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2

2019

Joint Report Series

Survey report from the joint Norwegian/Russian Ecosystem Survey in the Barents Sea and adjacent waters, August–October 2018

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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 of abiotic and biotic factors and changes of these in the Barents Sea ecosystem. 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 Knipovich Polar Research Institute of Marine Fisheries and Oceanography (PINRO) in Russia. The general survey plan and tasks are agreed upon at the annual IMR-PINRO Meeting in March. Ship routes and other technical details are agreed on by correspondence between the survey coordinators. BESS aims to cover the entire, ice-free area of the 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 index estimation, and additional acoustic transects for the capelin stock size estimation. Due to technical problems, deviations from the general design resulted in reduced coverage of the survey area in 2018. The 16-th joint Barents Sea autumn ecosystem survey (BESS) was carried out during the period from 13-th August to 04-th October 2018 by the Norwegian research vessels: “G.O. Sars”, “Johan Hjort”, and “Helmer Hanssen”, and the Russian vessel “Vilnyus”. Survey coordinators in 2018 was Dmitry Prozorkevich (PINRO) and Geir Odd Johansen (IMR). Two Russian experts participated in the Norwegian vessels in 2018. We would like to express our sincere gratitude to all the crew and scientific personnel onboard RVs “Vilnyus”, “G.O. Sars”, “Johan Hjort” and “Helmer Hanssen” for their dedicated work, as well as all the people involved in planning and reporting of BESS 2018. Photos and video documentation of the survey routines was taken at Norwegian vessels to start building up a freely available collection of documentation of the methods used at BESS. This report is a summary of the observations and status assessments based on the survey data. Further interpretation on drives, trends and consequences will be reported by ICES WGIBAR and other ICES working group reports.

Innhold

RV Helmer Hanssen, north of Svalbard October 2018. Photo GI. van der Meeren, IMR.

1 Background

Text by: G.O. Johansen and D. Prozorkevich

The aim of the joint Norwegian/Russian ecosystem survey in the Barents Sea and adjacent waters, August-October (BESS) is to monitor the status of abiotic and biotic factors and changes of these in the Barents Sea ecosystem. 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 Knipovich Polar Research Institute of Marine Fisheries and Oceanography (PINRO) in Russia.The general survey plan and tasks are agreed upon at the annual IMR-PINRO Meeting in March. Ship routes and other technical details are agreed on by correspondence between the survey coordinators.BESS covers the entire, ice-free area of the Barents Sea and usually progresses 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), some additional bottom trawl hauls for demersal fish survey index estimation, and additional acoustic transects for the capelin stock size estimation. The general survey design can be seen in figure 2.1. Deviations from the general design are described in chapter 2 of this report. The 16-th joint Barents Sea autumn ecosystem survey (BESS) was carried out during the period from 13-th August to 04-th October 2018 by the Norwegian research vessels: “G.O. Sars”, “Johan Hjort”, and “Helmer Hanssen”, and the Russian vessel “Vilnyus”. Survey coordinators in 2018 was Dmitry Prozorkevich (PINRO) and Geir Odd Johansen (IMR). Two Russian experts participated in the Norwegian vessels in 2018. The scientists, technicians and guests taking part in the survey onboard the research vessels are listed in Table 1 below. We would like to express our sincere gratitude to all the crew and scientific personnel onboard RVs “Vilnyus”, “G.O. Sars”, “Johan Hjort” and “Helmer Hanssen” for their dedicated work, as well as all the people involved in planning and reporting of BESS 2018.Photos and video documentation of the survey routines was taken at Norwegian vessels to start building up a freely available collection of documentation of the methods used at BESS. This report is a summary of the observations and status assessments based on the survey data. Further interpretation on drives, trends and consequences will be reported by ICES WGIBAR and other ICES working group reports.

Table 1. *Vessels and participants in the Barents Sea Ecosystem Survey 2018.*

Research vessel	Participants
”*Vilnyus*” (13.08–03.10)	Krivosheya P.V. (Cruise leader), Amelkin A.V., Gubanishchev M.A., Harlin S.N., Klepikovsky R.N., Nosov M.A., Nosova T.B., Pankova N.V., Uzbekova O.R., Kalashnikova M.U., Zhurbyk T.V., Kanischev A.A., Alexandrov D.I.
”*G.O. Sars*” (07.09–30.09)	Part 1 (07.09-18.09) Sigbjørn Mehl (Cruise leader), Olga Zimina, Anne Kari Sveistrup, Malin Lie Gulbrandsen, Anthony Mayer, Terje Haugland, Stine Karlson, Frøydis Tousgaard Rist Bogetveit, Alina Rey, Gaston Ezequiel Aguirre, Hilde Elise Heