.001	0.033	39.00
TSN (10^9)	75.460	135.787	57.692	1.250	0.008	270.197		
TSB (10^3 t)	324.674	964.078	860.680	24.052	0.188		2173.671	
Mean length (cm)	9.85	11.69	14.22	15.32	17.50	11.98		
Mean weight (g)	4.30	7.10	14.92	19.25	24.00			8.04
SSN (10^9)	0	8.234	34.833	1.085	0.008	44.160		
SSB (10^3 t)	0	133.063	662.616	21.613	0.241		817.476	

Target strength estimation based on formula: TS= 19.1 log (L) – 74.0

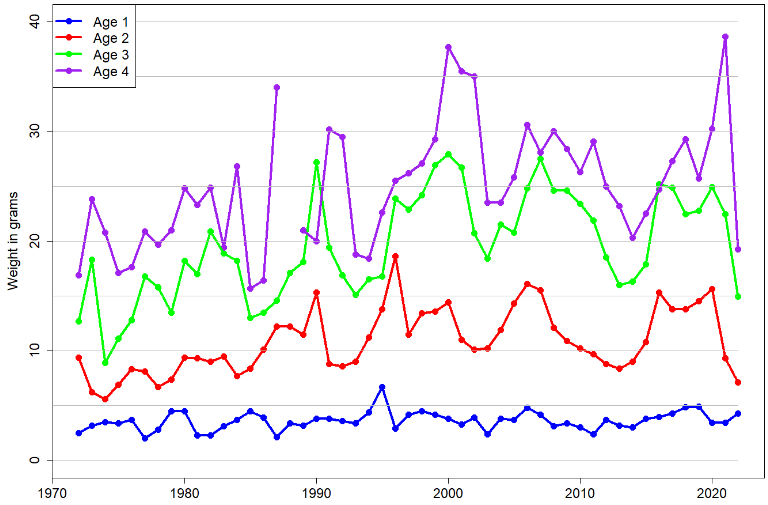

Figure 7.1.2.1. *Weight at age (grams) for capelin from capelin surveys (prior to 2003) and BESS. In 2022 data are used only for the western part of the survey area.*

Table 7.1.2.1b Barents Sea capelin. Summary of results from the acoustic estimate in October-November 2022 (eastern part).

Length (cm)	Age/year class					Sum (10^9)	Biomass (10^3 t)	Mean weight (g)
	1	2	3	4				
	2021	2020	2019	2018				
9.0-9.5	0.505					0.505	1.045	2.07
9.5-10.0	0.454					0.454	1.181	2.6
10.0-10.5	0.293					0.293	0.966	3.3
10.5-11.0	0.038					0.038	0.158	4.1
11.0-11.5	0.050					0.050	0.225	4.51
11.5-12.0	0.422					0.422	2.261	5.36
12.0-12.5		0.469				0.469	2.920	6.22
12.5-13.0		1.460	0.422			1.882	13.325	7.08
13.0-13.5		1.417	0.000			1.417	11.349	8.01
13.5-14.0		1.388	0.657			2.045	19.198	9.39
14.0-14.5		0.704	1.292			1.996	23.375	11.71
14.5-15.0		0.485	1.150			1.635	20.173	12.34
15.0-15.5		0.560	1.396			1.956	29.239	14.95
15.5-16.0		0.211	1.341			1.552	27.165	17.5
16.0-16.5			1.333	0.199		1.532	30.653	20.01
16.5-17.0			0.777			0.777	18.074	23.27
17.0-17.5			0.572			0.572	14.584	25.49
17.5-18.0			0.447	0.081		0.528	15.890	30.09
18.0-18.5			0.359			0.359	11.054	30.82
18.5-19.0			0.022			0.022	0.764	34.32
19.0-19.5			0.014			0.014	0.509	37.6
19.5-20.0			0.001			0.001	0.061	42.19
TSN (10^9)	1.762	6.695	9.782	0.280		18.518		
TSB (10^3 t)	5.836	63.938	167.984	6.411			244.168	
Mean length (cm)	10.23	13.63	15.53	16.68		14.36		
Mean weight (g)	3.31	9.55	17.17	22.91				13.19
SSN (10^9)	0	1.960	8.703	0.280		10.944		
SSB (10^3 t)	0	26.300	158.830	6.411		191.540		

Target strength estimation based on formula: TS= 19.1 log (L) – 74.0

*Table 7.1.2.2. Barents Sea capelin. Summary of acoustic estimates by age in autumn 1973- 2022. Biomass (B) in tons *10^9 and average weight (AW) in grams.*

Year	Age										Sum
	1		2		3		4		5		
	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	0.0 1	30.1	5.14
1974	1.06	3.5	3.06	5.6	1.53	8.9	0.07	20.8	+	25.0	5.73
1975	0.65	3.4	2.39	6.9	3.27	11.1	1.48	17.1	0.01	31.0	7.81
1976	0.78	3.7	1.92	8.3	2.09	12.8	1.35	17.6	0.27	21.7	6.42
1977	0.72	2.0	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	25.0	4.25
1979	0.05	4.5	2.47	7.4	1.53	13.5	0.10	21.0	+	27.0	4.16
1980	1.21	4.5	1.85	9.4	2.83	18.2	0.82	24.8	0.01	19.7	6.71
1981	0.92	2.3	1.83	9.3	0.82	17.0	0.32	23.3	0.01	28.7	3.90
1982	1.22	2.3	1.33	9.0	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			4.23
1984	0.57	3.7	1.43	7.7	0.88	18.2	0.08	26.8			2.96
1985	0.17	4.5	0.40	8.4	0.27	13.0	0.01	15.7			0.86
1986	0.02	3.9	0.05	10.1	0.05	13.5	+	16.4			0.12
1987	0.08	2.1	0.02	12.2	+	14.6	+	34.0			0.10
1988	0.07	3.4	0.35	12.2	+	17.1					0.43
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			5.83
1991	1.52	3.8	5.10	8.8	0.64	19.4	0.04	30.2			7.29
1992	1.25	3.6	1.69	8.6	2.17	16.9	0.04	29.5			5.15
1993	0.01	3.4	0.48	9.0	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			0.19
1996	0.24	2.9	0.22	18.6	0.05	23.9	+	25.5			0.50
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			4.27
2001	0.37	3.3	2.40	11.0	0.81	26.7	0.04	35.5	+	41.4	3.63
2002	0.23	3.9	0.92	10.1	1.04	20.7	0.02	35.0			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			0.32
2006	0.29	4.8	0.35	16.1	0.14	24.8	0.01	30.6	+	36.5	0.79
2007	0.93	4.2	0.85	15.5	0.10	27.5	+	28.1			2.12
2008	0.97	3.1	2.80	12.1	0.61	24.6	0.05	30.0			4.43

Year	Age										Sum
	1		2		3		4		5		
	B	AW	B	AW	B	AW	B	AW	B	AW	B
2009	0.42	3.4	1.82	10.9	1.51	24.6	0.01	28.4			3.77
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	16.0	0.16	23.2	+	29.1	3.96
2014	0.32	3.0	0.95	9.0	0.64	16.3	0.04	20.3			1.95
2015	0.14	3.8	0.40	10.8	0.20	17.9	0.09	22.5	+	28.1	0.84
2016	0.12	3.9	0.12	15.3	0.08	25.2	+	24.7			0.33
2017	0.37	4.3	1.70	13.8	0.42	24.9	0.01	27.3			2.51
2018	0.29	4.9	0.80	13.8	0.48	22.4	0.01	29.3			1.60
2019	0.09	4.9	0.13	14.5	0.16	22.8	0.03	25.7			0.41
2020	1.27	3.5	0.49	15.6	0.10	24.9	0.03	30.2	+	22.6	1.88
2021	0.76	3.4	3.08	9.3	0.16	22.5	+	38.7			4.00
2022	0.32	4.3	0.96	7.1	0.86	14.9	0.02	19.2	+	24.0	2.17
Average	**0.63**	**3.6**	**1.30**	**10.9**	**0.78**	**19.7**	**0.17**	**25.2**	**0.07**	**27.6**	**2.82**

Note:«+» <0.01*10^9 tons

Table 7.1.2.3. Summary of acoustic stock size estimates for capelin in 2021-2022.

A comparison between the estimates this year and last year (shaded background).

Year class		**Age**	**Numbers (10^6)**		**Mean weight (g)**		**Biomass (10^3 t)**	
2021	2020	1	75.5	220.8	4.30	3.43	324.7	757.7
2020	2019	2	135.8	329.9	7.10	9.34	964.1	3081.5
2019	2018	3	57.7	7.0	14.92	22.47	860.7	157.2
2018	2017	4	1.2	0.1	19.25	38.66	24.1	1.2
Total stock in:								
2022	2021	1-4	270.2	557.9	8.04	7.17	2173.7	3997.8

7.2 Polar cod (*Boreogadus saida*)

7.2.1 Geographical distribution

Only the western part of the Barents Sea was covered synoptically during BESS in 2022, the eastern part was covered late. The acoustic recordings of polar cod from both coverages are shown in Figure 7.2.1.1. There was very little polar cod observed in the west, the two significant concentrations were at 76°N close to the Russian border, and immediately north of Kong Karls land at ca. 77°N. In the eastern area, the polar cod had a wider distribution, although without very high concentrations. Polar cod was also recorded near the Kara Strait. The relatively low concentrations of polar cod this survey year contrast the wide area with polar cod aggregations from the previous two survey years.

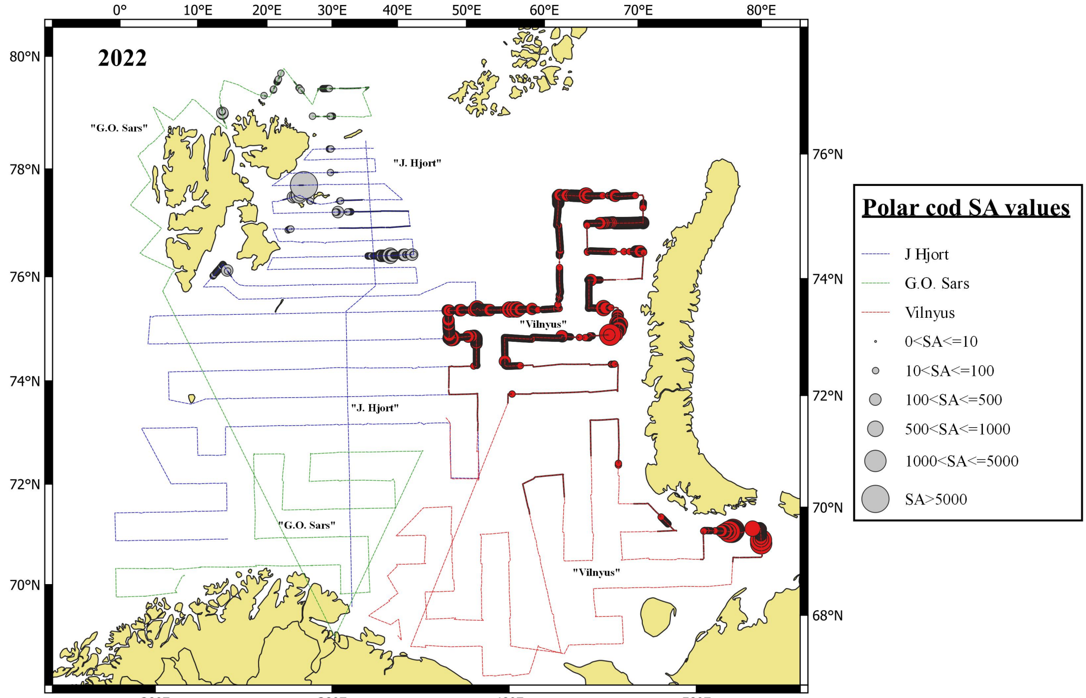

Figure 7.2.1.1 *Geographical distribution of polar cod in autumn 2022 based on acoustic data. Circle sizes correspond to s_A values (m^2/nmi^2) per nautical mile. The circles and transect marked with red colour are recordings from Vilnyus made later than the other vessels (see text for details).*

7.2.2 Abundance estimation

Due to the incomplete coverage, no polar cod abundance estimation was done for 2022.

7.3 Herring (*Clupea harengus*)

7.3.1 Geographical distribution

Only the Norwegian side of the Barents Sea was covered synoptically during BESS in 2022, the eastern part was covered late. The main distribution of young Norwegian spring spawning herring (NSSH) within the survey area was the North Cape bank around 30°E (Figure 7.3.1.1). In addition, there were concentrations of old fish (2016-yearclass) in the south-west. Very little herring was recorded during the late coverage in the east.

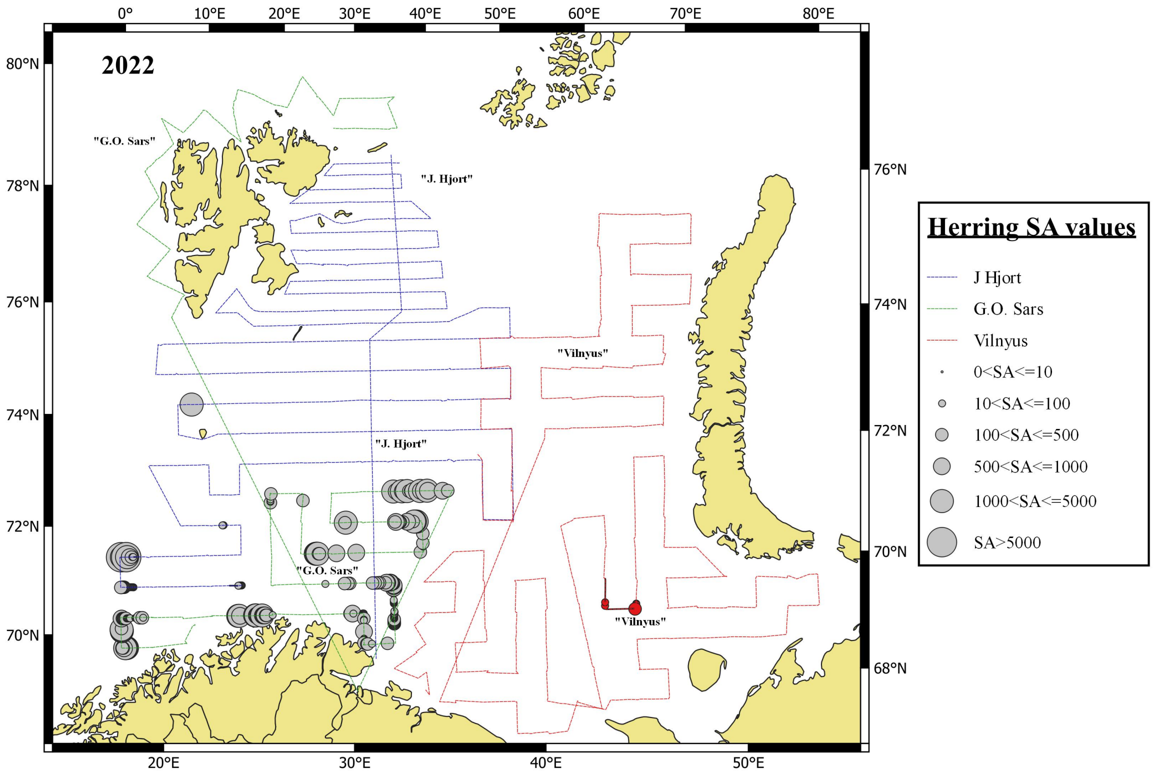

Figure 7.3.1.1 *Geographical distribution of herring in autumn 2022 based on acoustic recordings. Circle sizes correspond to s_A values (m^2/nmi^2) per nautical mile. The circles and transect marked with red colour are recordings from Vilnyus made later than the other vessels (see text for details).*

7.3.2 Abundance estimation

The estimated total number and biomass of NSSH in the Barents Sea in the autumn 2022 is shown in table 7.3.2.1, and the time series of abundance estimates is summarized in Table 7.3.2.2. Total numbers in 2022 was estimated at 6.78 billion individuals (Table 7.3.2.1). This is below the long-term average (Table 7.3.2.2). Abundance of all age groups were below the long-term average, and in particular the abundance of 3-year-olds was low as expected from the low number of 2-year-olds (2019 year-class) in the survey last year. 1-year-olds are dominating in abundance while the very strong 2016 year-class is still dominating the biomass estimate (Table 7.3.2.1).

Table 7.3.2.1. NSS herring. Acoustic estimate in the Barents Sea in August-October 2022 (only western coverage area included).

Length (cm)	**Age/year class**					**Sum (10^9)**	**Biomass (10^3 t)**	**Mean weight (g)**
	1	**2**	**4**	**5**	**6**			
	2021	**2020**	**2018**	**2017**	**2016**			
13-14	0.000					0.000	0.005	20.00
14-15	0.001					0.001	0.014	19.33
15-16	1.436					1.436	32.311	22.50
16-17	0.639					0.639	19.994	31.31
17-18	1.116					1.116	44.951	40.27
18-19	1.058	0.049				1.107	49.944	45.11
19-20	0.148	0.134				0.282	15.186	53.76
20-21	0.045					0.045	2.499	56.00
21-22		0.027				0.027	2.016	76.00
22-23		0.009				0.009	0.743	84.00
23-24		0.448				0.448	36.567	81.58
24-25						0.000		
25-26		0.215				0.215	27.592	128.16
26-27				0.009		0.009	1.273	144.00
27-28			0.009			0.009	1.326	150.00
28-29						0.000		
29-30			0.352			0.352	78.041	221.50
30-31			0.037		0.008	0.045	11.978	263.73
31-32				0.120	0.084	0.204	57.812	283.82
32-33			0.091	0.183	0.251	0.526	159.025	302.48
33-34				0.008	0.074	0.083	26.189	317.15
34-35					0.231	0.231	76.631	331.43
35-36						0.000	1.602	388.00
TSN (10^9)	4.442	0.882	0.490	0.320	0.649	6.783		
TSB (10^3 t)	155.248	76.574	117.268	92.468	202.539		645.699	
Mean length (cm)	16.54	22.53	29.60	31.49	32.67			
Mean weight (g)	34.95	86.78	239.44	289.16	312.03			94.95

Target strength estimation based on formula: TS= 20.0 log (L) – 71.9

Table 7.3.2.2. NSS herring. Summary of acoustic estimates by age in autumn 1999-2022. TSN and TSB are total stock numbers (10^9) and total stock biomass (10^3 tons) respectively.

Year	Age 1		Age 2		Age 3		Age 4+		Total	
	TSN	TSB	TSN	TSB	TSN	TSB	TSN	TSB	TSN	TSB
1999	48.759	716.0	0.986	31.0	0.051	2.0			49.795	749.0
2000	14.731	383.0	11.499	560.0					26.230	943.0
2001	0.525	12.0	10.544	604.0	1.714	160.0			12.783	776.0
2002	No data									
2003	99.786	3090.0	4.336	220.0	2.476	326.0			106.597	3636.0
2004	14.265	406.0	36.495	2725.0	0.901	107.0			51.717	3252.0
2005	46.380	984.0	16.167	1055.0	6.973	795.0			69.520	2833.0
2006	1.618	34.0	5.535	398.0	1.620	211.0			8.773	643.0
2007	3.941	148.0	2.595	218.0	6.378	810.0	0.250	46.0	13.164	1221.0
2008	0.030	1.0	1.626	77.0	3.987*	287*	3.223*	373*	8.866*	738*
2009	1.538	48.0	0.433	52.0	1.807	287.0	1.686	393.0	5.577	815.0
2010	1.047	35.0	0.315	34.0	0.234	37.0	0.428	104.0	2.025	207.0
2011	0.095	3.0	1.504	106.0	0.006	1.0			1.605	109.0
2012	2.031	36.0	1.078	66.0	1.285	195.0			4.394	296.0
2013	7.657	202.0	5.029	322.0	0.092	13.0	0.057	9.0	12.835	546.0
2014	4.188	62.0	1.822	126.0	6.825	842.0	0.162	25.0	13.011	1058.0
2015	1.183	6.0	9.023	530.0	3.214	285.0	0.149	24.0	13.569	845.0
2016	7.760	131.0	1.573	126.0	3.089	389.0	0.029	6.0	12.452	652.0
2017	34.950	820.0	2.138	141.0	3.465	412.0	0.982	210.0	41.537	1583.0
2018	No data									
2019	13.650	172.0	0.209	15.1	6.000	756.0	1.600	487.0	21.460	1430.0
2020			0.231	13.0	1.816	189.0	11.59*	2796*	13.636*	2998*
2021	1.410	80.8	0.120	10.1	0.360	39.5	0.720	144.7	2.610	275.1
2022**	4.442	155.2	0.882	76.6	0.000	0.0	1.459	412.3	6.783	645.7
Average	**14.760**	**358.3**	**5.190**	**341.2**	**2.490**	**292.6**	**1.720**	**386.9**	**22.680**	**1193.2**

*in mix with Kanin herring in the south-eastern part of the coverage area

**survey coverage only on Norwegian (western) side

7.4 Blue whiting (*Micromesistius poutassou*)

7.4.1 Geographical dirtribution

Blue whiting contributes to make up the mid-trophic pelagic component in the south-western part of the Barents Sea ecosystem. The Barents Sea is on the border of the distribution area for the blue whiting, but with incoming strong year-classes, increased abundance of young blue whiting in the Barents Sea is normally observed. During the 2022 survey, the westernmost parts of some transects were omitted due to reduction in effort (see Figure 7.4.1.1). These westernmost parts cover the shelf edge where blue whiting is typically distributed, and the cuts are likely to bias abundance of blue whiting downwards in comparison with previous years. The largest concentrations of blue whiting were found at the extreme south-western part of the survey area (Figure 7.4.1.1).

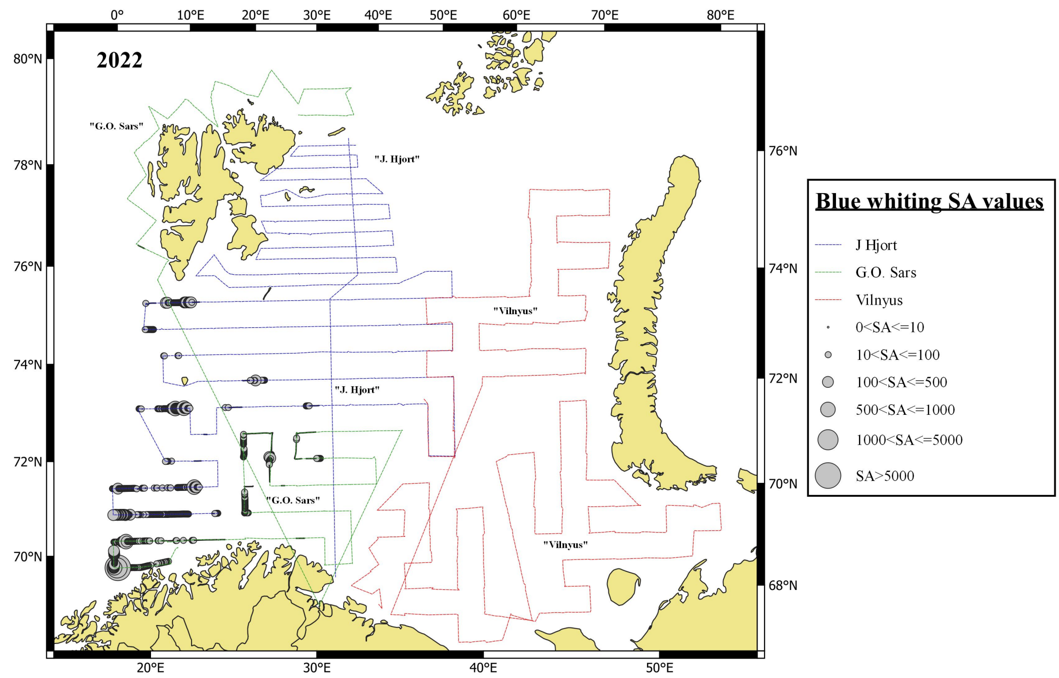

Figure 7.4.1.1. *Geographical distribution of blue whiting in autumn 2022 based on acoustic recordings. Circle sizes correspond to* s_A *values (*m^2/nmi^2*) per nautical mile. The transects marked with red colour are from Vilnyus carried out later than the other vessels (see text for details).*

7.4.2 Abundance by size and age

The estimated total number and biomass of blue whiting in the Barents Sea in the autumn 2022 is shown in table 7.4.2.1, and the time series of abundance estimates is summarized in Table 7.4.2.2. Only data from the western coverage area are included in the estimate since the coverage in the east was late, but normally there is no blue whiting found in the east.

From 2004-2007 estimated biomass of blue whiting in the Barents Sea was between 200 000 and 350 000 tons (Table 7.4.2.2). In 2008 the estimated biomass dropped abruptly to only about 18% of the estimated biomass in the previous year, and it stayed low until 2012. From 2012 onwards it has been variable, but the last five years it has been lower than average despite that recruitment (abundance at age 1) in both 2021 and 2022 were high. This year estimated biomass was similar to the estimates from 2018, 2019 and last year (Table 7.4.2.3).

The 2021 year class (1-year olds) dominated in abundance while the 2020 year class (2-year-olds) dominated in biomass, but all age groups are below average in abundance (Table 7.4.2.1).

Table 7.4.2.1 Blue whiting. Acoustic estimate in the Barents Sea in August-October 2022 (only western coverage area included).

Length (cm)	**Age/year class**									**Sum (10^6)**	**Biomass (10^3 t)**	**Mean weight (g)**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**10**			
	2021	**2020**	**2019**	**2018**	**2017**	**2016**	**2015**	**2014**	**2012**			
14-15	0.1									0.1	0.0	20.00
15-16												
16-17	2.9									2.9	0.1	22.11
17-18	14.4									14.4	0.4	26.10
18-19	47.0									47.0	1.5	32.76
19-20	64.8	1.2								66.0	2.5	38.28
20-21	48.9									48.9	2.3	47.06
21-22	10.5	14.0								24.5	1.4	55.84
22-23	6.1	19.3								25.5	1.7	66.00
23-24		21.6	6.5							28.1	2.1	75.76
24-25		39.8	2.9							42.7	3.7	86.39
25-26		18.6	17.3	3.8						39.8	3.9	97.76
26-27		16.1	6.1		2.7	2.0				26.9	3.0	111.17
27-28		12.6	1.7	3.6	0.9					18.7	2.3	124.83
28-29			5.2	3.9	1.7					10.8	1.5	138.45
29-30				3.7	1.0	2.2				6.8	1.0	153.03
30-31			1.1		4.5		2.0	2.4	0.8	10.8	1.8	166.90
31-32				1.2			1.3	5.9		8.4	1.6	189.10
32-33					0.4	0.3	0.5	4.0	0.8	5.9	1.2	205.97
33-34									2.7	2.7	0.6	215.48
34-35					1.1	1.3		1.2		3.7	0.8	229.32
35-36					0.4			0.2	1.2	1.9	0.5	289.75
36-37								0.3		0.3	0.1	282.91
37-38									0.2	0.2	0.1	338.67
38-39								0.2		0.2	0.1	325.22
TSN (10^6)	194.6	143.2	40.7	16.1	12.8	5.8	3.7	14.1	5.8	436.9		
TSB (10^3 t)	7.8	12.4	4.2	2.1	2.0	0.9	0.7	2.9	1.0		34.2	
Mean length (cm)	19.33	24.09	25.56	27.74	29.40	29.55	30.84	31.86	33.18			
Mean weight (g)	40.13	86.31	103.31	132.05	156.04	159.90	179.73	202.73	220.63			78.29

Target strength estimation based on formula: TS=20 log (L) - 65.2

Table 7.4.2.2 Blue whiting. Acoustic estimates by age in autumn 2004-2022. TSN and TSB are total stock numbers (10^6) and total stock biomass (10^3 tons) (only western coverage area included).

	Age 1		Age 2		Age 3		Age 4+		Total	
	TSN	TSB	TSN	TSB	TSN	TSB	TSN	TSB	TSN	TSB
2004	669	26	439	33	1056	98	1211	159	3375	327
2005	649	20	523	36	1051	86	809	102	3039	244
2006	47	2	478	34	730	70	922	129	2177	235
2007	+	+	116	11	892	92	743	107	1757	210
2008	+	+	+	+	10	1	238	36	247	37
2009	1	+	+	+	6	1	359	67	366	65
2010			2		5	1	155	31	163	33
2011	2	+	2	+	13	2	93	22	109	25
2012	583	27	64	8	58	9	321	77	1025	121
2013	1		349	28	135	13	175	42	664	84
2014	11	5	19	2	185	20	127	28	443	55
2015	1768	71	340	29	134	15	286	44	2529	159
2016	277	13	1224	82	588	48	216	36	2351	188
2017	43	2	253	22	503	49	289	38	1143	115
2018			18	1	74	8	215	29	332	40
2019	54	2	64	5	66	8	162	27	347	43
2020	110	5	19	2	11	1	56	11	196	18
2021	406	17	58	5	39	5	67	13	594	40
2022	195	8	143	12	41	4	58	10	437	34
Average	328	16	242	21	295	28	341	83	1131	109

Target strength estimation based on formula: TS = 20 log (L) - 65.2 (Recalculation by Åge Høines, IMR 2017)

Note:«+» <0.5

Table 7.4.2.3 Summary of stock size estimates for blue whiting in 2021-2022. A comparison between the estimates of numbers (10^6), Mean weight (g) and Biomass (10^3 t) for this year (left columns) and last year (right columns), respectively.

Year class		**Age**	**Numbers (10^6)**		**Mean weight (g)**		**Biomass (10^3 t)**	
2021	2020	1	194.6	405.8	40.13	43.49	7.8	
2020	2019	2	143.2	57.5	86.31	86.19	12.4	
2019	2018	3	40.7	39.3	103.31	120.07	4.2	
2018	2017	4+	58.4	67.0	169.04	190.70	9.6	
Total stock in:								
2022	**2021**	**Total**	**436.9**	**583.9**	**78.38**	**69.26**	**34.2**	

8 - COMMERCIAL DEMERSAL FISH

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Figures by: P. Krivosheya

In 2022 the eastern area was covered much later (covered 21/8-1/12) then the area covered by Norwegian vessels (16/8-4/10) so that the survey extended over a period of three and half months (see chapter 2). The lack of synoptic coverage and changes taking place during the survey period (e.g. migration between the western and the eastern part), may invalidate the results. The maps shown below should therefore be viewed with caution. Different colours show the surveyed areas in the Russian and Norwegian sectors.

Indices calculated from the ecosystem survey data are used in annual assessments of cod, haddock, the deep-water redfish and Greenland halibut. However, in 2023, the assessment-working group has to decide if the lack of synoptic coverage will make the indices too uncertain.

Data from the ecosystem survey is currently evaluated as part of the process of establishing an assessment model for the wolffish species.
Indices (number and biomass) calculated using Biofox for main bottom species except cod and haddock are presented in Table 8.1 and 8.2. Abundance indices by age based on the BESS data are used in annual assessments of cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*) and are given in Table 8.3 and 8.4.

Table 8.1. *Abundance (N, 10^6 individuals) and species biomass (B, 10^3 tonnes) of demersal species assessed by AFWG (except cod and haddock and not including 0-group).2018 * poor coverage in the eastern Barents Sea, indices only calculated for saithe and redfish. Biofox calculations.*

	Saithe		**Golden redfish**		**Deep-water redfish**		**Greenland halibut**	
Year	**N**	**B**	**N**	**B**	**N**	**B**	**N**	**B**
2004	36	40	13	9	263	104	182	39
2005	31	26	23	11	330	137	335	56
2006	28	49	16	16	526	219	430	77
2007	70	98	20	11	796	183	296	86
2008	3	7	42	17	864	96	153	76
2009	33	29	12	11	1003	213	191	90
2010	5	9	22	4	1076	112	186	150
2011	9	10	14	5	1271	105	175	88
2012	14	13	32	8	1587	196	209	86
2013	18	33	75	20	1608	256	160	94
2014	3	6	45	13	927	208	43	53
2015	105	153	9	5	894	214	79	52
2016	58	54	34	24	1527	319	82	40
2017	282	193	34	18	1705	212	134	74
2018*	30	24	73	21	1298	260		
2019	58	80	27	21	1126	313	166	61
2020	291	301	26	8	1086	291	276	55
2021	130	151	21	14	1701	191	141	56
2022	6	14	22	8	1257	231	558	142
Mean	**66**	**70**	**27**	**12**	**1086**	**200**	**211**	**76**

Table 8.2. *Abundance (N, 10^6 individuals) and species biomass (B, 10^3 tonnes) of abundant demersal species not assessed by AFWG (not including 0-group). 2018 * poor coverage in the eastern Barents Sea, indices not calculated. Biofox calculations.*

	Plaice		**Long rough dab**		**Atlantic wolffish**		**Spotted wolffish**		**Northern wolffish**	
Year	**N**	**B**	**N**	**B**	**N**	**B**	**N**	**B**	**N**	**B**
2004	53	43	2951	306	15	7	12	31	3	26
2005	19	11	2753	272	16	6	11	26	3	26
2006	36	19	3705	378	26	11	12	46	2	19
2007	120	55	5327	505	42	11	12	42	3	25
2008	57	29	3942	477	25	14	13	51	3	22
2009	21	13	2600	299	20	8	9	47	3	31
2010	34	21	2520	356	17	17	7	37	3	25
2011	36	26	2507	322	20	13	9	47	6	42
2012	21	13	4563	584	22	9	13	83	8	45
2013	36	29	4932	565	27	30	13	84	12	52
2014	170	121	3046	413	12	12	8	51	6	34
2015	107	79	3624	438	33	37	12	86	9	63
2016	37	29	3369	402	40	24	13	40	8	51
2017	17	19	4604	538	30	29	14	63	8	63
2018*										
2019	146	101	3627	472	37	20	15	51	13	76
2020	94	37	3443	454	44	27	22	55	13	65
2021	195	106	3688	396	42	28	17	37	7	59
2022	242	109	3734	404	24	20	9	49	5	40
Mean	**80**	**48**	**3608**	**421**	**27**	**18**	**12**	**51**	**6**	**42**

Table 8.3. *Bottom trawl indices (10^6 individuals) for cod calculated with Biofox. The indices are used in stock assessment. *adjusted for lack of coverage in the northern (2014) and eastern (2018) Barents Sea– bold: indices not used for assessment due to lack of survey coverage.*

Year/age	1	2	3	4	5	6	7	8	9	10	11	12+
2004	330.6	329.7	147.7	421.5	150.2	79.8	40.2	10.1	2.2	0.5	0.1	0.2
2005	440.7	146.6	216.6	55.8	100.9	28.0	15.6	5.7	1.2	0.5	0.1	0.1
2006	479.0	509.7	186.1	205.6	59.9	69.8	17.6	8.1	2.6	0.6	0.2	0.0
2007	333.3	505.4	586.2	159.2	79.1	24.6	26.9	6.0	2.2	0.9	0.1	0.2
2008	130.9	372.6	652.6	483.4	132.3	51.1	12.8	17.5	3.3	0.9	0.2	0.4
2009	569.7	93.5	202.3	280.6	289.6	101.7	31.9	12.7	7.3	2.6	0.8	0.5
2010	310.3	84.2	56.8	177.0	397.2	424.9	142.7	38.5	10.5	6.8	1.6	0.6
2011	509.8	160.0	123.6	101.5	240.2	300.4	178.4	32.3	7.7	1.8	1.3	0.9
2012	1454.3	255.9	229.1	146.4	70.0	150.8	165.2	84.5	12.7	4.4	1.6	2.1
2013	914.2	659.0	249.1	183.6	125.7	63.2	118.2	130.2	53.8	9.1	3.3	2.5
2014	308.2	155.1	190.0	108.6	93.9	52.8	30.4	50.2	36.3	12.1	3.4	2.4
2014 *	339.0	184.0	226.3	122.2	103.4	67.7	42.1	81.3	78.9	28.1	4.7	2.8
2015	725.3	154.0	174.4	225.2	141.3	72.6	48.6	26.2	35.3	26.6	7.9	2.7
2016	350.8	341.3	77.2	93.7	121.6	70.1	44.4	27.2	13.8	13.2	5.4	3.0
2017	757.5	260.6	375.0	141.5	104.9	120.9	62.6	28.0	11.2	6.4	4.4	7.2
2018*	2100.3	413.8	183.6	148.9	60.0	37.6	57.1	20.2	14.4	5.8	3.6	6.3
2019	560.2	475.2	416.6	232.3	215.1	76.6	42.2	44.4	16.1	4.9	2.2	2.9
2020	66.5	104.7	133.7	134.3	98.6	79.6	31.6	15.7	11.4	2.9	1.1	1.1
2021	61.2	51.8	84.0	100.0	80.3	46.2	33.6	12.5	4.7	5.0	2.4	1.4
2022	214.0	39.2	25.5	32.8	34.4	33.7	18.5	9.8	2.5	0.8	0.5	0.3

Table 8.4. *Bottom trawl indices (10^6 individuals) for haddock calculated with Biofox. The indices are used in stock assessment. * indices not used for assessment due to lack of survey coverage.*

Year/age	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12+**
2004	189.0	268.5	123.4	70.3	69.1	31.5	3.0	1.7	0.0	0.1	0.0	0.1
2005	603.8	114.2	324.6	89.5	30.4	32.2	15.0	0.5	0.7	0.2	0.1	0.2
2006	2270.2	929.1	107.5	124.6	41.6	19.0	17.5	7.3	0.8	0.5	0.1	0.1
2007	988.4	1818.9	1282.9	88.5	90.4	19.2	5.9	7.1	1.9	0.9	0.2	0.2
2008	322.0	1291.9	1154.9	406.0	43.1	35.5	4.9	2.5	2.3	0.3	0.0	0.0
2009	134.8	143.8	650.7	619.1	305.9	21.0	6.5	0.9	0.5	0.0	0.0	0.0
2010	274.4	65.1	184.0	865.3	666.4	147.7	15.8	2.7	0.0	0.1	0.1	0.3
2011	105.3	113.6	40.4	73.8	392.9	301.4	37.4	3.0	0.3	0.1	0.0	0.2
2012	591.1	41.5	92.5	20.3	67.6	214.1	152.0	12.7	0.3	0.2	0.0	1.5
2013	155.9	223.0	25.8	65.2	19.6	50.8	150.1	76.4	7.0	0.4	0.0	0.2
2014	264.8	75.1	261.6	40.8	70.2	25.8	60.5	85.8	18	1.4	0.2	0.0
2015	320.0	145.2	42.1	213.6	25.1	37.1	20.6	47.9	33.8	8.6	0.2	0.2
2016	793.8	144.9	209.3	34.4	184.1	48.0	56.8	40.4	65.8	47.5	11.8	0.9
2017	935.8	189.3	70.3	70.3	11.5	20.5	4.0	4.0	5.4	4.4	4.8	0.7
2018*												
2019	379.4	585.3	897.0	160.7	38.1	15.1	5.3	5.0	1.9	2.1	2.1	5.6
2020	26.8	57.8	204.1	341.4	58.8	4.9	2.0	0.8	0.2	0.7	0.1	0.5
2021	107.8	35.9	129.6	346.8	329.0	32.3	5.4	0.9	0.3	0.6	0.4	0.1
2022	690.2	106.6	18.7	59.4	84.6	80.2	9.5	2.2	0.0	0.0	0.2	0.0

8.1 Cod (*Gadus morhua*)

At the time of survey cod usually reaches the northern and eastern limits of its feeding area. In general, the cod was distributed almost over the entire area surveyed (Fig. 8.1) .

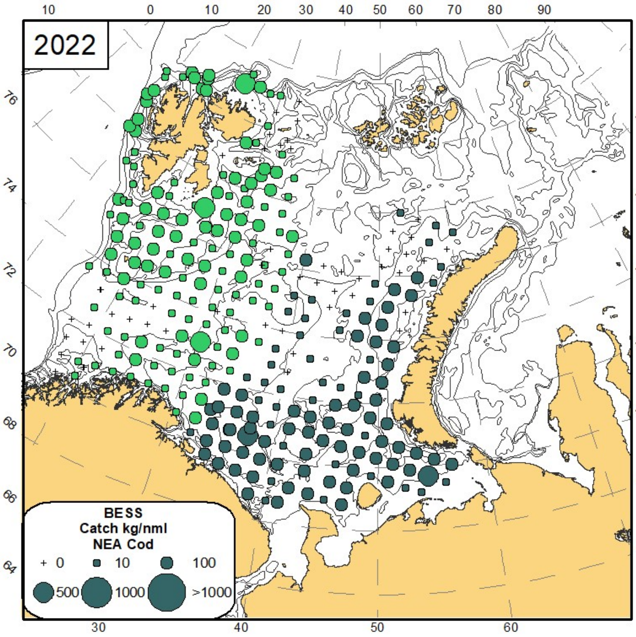

Figure 8.1. *Distribution of cod (Gadus morhua), August-December 2022.*

8.2 Haddock (*Melanogrammus aeglefinus*)

Main concentrations of haddock were found along the along Finnmark and Murman coasts, and in the south-eastern Barents Sea (Fig.8.2).

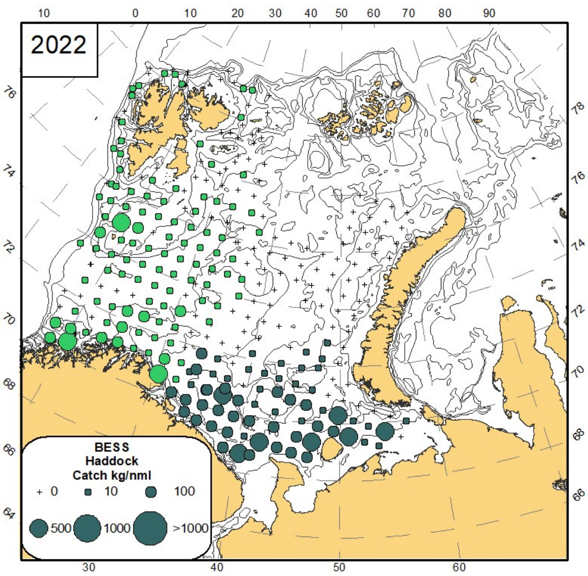

Figure 8.2. *Distribution of haddock (Melanogrammus aeglefinus), August-December 2022.*

8.3 Saithe (*Pollachius virens*)

The ecosystem survey only covers a small part of the distribution of saithe and the data is not used for stock assessment. As in previous years, the highest catches were in the south west and along the Norwegian coast (Fig.8.3).

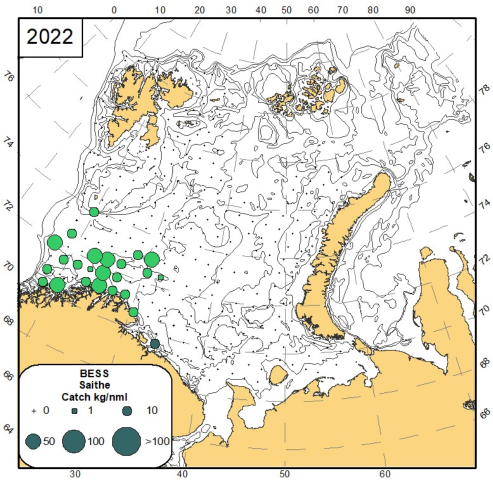

Figure 8.3. *Distribution of saithe (Pollachius virens), August-December 2022.*

8.4 Greenland halibut (*Reinhardtius hippoglossoides*)

BESS covers mainly an area where young Greenland halibut is found, including nursery aresa in the northernmost part. However, in recent years larger Greenland halibut has increasingly been registered in the deep-water central parts of Barents Sea. This affects the stock indices when expressed in biomass. The BESS registrations are divided into northern (nursery) areas and southern part. Thus, two indices are estimated, each of them additionally divided by sex, based on BESS. Moreover two trawl indices from surveys that cover deeper waters than BESS, at the continental slope, are also used.

As in previous years, the Greenland halibut was observed in almost all catches in the deep areas of the Barents Sea (Fig. 8.4). Compared to last year the distribution pattern was similar. The main concentrations of G. halibut were observed around Svalbard (Spitsbergen), to the west of Franz Josef Land, and in the Bear Island Trench. Noticeably there were substantial registrations of G. halibut in an area towards the Yermak Plateau that has not been covered in previous surveys.

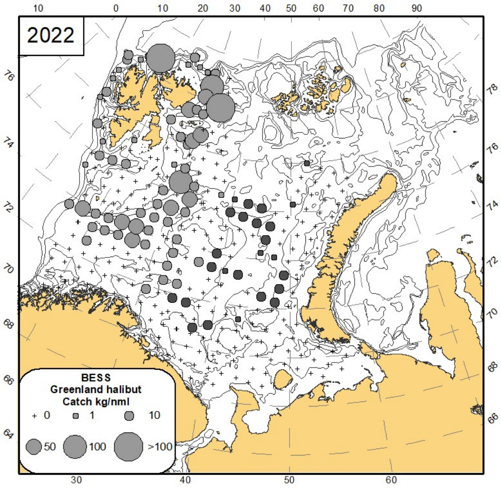

Figure 8.4. *Distribution of Greenland halibut (Reinhardtius hippoglossoides), August-December 2022.*

8.5 Golden redfish (*Sebastes norvegicus*)

Data from the ecosystem survey is not used in the assessment of golden redfish. In 2022, centres of abundance for golden redfish were observed along the coast of the Troms region in Norway and along the Murman coast, with the highest catches in the latter region (Fig. 8.5). The distribution north and west of Svalbard was very similar to 2021 and as in earlier years observations in the eastern Barents Sea, were few and of low abundance.

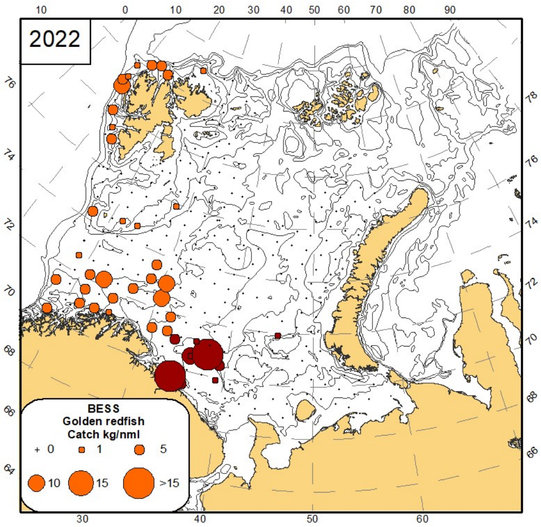

Figure 8.5. *Distribution of golden redfish (Sebastes norvegicus), August-December 2022.*

8.6 Deep-water redfish (*Sebastes mentella*)

Data from BESS are used in the assessment of deep-water redfish. As in previous years, deep-water redfish were only absent from an area north of Bear Island and in the south-eastern part of the Barents Sea. (Fig. 8.6). Highest catches of deep-water redfish were concentrated in the area south and southeast of Bear Island, particularly along the Bear Island Trench. Likewise high catches were recorded along the shelf break north of

Bear Island and up to Svalbard. Catch weight decreased towards the eastern Barents Sea.

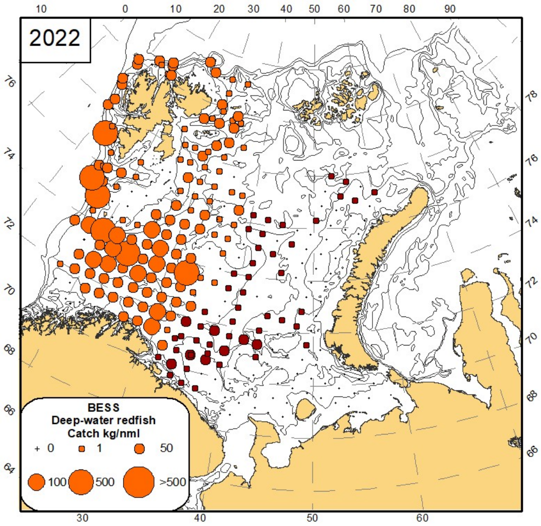

Figure 8.6. *Distribution of deep-water redfish (Sebastes mentella), August-December 2022.*

8.7 Long rough dab (*Hippoglossoides platessoides*)

As usual, long rough dab were found in the entire area surveyed (Fig. 8.7). The highest catches were in the northern part of the surveyed area along the slopes of the Svalbard and Central Banks.

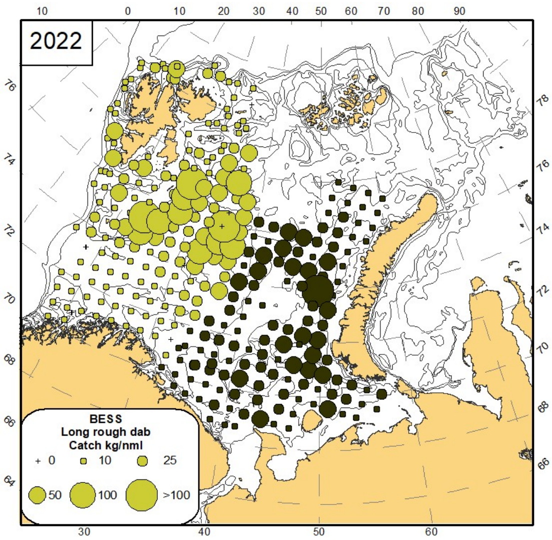

Figure 8.7. *Distribution of long rough dab (Hippoglossoides platessoides), August-December 2022.*

8.8 Plaice (*Pleuronectes platessa*)

Plaice is mainly found in the southeastern Barents Sea. In 2022 almost the entire distribution area of plaice was covered (Fig. 8.8).

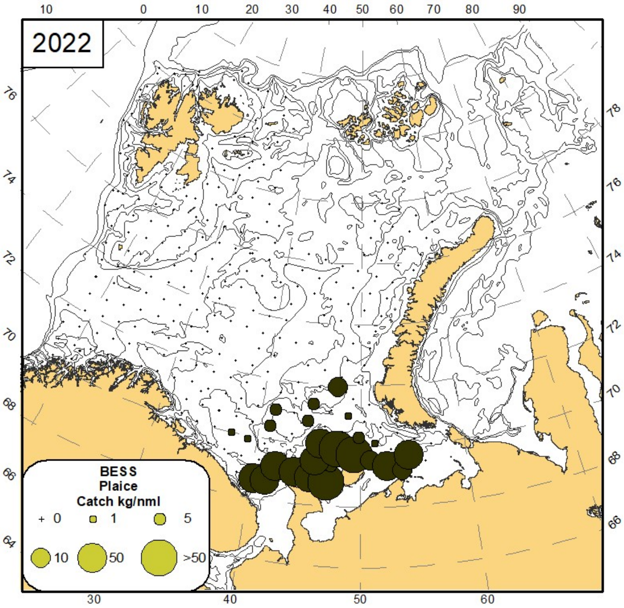

Figure 8.8. *Distribution of plaice (Pleuronectes platessa), August-December 2022.*

8.9 Atlantic wolffish (*Anarhichas lupus*)

Atlantic wolffish is the most numerous of the three species of wolffishes inhabiting the Barents Sea, while due to its smaller size has the lowest biomass of the three species. Atlantic wolffish was mainly found in Atlantic water along the western coast of Svalbard (Fig. 8.9).

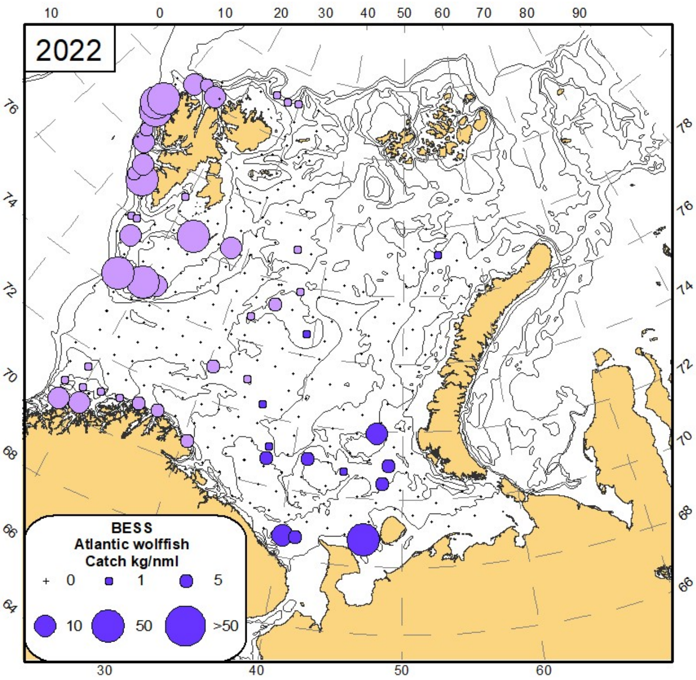

Figure 8.9. *Distribution of Atlantic wolffish (Anarhichas lupus), August-December 2022.*

8.10 Spotted wolffish (*Anarhichas minor*)

In 2020 the spotted wolffish was found along the slopes of the Svalbard and Central Banks (Fig. 8.10).

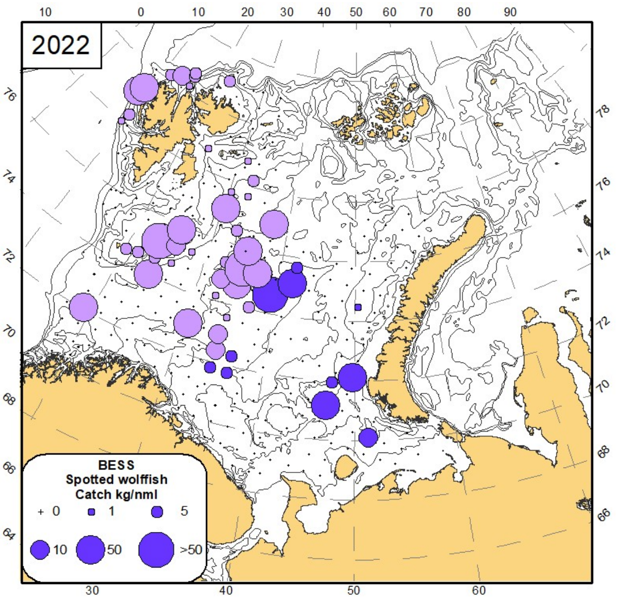

Figure 8.10. *Distribution of spotted wolffish (Anarhichas minor), August-December 2022.*

8.11 Northern wolffish (*Anarhichas denticulatus*)

In 2022 Northern wolffish was distributed along the slopes of west of Svalbard, along the slopes of Hopen Trench extending into the slopes of the Central Basin in the eastern Barents Sea (Fig. 8.11).

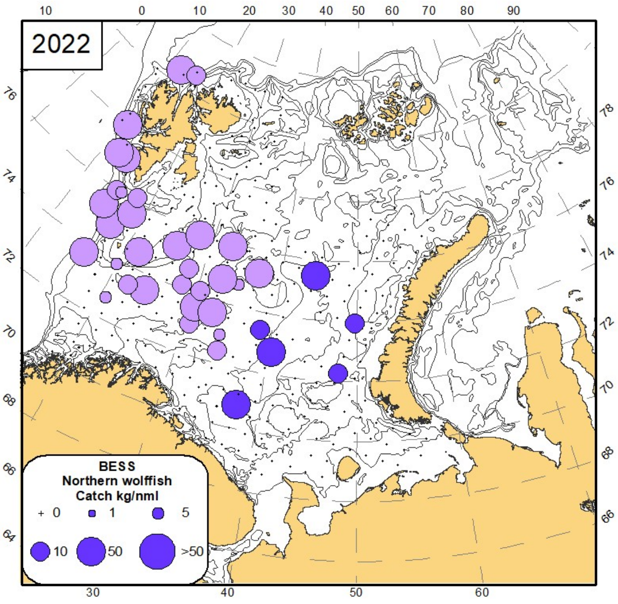

Figure 8.11. *Distribution of northern wolffish (Anarhichas denticulatus), August-December 2022.*

9 - FISH BIODIVERSITY

Author(s): Elena Eriksen (IMR), Tatiana Prokhorova (VNIRO-PINRO), Edda Johannesen (IMR), Andrej Dolgov (VNIRO-PINRO), Rupert Wienerroither (IMR) and Pavel Krivosheya (VNIRO-PINRO)

9.1 Small non-target fish species

Text: Elena Eriksen

The small non-target fish species from the BESS 2022 survey will not be ready for publication in this report. The data will be included in the BESS 2023 survey report.

9.2 Fish biodiversity in the demersal compartment

by Tatiana Prokhorova, Edda Johannesen, Andrej Dolgov, Rupert Wienerroither and Pavel Krivosheya

Figures by P. Krivosheya

Norway pout (*Trisopterus esmarkii*). Norway pout is usually found in the western part of the ecosystem survey area, and as in the previous years the highest concentrations in 2022 were found in the Norwegian part of the area (Fig. 9.2.1). Thus, the results on the distribution of this species in 2022 is likely hardly impacted by the time differences in survey coverage in the eastern and western Barents Sea.

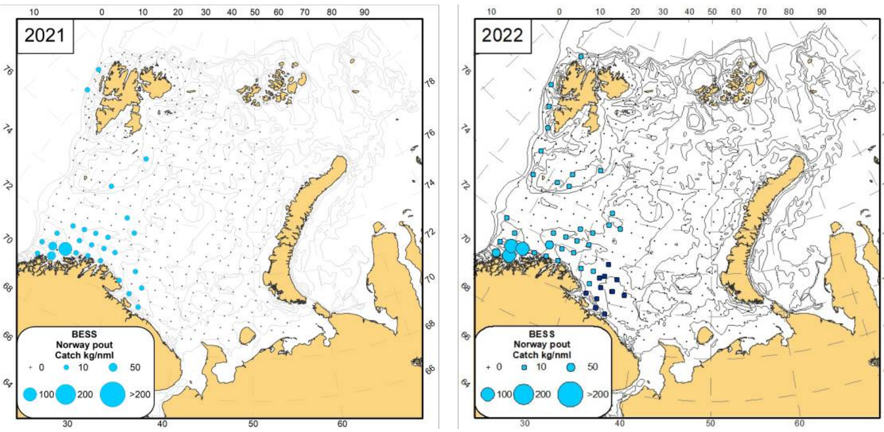

Figure 9.2.1. *Distribution of Norway pout (Trisopterus esmarkii), August -September 2021 (light-blue circles) and August-October 2022 (Norwegian vessels, light-blue circles), October-December 2022 (Russian vessel, dark-blue circles).*

Norway redfish (*Sebastes viviparus*). Norway redfish is usually found in the southwestern part of the surveyed area. Thus, the results for this species are less impacted by the gap in research time between the Russian and Norwegian zones than species with a wider distribution.

In 2022 Norway redfish was distributed approximately in the same area as in 2021 (Fig. 9.2.2). The main concentrations of this species occurred in the south-western area of the survey along the Norwegian coast.

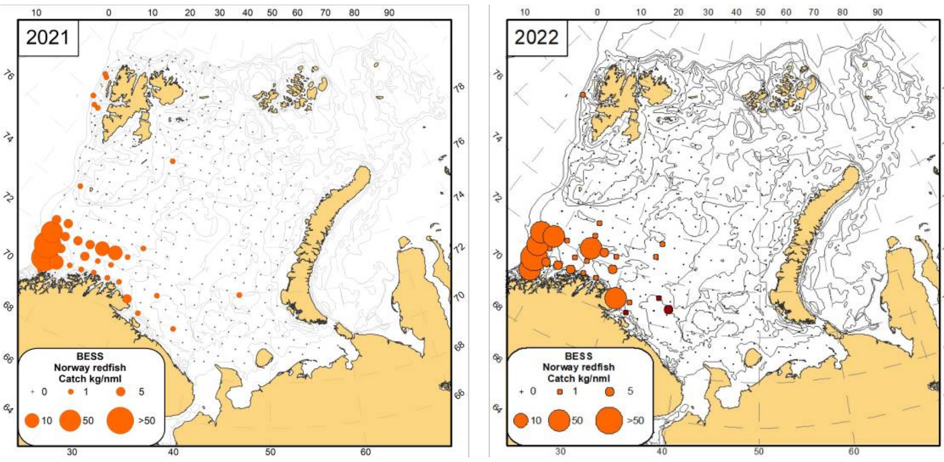

Figure 9.2.2. *Distribution of Norway redfish (Sebastes viviparus), August -September 2021 (orange circles) and August-October 2022 (Norwegian vessels, orange circles), October-December 2022 (Russian vessel, red circles).*

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 mainly boreal zoogeographic group and is widely distributed in the Barents Sea except the most north-eastern areas, while Arctic skate belongs to the Arctic zoogeographic group and is distributed in the cold waters of the northern area.

In 2022 thorny skate was distributed in a wide area from the north-western to the south-western and south-eastern Barents Sea where warm Atlantic and Coastal Waters dominated (Figure 9.2.3).

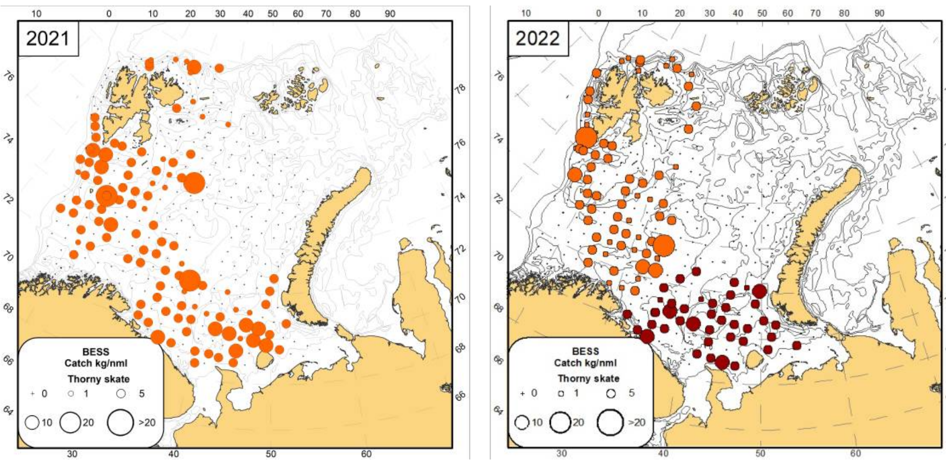

Figure 9.2.3. *Distribution of thorny skate (Amblyraja radiata), August -September 2021 (orange circles) and August-October 2022 (Norwegian vessels, orange circles), October-December 2022 (Russian vessel, red circles).*

Only one specimen of Arctic skate was observed in 2022 (compared to six stations in 2021), (Figure 9.2.4). It was found in 157 m depth.

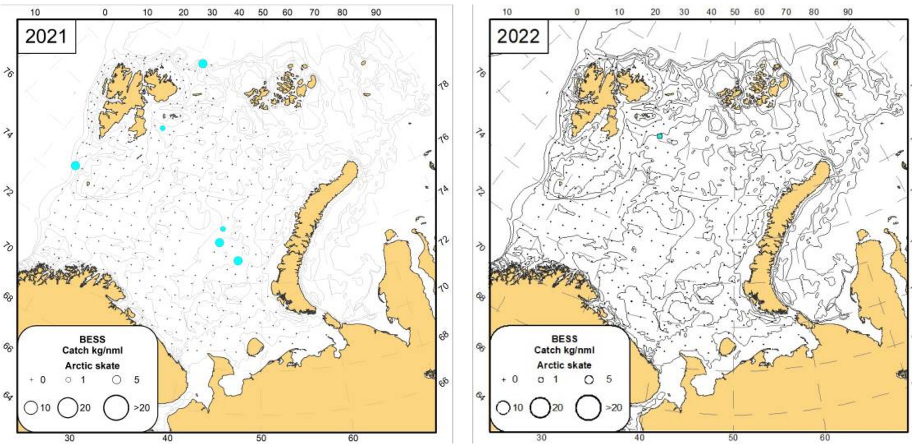

Figure 9.2.4. *Distribution of Arctic skate (Amblyraja hyperborea), August -September 2021 (light-blue circles) and August-October 2022 (Norwegian vessel).*

9.3 Uncommon or rare species

Text by Tatiana Prokhorova, Edda Johannesen, Andrei Dolgov, Rupert Wienerroither and Pavel Krivosheya

Figures by P. Krivosheya

Rare or uncommon species are either species that are not caught at the Barents Sea ecosystem survey every year, or caught most years but in low numbers and with limited occurrence. Most of these species usually occur in areas adjacent to the Barents Sea and were therefore found mainly along the border of the surveyed area. Some uncommon species were also observed in the Barents Sea during the ecosystem survey in 2022 (Figure 9.3.1).

For example, hooknose *Agonus cataphractus* known in coastal waters of the eastern North Atlantic and the adjacent Arctic from the British Isles northward to the southern Barents Sea and the White Sea, within the temperature range 4-12 °C (Wienerroither et al., 2011; Mecklenburg et al., 2018). During the survey 15 individuals of this species were found on 2 stations in the shallow regions in the south-eastern area of the survey (Figure 9.3.1). Hooknose was observed at 24-33 m depth and bottom temperature 3.3-3.9 °C in 2022.

Arctic rockling *Gaidropsarus argentatus* is known from off southern Greenland, off Iceland and the Faroe Islands to the Norwegian coast and northward to the Barents Sea (Wienerroither et al., 2011; Mecklenburg et al., 2018). This species usually lives at depths below 500 m and prefers low temperature (around 0 °C). Accordingly, during the survey 2 individuals of this species were found on 2 stations in deepwater areas in the north (at 526 m depth) and west (at 461 m depth) of the Barents Sea (Figure 9.3.1).

Arctic lamprey *Lethenteron camtschaticum* is an anadromous species known from northeastern Norway eastward to the Bering Sea, and the northwestern Pacific Ocean (Wienerroither et al., 2011. This species usually lives near the coast, but can also be found in open areas of the sea in the upper layers (Dolgov et al., 2018). This species parasitizes on various marine and freshwater fishes and is rather rare to observe. Despite Arctic lamprey was found in the southeastern part of the surveyed area only in previous years, it was found in the central part in 2022 (Figure 9.3.1).

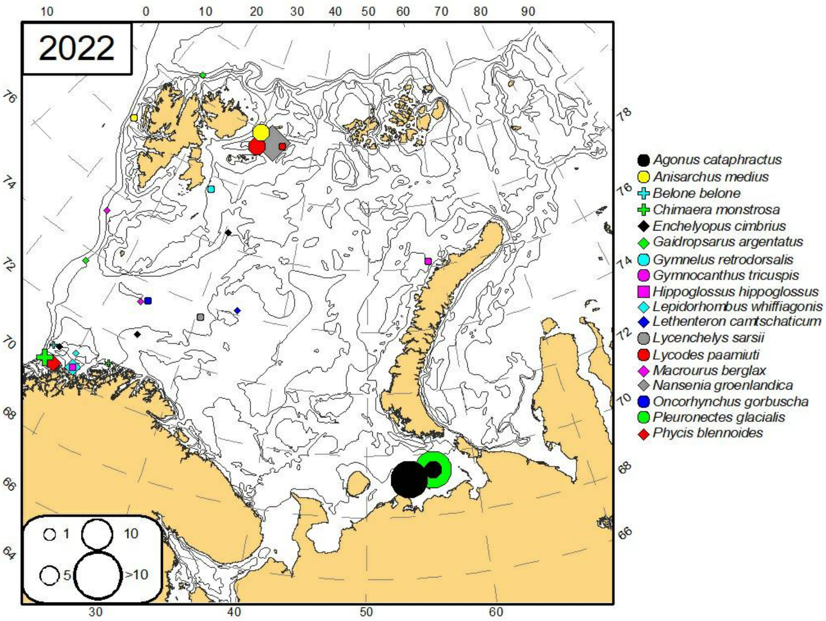

Figure 9.3.1. *Distribution of uncommon or rare species which were found in the survey area in 2022.*

9.4 Zoogeographic groups

Text by Tatiana Prokhorova, Edda Johannesen, Andrej Dolgov, Rupert Wienerroither and Pavel Krivosheya

Figures by P. Krivosheya

During the 2022 ecosystem survey in total 85 fish species from 31 families were recorded in the catches, and some specimens were only identified to genus or family level. The highest number of species were found in the families Zoarcidae (12 species), Cottidae, Gadidae, and Pleuronectidae (8 species each). 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). Mecklenburg et al. (2018) in the recent “Marine Fishes of the Arctic Region” reclassified some of the species and the zoogeographic categorisation comprises six groups: **widely distributed, boreal, mainly boreal, Arctic- boreal, mainly Arctic and Arctic**. We use Andriashev and Chernova classification here due to the lack of comparative studies of the old and new classification applied to the Barents Sea. 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 (Andriashev and Chernova, 1994, Parin, 1968, 1988). Among the analyzed species most belong to the Arctic (27.1 %), mainly boreal (27.1 %), and boreal (22.0 %) zoogeographic groups.

Widely distributed (only ribbon barracudina *Arctozenus risso* represents this group), **south boreal** (e.g. grey gurnard *Eutrigla gurnardus*, silvery pout *Gadiculus argenteus*, greater forkbeard *Phycis blennoides*) and **boreal** (e.g. lemon sole *Microstomus kitt*, stout eelblenny *Anisarchus medius*, silvery lightfish *Maurolicus muelleri*) species were mostly found in the central, southwestern and western part of the survey area where warm Atlantic and Coastal Waters dominate (Figure 9.4.1).

Mainly boreal species (e.g. lesser sandeel *Ammodytes marinus*, snakeblenny *Lumpenus lampretaeformis*, greater eelpout *Lycodes esmarkii*) were widely found throughout the survey area (Figure 9.2.1).

Arctic-boreal species (e.g. Atlantic poacher *Leptagonus decagonus*, ribbed sculpin *Triglops pingelii*) were found in the central and northern part of the Barents Sea (Figure 9.4.1).

Mainly Arctic (e.g. Arctic flounder *Liopsetta glacialis*, Atlantic spiny lumpsucker *Eumicrotremus spinosus*, slender eelblenny *Lumpenus fabricii*) and **Arctic** (e.g. Arctic alligatorfish *Aspidophoroides olrikii*, pale eelpout *Lycodes pallidus*, leatherfin lumpsucker *Eumicrotremus derjugini*) species were mainly found on the northern part of the Barents Sea (Figure 9.4.1). Species of these groups mostly occur in areas influenced by cold Arctic Water, Spitsbergen Bank Water and Novaya Zemlya Coastal Water.

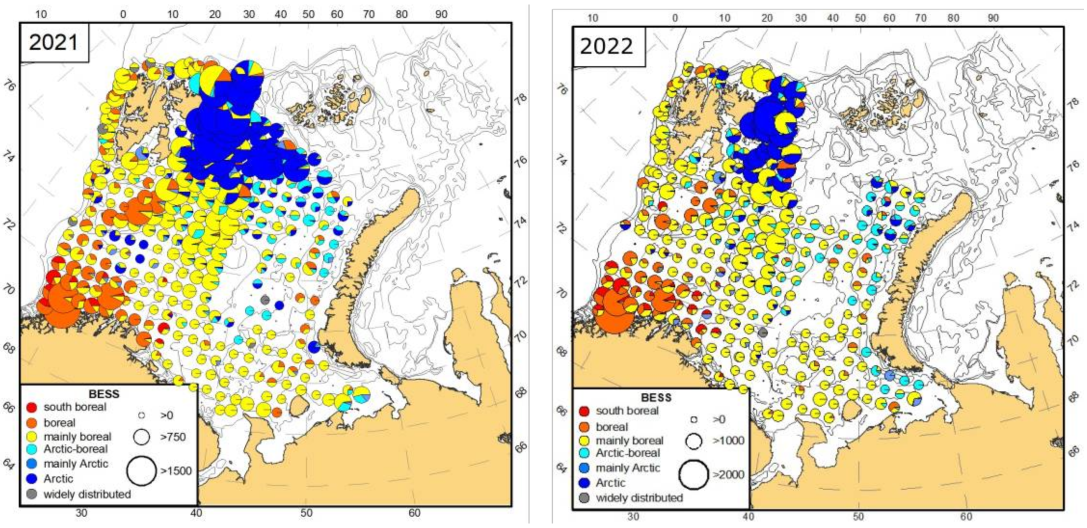

Figure 9.4.1. *Distribution of non-commercial fish species from different zoogeographic groups during the ecosystem survey 2021 (left) and 2022 (right). The size of circles corresponds to total abundance (individuals per nautical mile, only bottom trawl stations were used, both pelagic and demersal species are included).*

References

Dolgov, A.V., A.P. Novoselov, T.A. Prokhorova, G.V. Fuks, D.V. Prozorkevich, N.V. Chernova, V.S. Sherstkov, A.L. Levitskiy. Atlas of the Kara Sea fish. – Murmansk: PINRO, 2018. – 271 pp. (in Russian)

Mecklenburg, C.W., A. Lynghammar, E. Johannesen, I. Byrkjedal. J.S. Christiansen, A.V. Dolgov, O.V. Karamushko, T.A. Mecklenburg, P.R. Møller, D. Steinke, and R.M. Wienerroither. 2018. Marine Fishes of the Arctic Region. Conservation of Arctic Flora and Fauna, Akureyri, Iceland.

Wienerroither R., Johannesen E., Dolgov A., Byrkjedal I., Bjelland O., Drevetnyak K., Eriksen K.B., Høines Å., Langhelle G., Langøy H., Prokhorova T., Prozorkevich D., Wenneck T. Atlas of the Barents Sea fishes. IMR/PINRO Joint Report Series, No. 1/2011. – 272 pp.

10 - COMMERCIAL SHELLFISH

Author(s): (IMR), Sergei Bakanev (VNIRO-PINRO), (IMR), Aleksei Stesko (VNIRO-PINRO), Daria Blinova (VNIRO-PINRO) and Lis lindal Jørgensen (IMR)

10.1 Northern shrimp (*Pandalus borealis*)

Text by: Sergei Bakanev and Carsten Hvingel

Figures by: J. Zhak

During the survey in 2022 293 trawl hauls were completed – 246 of them contained northern shrimp. The biomass of shrimp varied from several grams to 244.8 kg/nm with an average catch of 6.6±1.0 kg nm (Table 10.1.1). Average values are reported with standard error (SEM).

Table 10.1.1. The catch characteristics of the Northern shrimp (include SEM) during BESS in 2005-2022.

Year	Total number of station	Number of station with shrimp	Mean catch, ind./nml	Mean catc kg/nml
2005	224	169	856.3±12.1	12.1±4.3
2006	637	480	3460.8±21.4	15.0±0.9
2007	551	426	2875.5±19.7	13.2±0.9
2008	431	329	1846.6±17.7	9.2±0.7
2009	378	310	1673.0±17.4	7.9±0.9
2010	319	238	2625.5±15.3	12.0±1.2
2011	391	304	2165.2±17.2	10.4±0.9
2012	443	325	2351.2±18.0	12.0±1.0
2013	487	388	1838.2±19.1	9.5±0.6
2014	165	101	1676.0±10.1	8.4±1.0
2015	334	247	1371.0±15.6	7.1±0.6
2016	317	187	1457.9±13.1	7.0±0.6
2017	339	281	2021.4±16.3	13.8±1.9
2018	217	160	1759.0±11.9	10.2±1.4
2019	323	254	1577.5±3.1	9.1±0.2
2020	461	317	717.2±77.3	4.6±0.4
2021	341	275	1487.4±68.2	7.8±0.4
2022	293	246	1175.8±177.4	6.6±1.(
Total	**7064**	**5154**	**1417.5±42.6**	**8.1±0.2**

As in previous years the densest concentrations of shrimp in 2022 were registered in central part of the Barents Sea, around Svalbard (Spitsbergen) and in the Franz Victoria Trough (Fig. 10.1.1).

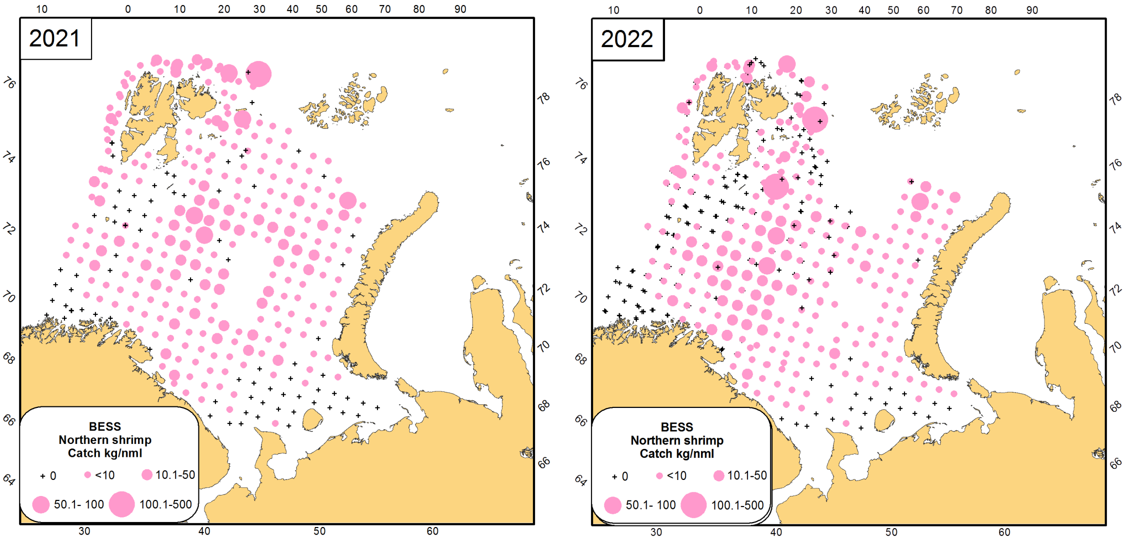

Figure 10.1.1. *Distribution of the Northern shrimp (Pandalus borealis) in the Barents Sea, in the Barents Sea in August-December 2021-2022.*

Biological analysis of the northern shrimp was conducted in 2022 by Russian scientists in the eastern part of the survey area. As in 2021, the bulk of the population of the eastern Barents Sea shrimp was made up of smaller individuals, i.e males with a carapace length of 10-25 mm in addition to females with a carapace length of 15-30 mm (Fig. 10.1.2). In 2022 proportion of males and females was almost equal.

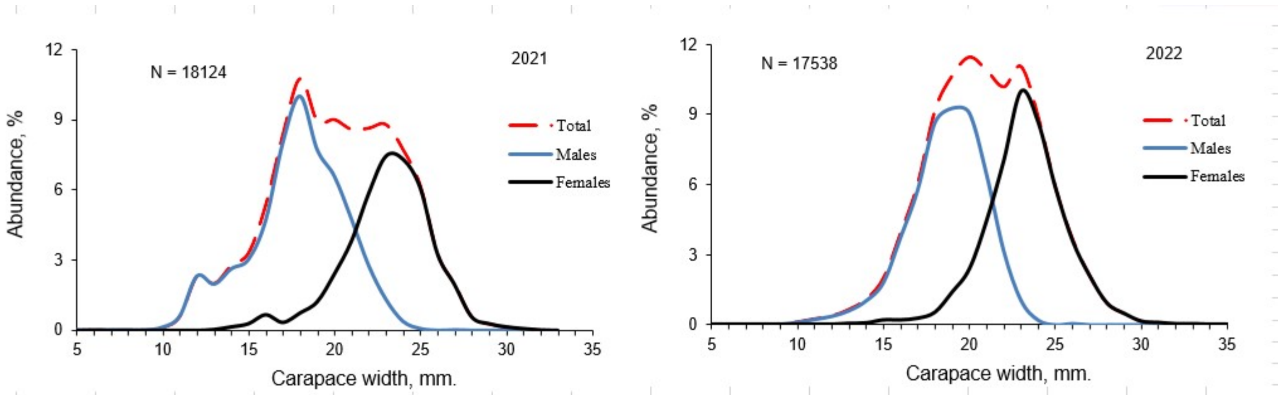

Figure 10.1.2. *Size and sex structure of catches of the Northern shrimp (Pandalus borealis) in the eastern Barents Sea 2021-2022.*

10.2 Red king crab (*Paralithodes camtschaticus*)

Text by: Aleksei Stesko and Ann Merete Hjelset

Figures by: J. Zhak

During BESS-2022 the red king crab was recorded in 23 of 293 trawl catches: in 1 station in Norwegian water and in 22 stations in Russian part of survey (Table 10.2.1). Compared to previous years, in 2022 there was not recorded any expansion of red king crab range to north or east (Fig. 10.2.1).

Despite the identical coverage of the red king crab area by stations, in 2022 compared to 2021 both the number of recording and the total catch were significantly lower (Table 10.2.1, Fig. 10.2.1).

As in previous years, the most abundant catches were recorded in Russian water near peninsula Kanin Cap.

Table 10.2.1. *The total catches of the red king crab during BESS 2005-2022.*

Year	Total number of station	Number of station with red king crab	Total catch, ind.	Total catch, kg
2005	649	8	106	309
2006	550	66	1243	3350
2007	608	30	1521	3869
2008	452	10	127	93
2009	387	7	15	25
2010	331	6	12	25
2011	401	4	40	22
2012	455	8	126	308
2013	493	3	272	437
2014	304	11	168	403
2015	335	14	255	517
2016	317	11	202	552
2017	376	13	299	687
2018*	217	5	73	175
2019	323	32	1635	2897
2020	461	22	233	547
2021	341	26	373	1186
2022	293	23	306	1035

* reduced coverage of the red king crab area

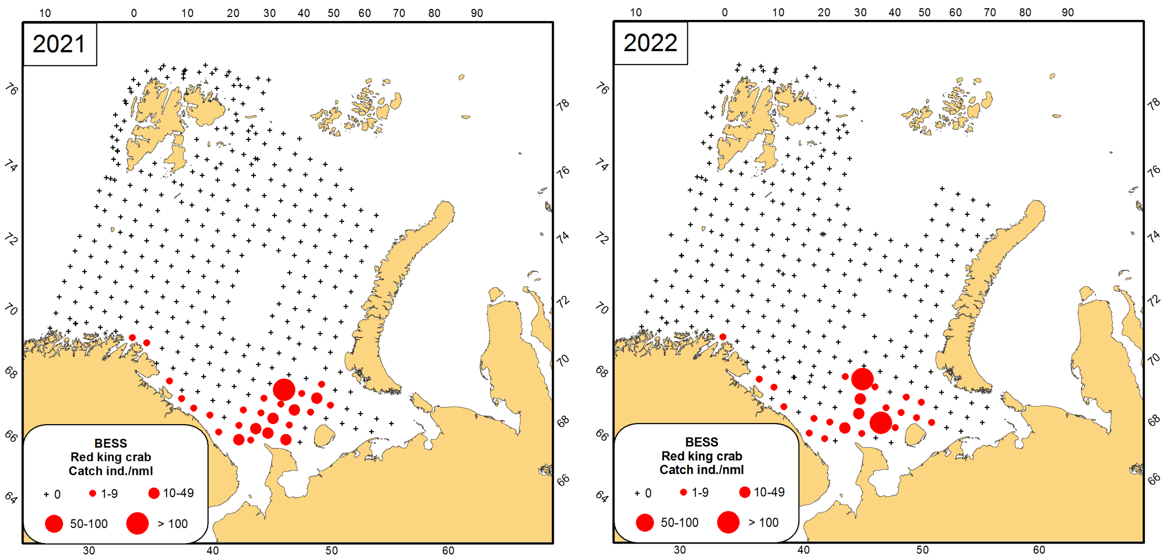

Figure 10.2.1. *Distribution of the red king crab (Paralithodes camtschaticus) in the Barents Sea in August-December 2021-2022.*

The biomass of red king crab catches in 2022 varied from 4.8 to 548.4 kg/nm compared with 0.8 to 511.6 kg/nm in 2021. The average biomass was 54.3±27.5 kg/nm compared with 54.9±23.8 kg/nm in 2021.

The abundance of crab in 2022 ranged from 1.2 to 149.4 ind./nm given an average crab abundance of 16.1±7.6 ind./nm compared with 1.3-201.2 ind./nm and 17.3±7.7 ind./nm in 2021.

The size structure of the red king crab population in 2022 is characterized by domination of two groups of crabs with carapace width 140-170 and 190-230 mm. (Fig. 10.2.2).

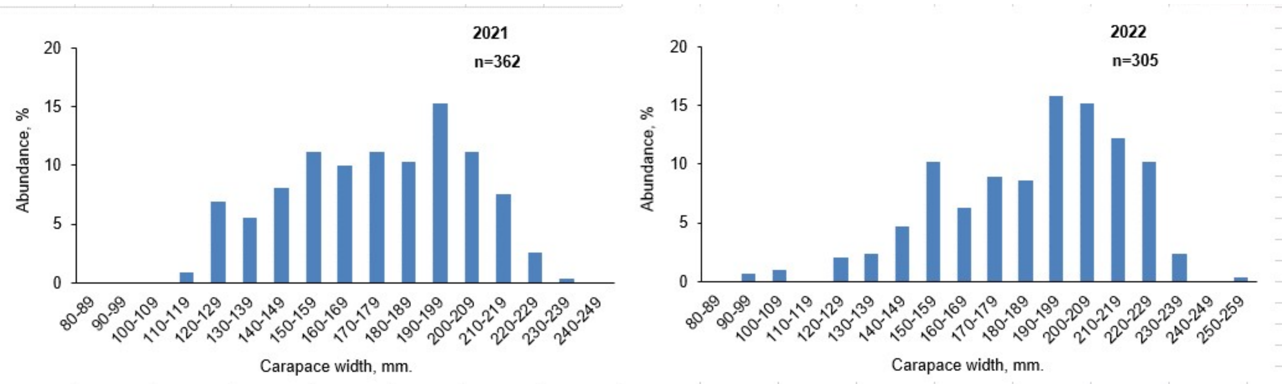

Figure 10.2.2. *Length distribution of the red king crab in the Barents Sea in August-December 2021- 2022 (by BESS data).*

10.3 Snow crab (*Chionoecetes opilio*)

Text by: Sergei Bakanev, Aleksei Stesko and Ann Merete Hjelset

Figures by: J. Zhak

In 2022, snow crabs were recorded in 95 out of 293 trawl catches. Compared to previous year, the total catch of snow crab decreased, but also the number of stations is fewer compared with previous years. (Table 10.3.1).

During the sampling period, there have been single observations of snow crab outside central Barents Sea. In 2017 the snow crab was for the first-time recorded northwest of Svalbard (Spitsbergen). In 2018 one small male

(CW= 34 mm) and weight 12 g was caught south-west of South Cap of Spitsbergen at 350 m. In 2019 and 2020 snow crab was not recorded in the water around Svalbard (Spitsbergen), however in 2021-2022 it was caught in South and the South-eastern part of Svalbard (Spitsbergen) area, but no more than 9 ind./nm.

Within the survey area and stations with catches of crab, the biomass per station in 2022 varied from 0.001 to 6.63 kg/nm with an average 0.671±0.1 kg/nm compared with 0.001 to 18.3 kg/nm with an average 1.3±0.1 kg/nm in 2021 (Fig. 10.3.1, Table 10.3.1).

The abundance in 2022 ranged from 1 to 382 ind./nm with an average of 12.04±3.91 ind./nm compared with 1-398 ind./nm and 19.8±0.9 ind./nm in 2021 (Fig. 10.3.1, Table 10.3.1).

Table 10.3.1. *The total and mean (per nautical mile) catches of snow crab during BESS in 2005-2022.*

Year	Total number of stations	Number of stations with snow crab	Total catch, ind.	Total catch, kg	Mean abundance, ind./nm	Mean biomass, kg/nm
2005	649	10	14	2.5	1	0.3
2006	550	28	68	11	3	0.5
2007	608	55	133	18	3	0.4
2008	452	76	668	69	11	1.2
2009	387	61	276	36	6	0.8
2010	331	56	437	22	10	0.5
2011	401	78	6219	154	99	2.4
2012	455	116	37072	1169	395	12.6
2013	493	131	20357	1205	210	12.7
2014	304	78	12871	658	206	10.5
2015	335	89	4245	378	57	5.2
2016	317	84	2156	137	26	1.9
2017	376	159	25878	1422	147	10.0
2018*	217	61	19494	846	393	16.7
2019*	323	87	15523	608	145	6.6
2020	461	141	4403	436	38	3.7
2021	341	105	1705	110	20	1.3
2022	293	95	891	50	12	0.7

** Some stations in the snow crab area were not surveyed in 2018 and 2019*

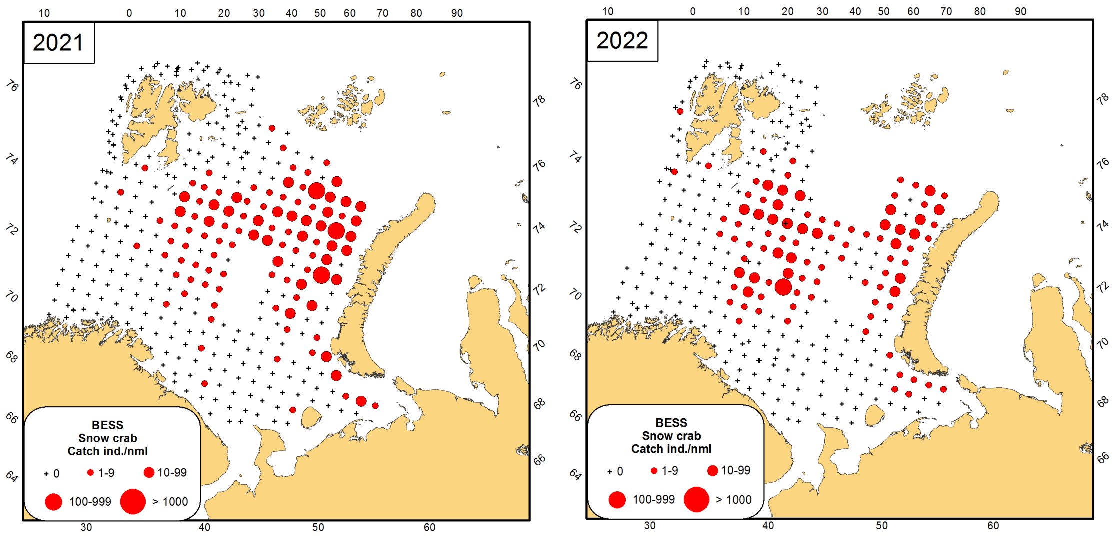

Figure 10.3.1. *Distribution of the snow crab (Chionoecetes opilio) in the Barents Sea in August-December 2021-2022.*

The measured size composition of snow crabs caught in 2022 were dominated by females with 30-40 mm carapace width and males with carapace width 30-40 and 70-100 mm (Fig. 10.3.2 B). The size structure of snow crab catches in 2022 was very close to the structure in 2021 (Fig. 10.3.2).

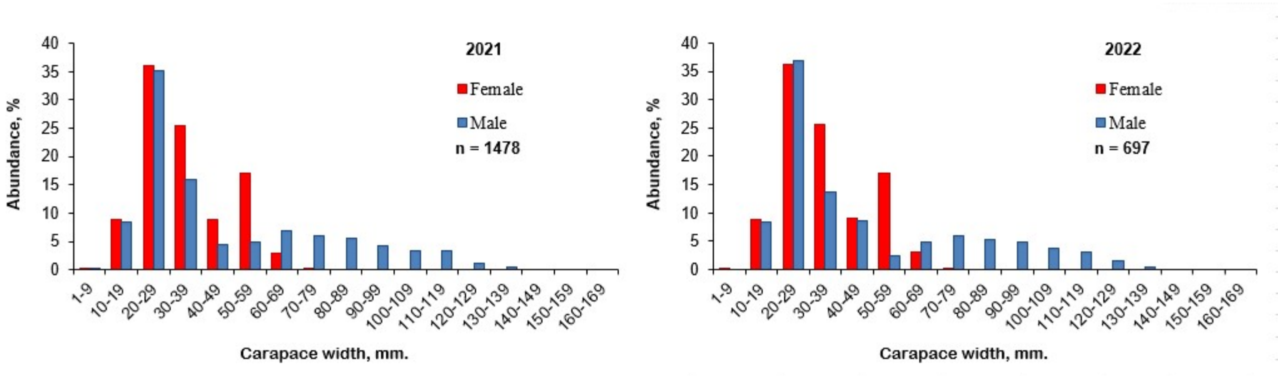

Figure 10.3.2. *Size and sex structure of the snow crab in the Barents Sea in August-December 2021- 2022 (by BESS data).*

10.4 Iceland scallop (*Chlamys islandica*)

Text by: Daria Y. Blinova and Lis Lindal Jørgensen

Figures by: D. Blinova

The Iceland scallop was recorded in 77 of 287 trawl catches in 2022 (Table 10.4.1). The survey showed a wide distribution of scallops in the Barents Sea. The deepest record in 2022 was at 520 m, but the most abundant catches were recorded in the shallow banks and elevations of the bottom is Spitsbergen Bank (Figure 10.4.1).

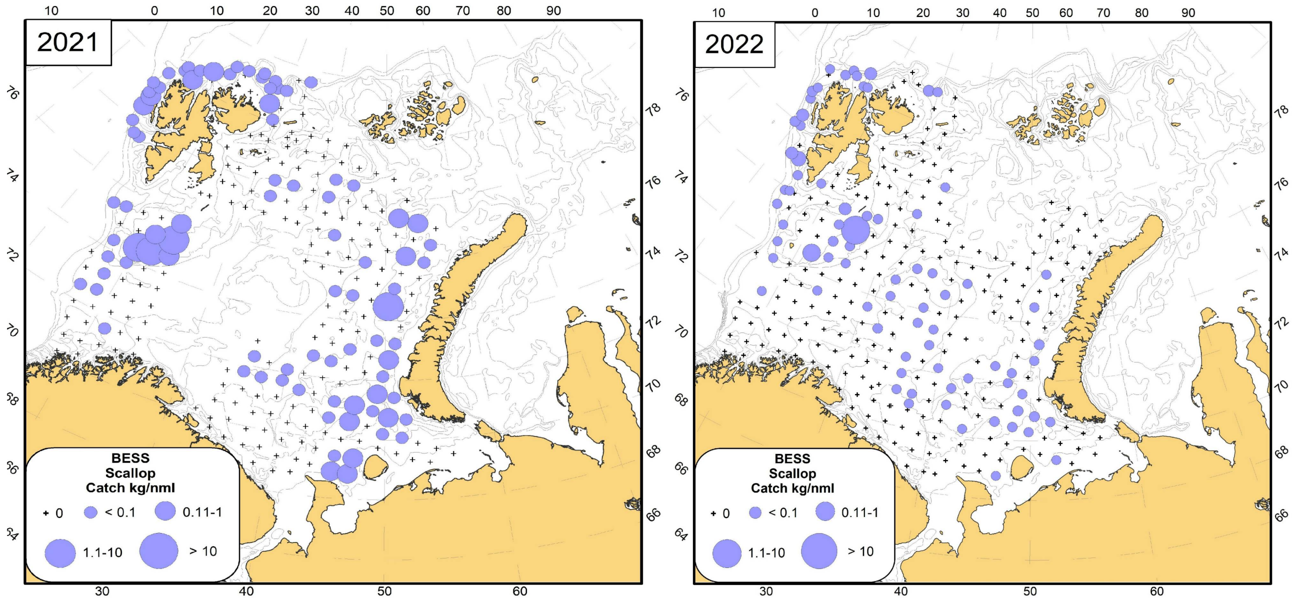

Figure 10.4.1. *Distribution of Iceland scallop (Chlamys islandica) in the Barents Sea, August-October 2021 (left) and August to December 2022 (right).*

The biomass of scallops in 2022 varied from 0.3 to 2622 g/haul (0.35-2714.75 g/nml). The average biomass is 191.3±37.3 g/haul (224.8±39.9 g/nml) (table 10.4). The abundance ranged from 1 to 276 ind./haul (1-789 ind./nml). The average abundance of scallops is 27±4 ind./haul (34±6 ind./nml).

Table 10.4.1. *Annual parameters of scallop population in the Barents Sea*

Year	Stations (% of total)	Abundance, ind./nml	Biomass, g/nml
2011	101 (26)	35±5	1294±235
2012	146 (33)	62±7	1580±195
2013	131 (27)	115±17	8378±1359
2014*	50 (36)	29±4	812±121
2015	103 (31)	13±1	264±32
2016*	76 (24)	18±2	268±38
2017	125 (33)	82±11	1486±198
2018*	65 (30)	31±4	537±91
2019*	112 (35)	42±11	1039±334
2020	97 (23)	15±5	146±40
2021*	88 (35)	20±6	225±51
2022*	77 (27)	34±6	224.8±39.9

* - survey area was not complete

11 - BENTHIC INVERTEBRATE COMMUNITY

Author(s): Natalia Strelkova (VNIRO-PINRO) and Lis lindal Jørgensen (IMR)

Figures by: A. Kudryashova

The list of benthic experts onboard Russian and Norwegian RVs is given in Table 1 (Ch 1).

In 2021, megabenthos was recorded from 254 bottom trawl hauls across four R/Vs during the BESS in 2021. Megabenthos was processed to closest possible taxon with abundance and biomass recorded on all four ships. This was done by two benthic experts from “VNIRO”, and by seven experts from IMR. Benthos was not processed on Part 1 of R/V ”Johan Hjort” due to the absence of benthic experts onboard.

11.1 Species diversity

The total number of megabenthic taxa identified from the trawl-catch across all vessels is presented in Table 11.1. Detailed information about the taxonomic processing onboard the vessels are given in Table 11.2.

A total of 562 invertebrate taxa (382 identified to species level) was recorded in 2022, which is very close to the data of 2021, possible, due to a similar level of the station numbers (Table 11.1). In 2022 68.0 % of benthic invertebrate animals were identified to species level versus 67.1 % in 2021 (Table 11.2).

Table 11.1. *The measures obtained in BESS since 2005-2022. Pelagobenthic Pandalus borealis (Northern shrimp) are excluded from abundance and biomass values*

Year	Number of stations	Total		Average abundance, ind./n.ml	Average biomass, kg/n.ml	Number	
		abundance, ind.	biomass, t			species	taxa
2005	224	83077	2.1	522.5	12.7	142	218
2006	637	779454	20.7	1576.0	42.1	261	388
2007	551	526263	18.2	1240.2	44.6	222	351
2008	431	757334	12.2	2183.7	35.7	157	244
2009	378	653918	12.3	2056.4	42.2	283	391
2010	319	239282	6.8	900.0	27.3	273	360
2011	391	1089586	10.8	3411.4	34.3	282	442
2012	443	3521820	42.6	9832.1	125.5	354	513
2013	487	1573121	27.6	3885.0	71.7	362	538
2014	165	390444	5.3	2806.7	36.7	220	333
2015	334	481602	5.3	1815.1	19.9	398	599
2016	317	1116405	6.8	4230.1	36.3	266	423
2017	339	1073697	16.2	3769.4	58.6	319	500
2018	217	852613	15.4	4887.8	89.2	404	574
2019	305	1292902	19.0	4239.0	62.5	427	621
2020	429	898168	10.7	1719.1	30.4	401	611
2021	254	212931	10.2	1076.6	50.6	384	572
2022	283	426850	5.8	2101.2	31.3	382	562
Total:	6411	15 969 467	248.0			815	1290
Average*:	**370±32**	**795848±100910**	**13.2±1.6**	**2619±319**	**44.6±4.5**	**315±20**	**466±29**

* The average long-term value for the period 2006-2022 except invalid (inflated) abundance and biomass data of 2012.

Table 11.2. *Statistics of megabenthos bycatch processing and assessment of the quality of taxonomic processing of invertebrates in the BESS 2022.*

Research vessels	"G.O. Sars"	"Johan Hjort"	"Vilnyus"	Total
Number of processed hauls	64	93	126	283
Phylum	13	13	11	14
Class	28	28	20	29
Order	78	82	58	88
Family	170	179	99	211
Species	248	300	133	382
Total number of taxa	368	417	173	562
Percentage of species identification*	**67.4**	**71.9**	**76.9**	**68.0**

* calculated as quotient from division of total number of identifications till species to total number of identifications, %.

The taxonomical structure of the Barents Sea megafauna are almost identical between 2021 and 2022 (Fig. 11.1.1), despite the different interannual area coverage (Fig. 11.1.2). Mollusca had the highest number of taxa (124 taxa) followed by Arthropoda (106 taxa), and Echinodermata (89 taxa). Among the mollusks, 56 % of taxa belonged to Gastropoda (70 taxa), 31 % – to Bivalvia (39 taxa), 10 % to Cephalopoda (10 taxa) and the remaining 4 % were distributed between Solenogastres and Polyplacophora. The Arthropoda phylum were primarily presented by Malacostraca (83 taxa) and Pycnogonida (20 taxa); only 3 taxa belong to Hexanauplia and Thecostraca. Among the Echinoderms the most diverse groups was Asteroidea (43 % of taxa), Ophiuroidea (21 % of taxa) and (Holothuroidea (17 % of taxa).

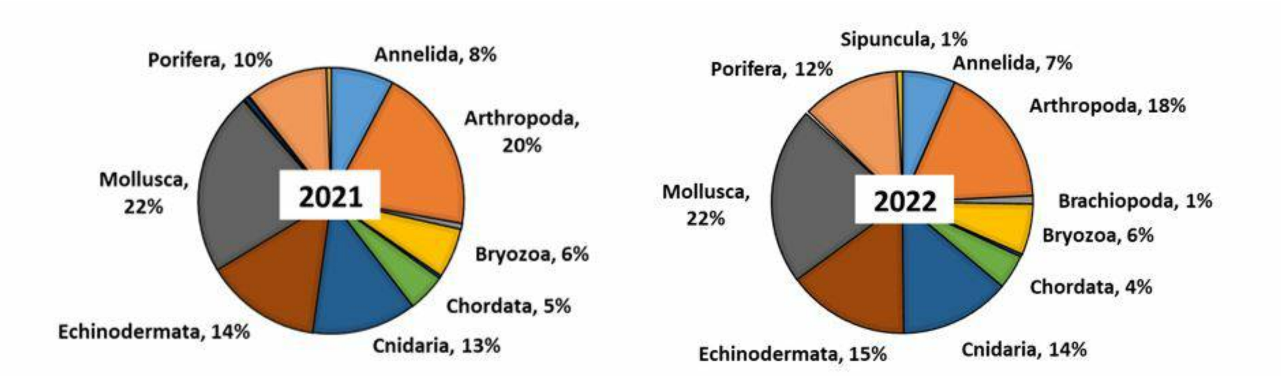

Figure 11.1.1. *The number of taxa given as the % distribution among megabenthic phyla in the Barents Sea, August-September 2021 and August-December 2022.*

The species density in the terms of the number of taxa in standard trawl catches ranged from 1 to 101 with average of 32.7±1.5 taxa per trawl-catch (versus 29.7±1.4 taxa per trawl-catch in 2021). At the significance level of 0.05, the differences between 2021 and 2022 data are statistically insignificant ($p = 0.74$).

The lowest level of diversity (1-10 taxa per haul) was recorded in the south-eastern part of the survey area (Fig. 11.1.2). In north-western sector of the sea in the water around Svalbard number of megabenthic taxa reach 101 per station and practically everywhere exceeded 50 taxa per trawling (Fig. 11.1.2)

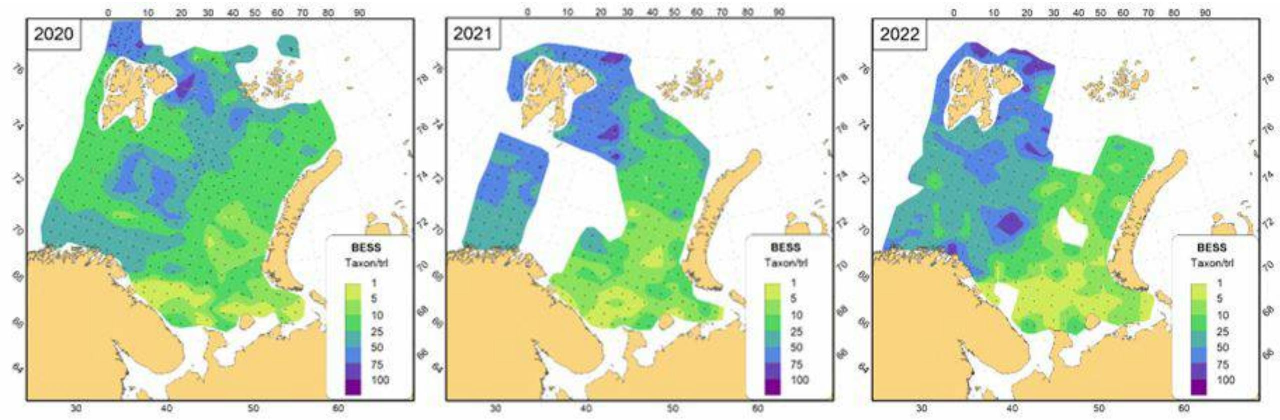

Figure 11.1.2. *The number of megabenthic taxa per trawl-catch in the Barents Sea in September-November 2020, August-September 2021 and August-December 2022.*

The ten most frequently species taken by trawl in the investigated part of the Barents Sea in 2022 were the decapod crustaceans *Sabinea septemcarinata* (taken by 67 % of the trawl-hauls), sea stars *Ctenodiscus crispatus* (65 %), *Pontaster tenuispinus* (40 %), *Henricia species* (37 %) and *Urasterias lincki* (36 %), the brittle stars *Ophiopholis aculeate* (53 %), *Ophiacantha bidentata* (47 %), and *Ophiura sarsii* (40 %), soft coral *Gersemia rubiformis* (39 %) and polychaetes *Spiochaetopterus typicus* (37 %).

11.2 New species records

During the BESS 2022, twelve new species was recorded for the first time since 2005 when the ecosystem surveys started (mainly in the Norwegian part of the Barents Sea): decapod shrimp *Crangon crangon*, bryozoans *Carbasea carbasea* and *Chartella papyracea*, sea-squirts *Rhizomolgula globularis*, sea-stars *Luidia sarsii* and *Culcitopsis borealis*, bivalve mollusks *Cyrtodaria kurriana* and *Asperarca nodulosa*, gastropods mollusk *Propilidium exiguum*, and sponges *Isodictya palmata*, *Hexadella dedritifera* and *Mellonympha mortenseni* (Fig. 11.2.1).

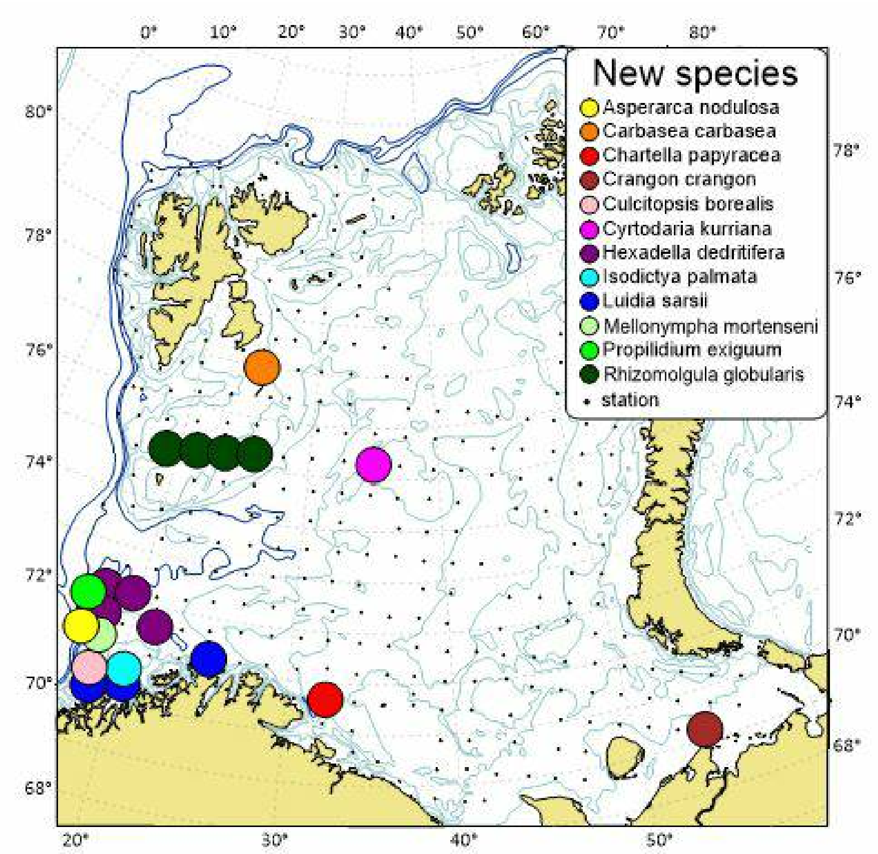

Figure 11.2.1. *Sites of finding of megabenthic species that has been named for the first time in 2022 in the Barents Sea and adjacent water since the beginning of the BESS (year 2005).*

Records of six warm water species (*Ch. papyracea, L. sarsii*, *C. borealis, A. nodulosa*, *P. exiguum*, and *M. mortenseni*) may be a results of their spreading to the east and north due to the long warming period. The other new species for the BESS are already known from the Barents Sea and adjacent shelf areas according to literary and Internet sources, and can be a result of a more detailed and/or qualified species identification made by the benthos expert onboard

11.3 Abundance (number of individuals)

The number of megabenthos individuals in the trawl-catches in 2022 (excluding the pelagobenthic species Pandalus borealis) ranged from 1 to 237681 (1-333250 ind./n.ml) with an average of 1590±844 ind. per trawl-catch (2101±1182 ind./n.ml). This is 49 % more than in year 2021 (Table 11.1), what can be caused by interannual variation and difference in station coverage (Fig. 11.3.1).

The largest catch in number of individuals (237681 ind./trawl-catche), mainly consisted of sea-squirt (Ascidiacea) *Rhizomolgula globularis* (237430 ind./ trawl-catch) was obtained in the western part of the Barents Sea near Bear Island (75.00° N, 19.01° E) at the depth 63 m (Fig. 11.3.1). In 2020 similar extra high abundance of sea-squirts, non identified to species level, (265775 ind./trawl-catch) were recorded in the identical position (75.01° N, 18.95° E) at the depth 61 m. As in previous year, the lowest abundances (less than 50-100 ind. per hall) was recorded in the south-eastern part of the sea within the Russian part of the survey.

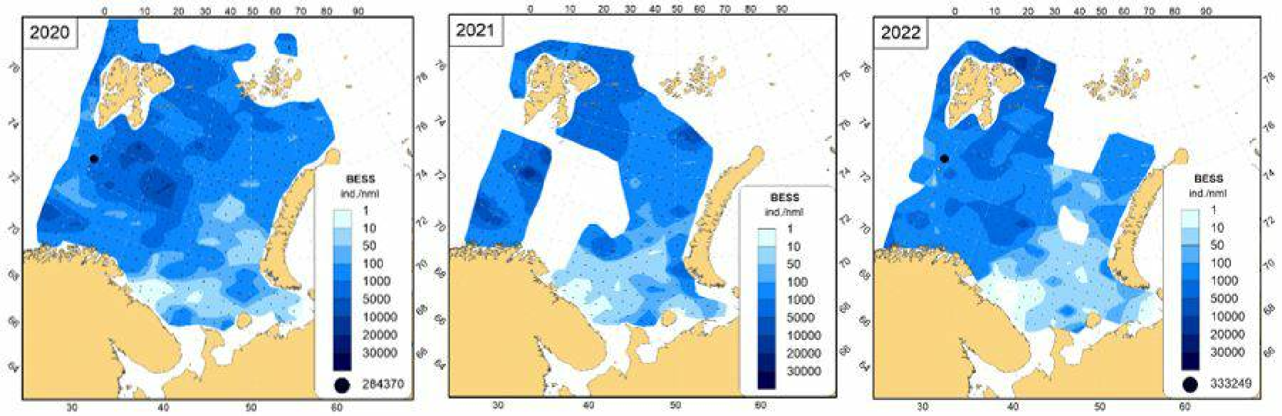

Figure 11.3.1. *Abundance (ind./n.ml) of megabenthos (excluding Pandalus borealis) in the Barents Sea in September-November 2020, August-September 2021 and August-December 2022. Big black points in the maps of 2020 and 2022 show extremely high catches of Ascidiacea g. sp. in the 2020 and sea squirts Rhizomolgula globularis in 2022.*

The mentioned extraordinary catch of sea squirts (Chordata in fig 11.2.2) in 2022 changed the distribution of abundance across the main megabenthic groups from the usual dominance of echinoderms and crustaceans to a predominance of ascidians. In 2021 the percentage between the main groups of megabenthos taxa (on the terms of abundance) corresponded to the long-term pattern (Fig. 11.3.2).

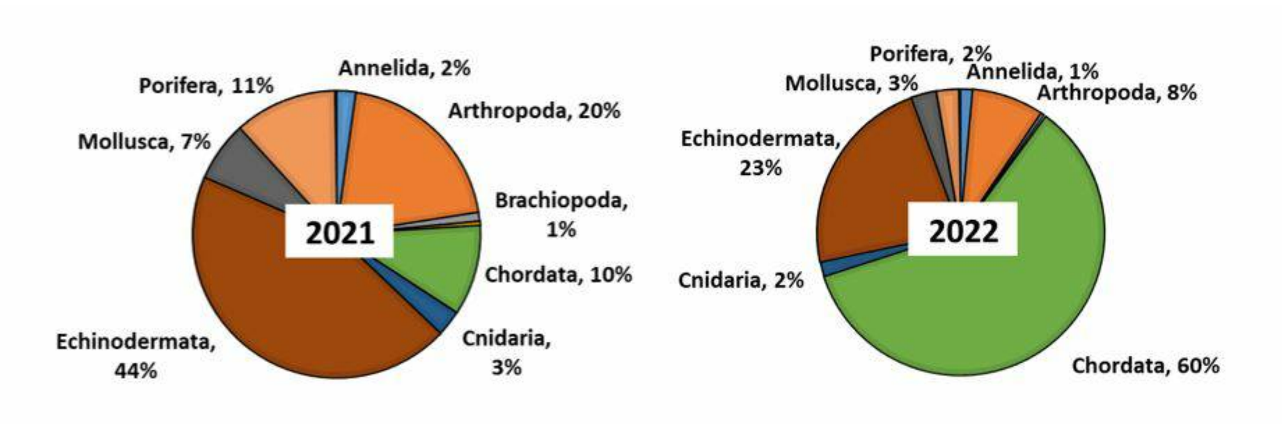

Figure 11.3.2. *Distribution of abundance (excluding Pandalus borealis) across the main megabenthic groups (%) in the Barents Sea, August-September 2021 and August-December 2022.*

The ten most abundant species (in the term of total number of individuals caught during the BESS 2022) were the sea-squirts *Rhizomolgula globularis* (66.0 % of total abundance) and *Kukenthalia borealis* (0.9 %), sea star *Ctenodiscus crispatus* (5.4 %), shrimp *Sabinea septemcarinata* (4.1 %), the brittle stars *Ophiacantha bidentata* (1.8 %), *Ophiopholis aculeata* (1.3 %), and *Ophiura sarsii* (1.2 %), sea urchins of genera *Strongylocentrotus* (in the main *S. pallidus*) (2.0 %), bivalve *Bathyarca glacialis* (1.1 %) and barnacle *Balanus balanus* (0.6 %).

11.4 Biomass

As in previous years, were the main part of the total biomass made up by Sponges, Echinoderms, and Crustaceans (total 94 %), but compared to 2021 had Chordata a slight increase in biomass due to the extraordinary large catch in the Bear Island Bank (Fig. 11.4.1).

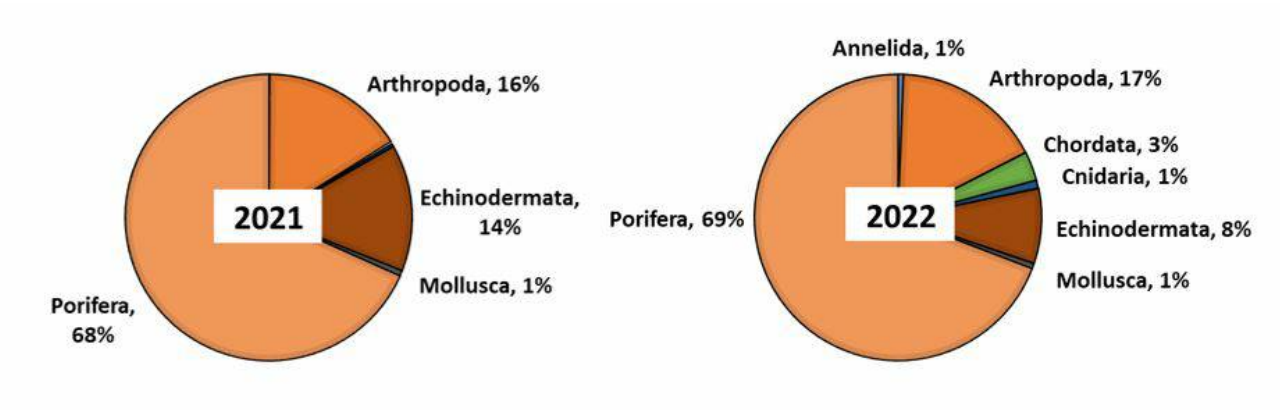

Figure 11.4.1. *The distribution of biomass (excluding Pandalus borealis) across the main megabenthic groups (%) in the Barents Sea, August-September 2021 and August-December 2022.*

The megabenthos biomass taken by the trawl (excluding the semipelagic species *Pandalus borealis*) in 2022 varied from 0.003 to 1632 kg (0.004-2197 kg/n.ml) with an average of 21.1±6.7 kg per trawl-catch (31.3±9.7 kg/n.ml). This average is 38.1 % less than in the previous year and 31 % less than the average long-term value for the period 2006-2021 except the invalid 2012 (Table 11.1). The biomass distribution in 2022 was very close to the pattern of previous years (Fig. 11.4.2).

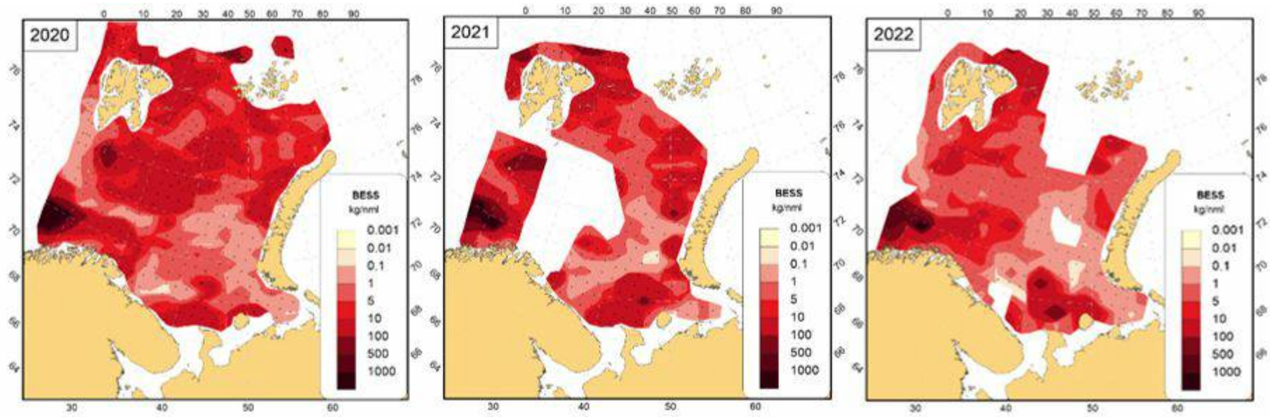

Figure 11.4.2. *The biomass distribution of megabenthos (excluding Pandalus borealis) in the Barents Sea in September-November 2020, August-September 2021 and August-December 2022.*

A trawl catch with biomass larger than 1-t was taken in 2022 at one station in the south-western part of the Barents Sea, from 331 m depth (Fig. 11.4.2). This haul was dominated by sponges: *Geodia macandrewii* (999 kg and 61.2 % of the total station biomass), *G. barretti* (422 kg; 26.5 %), *Stelletta rhaphidiophora* (88 kg; 5.4 %), *Stryphnus ponderosus* (30,5 kg: 1.9 %), and *G. phlegrae* (29,7 kg; 1.8 %). Other hot spots of biomass (more than 100 kg per trawling) was recorded in Spitsbergen Bank at the depth 93 m (dominated by 197 kg of sea-squirts *Rhizomolgula globularis* accounting for up to 93 % of the total biomass in the station), north of Spitsbergen (*Geodia macandrewii*, 90 kg; 82 %), and in the south-eastern part of the sea, north of Kanin Nos peninsula (298 kg of *Paralithodes camtschaticus* making up to 99,9 % of the total biomass on the station).

More than half of the megabenthic biomass (51.7 % of the total biomass of by-catches) belonged to the *Geodia barretti*, and *G. macandrewii* sponges. Other top-dominant species in biomass was crabs *Paralithodes camtschaticus* (17.3 % of the total biomass), sea-squirts *Rhizomolgula globularis* (3.3 %), sponges *Stelletta rhaphidiophora* (2.5 %) and *Stryphnus ponderosus* (1.6 %), sea stars *Ctenodiscus crispatus* (2.1 %), and sea-cucumber *Cucumaria frondosa* (1.3 %). The contribution of each of the other species did not exceed 1% of the total biomass of megabenthos bycatches.

12 - MARINE MAMMALS AND SEABIRDS

Author(s): Nils Øien, Frederike Boehm (IMR), Roman Klepikovskiy (VNIRO-PINRO) and Per Fauchald (NINA)

12.1 Marine mammals

Due to lack of synchronisation between the Norwegian and Russian part of the 2022 survey, the observatiosn of sea mammals are this time presented in two suchapters, one for each sector.

12.1.1 Marine mammals observed in Norwegian sector

Text by: Nils Øien, Frederike Böhm

Figures by : F. Böhm

During BESS 2022, marine mammal observers were onboard the two vessels Johan Hjort and G.O.Sars which covered the Norwegian sector.

In total, 549 observations were made of groups of marine mammals, comprising altogether a minimum of 2040 individuals. There were eleven marine mammal species identified, of which eight cetacean species and three seal species. Some of the observations were not identified to species but recognized unspecified as either a large whale, dolphin, or seal. The recorded observations are listed in Table 12.x.1 and the distribution of observations by species are given in Figures 12.1.1 (toothed whales) and 12.x.2 (baleen whales).

The dominant species during the ecosystem surveys are the baleen whales minke (*Balaenoptera acutorostrata*), fin (*Balaenoptera physalus*) and humpback whales (*Megaptera novaeangliae*) (Fig. 12.1.1, left). The most constrained distribution of these species is shown by humpback whales which during BESS 2022 were only observed east off Svalbard in the Hopen area and the Olga Strait where they overlap with the traditional capelin concentrations. However, both minke and fin whales are also abundant in this area. In addition, the two latter species have a wide distribution within the surveyed area. The fin whales are especially concentrated in the coastal areas off northern Norway and southwest of Spitsbergen while the minke whales appeared to be associated with the continental slopes from northern Norway to north of Spitsbergen. One blue whale was observed north of Spitsbergen.

Table 12.1.1. *Number of observations of marine mammals made from the Norwegian vessels. Also given are the minimum number of individuals in these observations and mean observed group sizes for each species recorded.*

Species	Number of observations	Number of individuals	Group size
Unidentified large whale	12	24	2,00
Minke whale	143	152	1,06
Fin whale	105	314	2,99
Blue whale	1	1	1,00
Humpback whale	58	87	1,50
Unidentified dolphin	1	1	1,00
Harbour porpoise	7	11	1,57
Killer whale	1	2	2,00
White-beaked dolphin	217	1447	6,67
Sperm whale	4	4	1,00
Unidentified seal	2	2	1,00
Harp seal	1	1	1,00
Ringed seal	2	2	1,00
Walrus	6	15	2,50
Totals	**549**	**2040**	

The occurrence of toothed whales was completely dominated by the presence of the white-beaked dolphin (Fig. 12.1.1, right). It is a very common species in the Barents Sea and has extended its distribution northwards in recent years to comprise the shelf areas of Spitsbergen and the Barents Sea north to about 78° to the east of Edgeøya. Other toothed whales observed, however in small numbers, were harbour porpoise (*Phocoena phocoena*), killer whale (*Orcinus orca*, 1 individual), and sperm whale (*Physeter macrocephalus*).

Only a few pinnipeds were observed: Harp seal (*Pagophilus groenlandicus*), ringed seal (*Phoca hispida*) and walrus (*Odobenus rosmarus*). The lack of seal observations during the ecosystem survey is most probably caused by ice free areas. During a whale survey in summer 2022 covering the same areas, many harp seals were registered especially in the areas of Hinlopen and the Olga Strait.

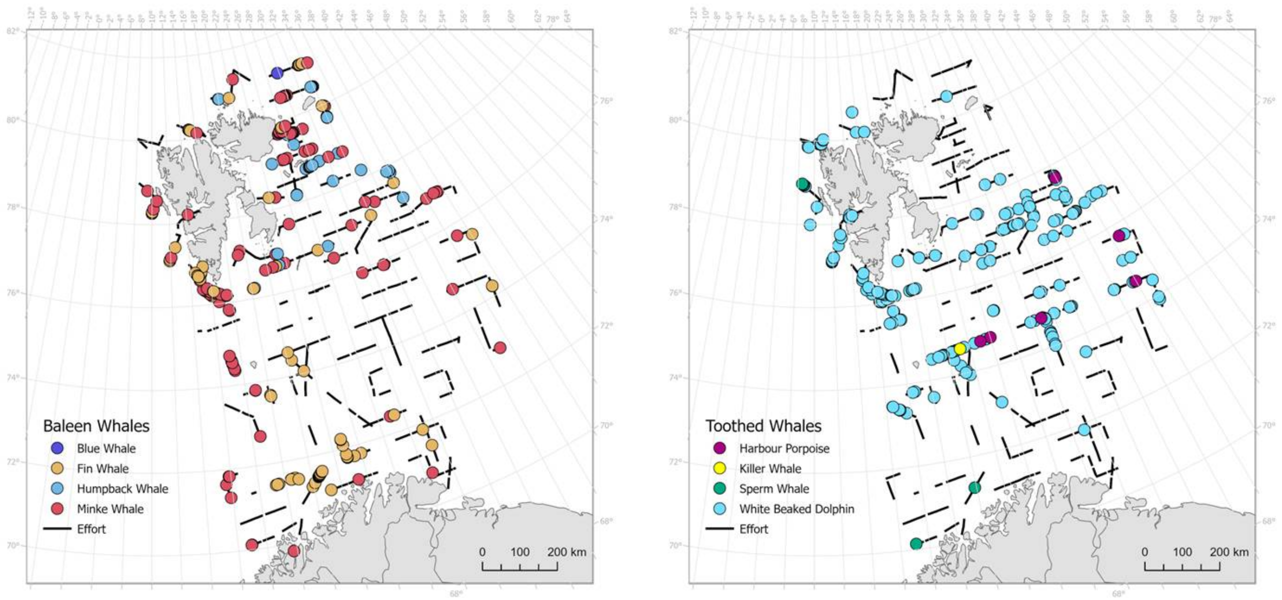

Figure 12.1.1. *Distribution of baleen whales (left) and toothed whales (right) in BESS 2022-Norway.*

12.1.2 Marine mammals observed in Russian sector

Text and figures by : R. Klepikovskiy

Observations of marine mammals from Russian vessel Vilnyus in the eastern Barents Sea in to 2022 were carried out in end September, end October, November and even first day of December. Due to this, the occurrence of marine mammals was significantly lower compared to observations made at standard times in August-September.

During the observations period, 4 species of marine mammals were registered, with a total number of 195 individuals. Data of observations are presented in the table 12.1.2 and in the figure 12.1.2. The most numerous species was the white-beaked dolphin who was recorded in groups of 2 to 50 individuals, mainly in areas located north of 74º N in places of concentrations of capelin and polar cod. In addition to the white-beaked dolphin, among the toothed whales, only the harbor porpoise was observed, a group of 10 individuals of which was recorded in mid-November in the Pechora Sea on herring concentrations.

Minke whale and humpback whale have been observed among baleen whales. During the research, only 3 observations with minke whale were registered. In December, one humpback whale was recorded near the Murmansk coast.

Such common species as fin whale and killer whale were not observed.

Also this year, due to surveying in more southerly areas far from the ice, pinnipeds and polar bears (Ursus maritimus) were not observed.

Table 12.1.2. *Number of observations of marine mammals made from the Russian vessel. Also given are the minimum number of individuals in these observations and mean observed group sizes for each species recorded.*

Species	Number of observations	Number of individuals	Group size
Minke whale	3	3	1
Humpback whale	1	1	1
White-beaked dolphin	25	181	7,2
Harbour porpoise	1	10	10
Totals	**30**	**195**	

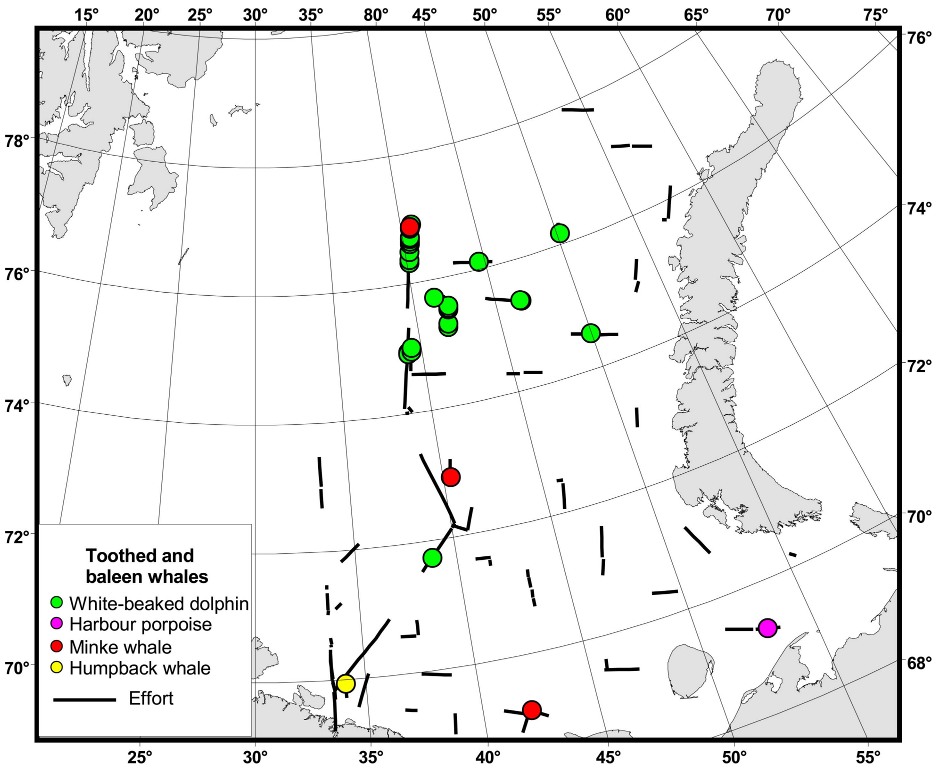

Figure 12.1.2. *Distribution of toothed and baleen whales in BESS 2022- Russia.*

12.2 Seabird observations

Text and figures by: Per 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. Counts were done only during daylight and when visibility allowed a complete overview of the transect. On GO Sars and Johan Hjort, birds following the ship i.e. “ship-followers”, were counted as point observations within the sector every ten minutes. Ship-followers included the most common gull species and Northern fulmar. On Vilnus, ship-followers were counted continuously along the transects, and by a point observation at the start of each transect. 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.

The Norwegian sector were covered by GO Sars and Johan Hjort in the period 16 August to 4 October. The Russian sector was covered by Vilnus in the period from 21 September to 1 December. Total transect length covered by GO Sars and Johan Hjort was 7246 km. Total transect length covered by Vilnus was 2959 km. A total of 35 624 birds belonging to 34 different species were counted. The distribution of the dominant auk species is shown in Fig 1 and the distribution of the most common gull species and Northern fulmar is shown in Fig 2. Because several seabird species migrate in and out of the Barents Sea during autumn, the time difference between the coverage of the Norwegian and Russian sectors might cause some biases in the distribution pattern shown in Figs 1 and 2.

Broadly, the distribution of the different species (Figures 12.2.1 and 12.2.2) was similar to the distribution in previous years. For the auks (Figur 12.2.1), high density of little auks (*Alle alle*) was found north of Spitsbergen. Thick-billed murres (*Uria lomvia*) were found in the northern part of the Barents Sea with the highest densities east of Spitsbergen. Atlantic puffins (*Fratercula arctica*) were found in the southern and western Barents Sea and common guillemots (Uria aalge) were found in the southern part of the area. Northern fulmar (*Fulmarus glacialis*) and black-legged kittiwake (*Rissa tridactyla*) were encountered throughout the Barents Sea but with highest density in northeast (Figures 12.2.2). For the large gull species, herring gull (*Larus argentatus*) and great black-backed gull (*Larus marinus*) were found along the coast of Kola and Finnmark, while glaucous gull (*Larus hyperboreus*) was mainly encountered in the southeastern Barents Sea and Pechora Sea but was also present in the central and northern part of the area.

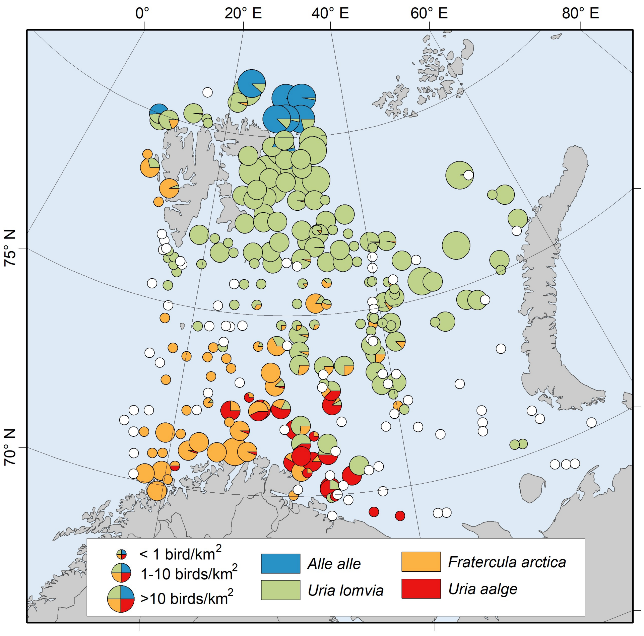

Figure 12.2.1. *Density of auk species along seabird transects in 2022. White-filled circles are zero density.*

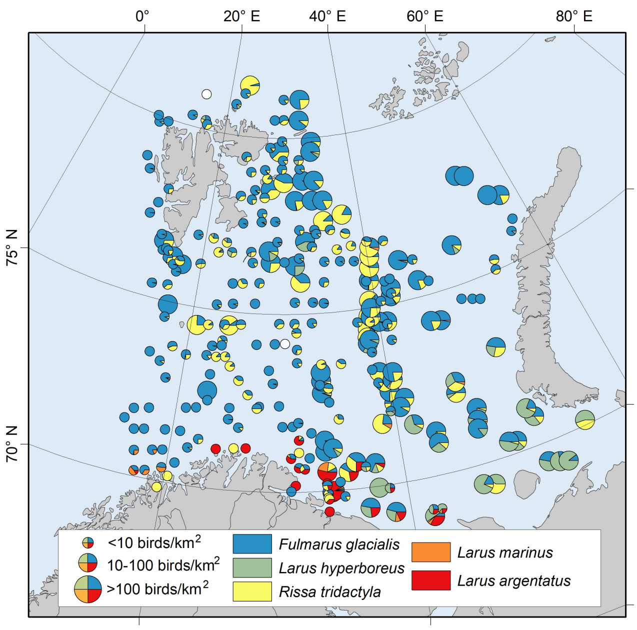

Figure 12.2.2. *Density of the most common gull species and Northern fulmar along seabird transects in 2022. White-filled circles are zero density. Note that because these species are attracted to and tend to follow the ship, densities are systematically over-estimated.*

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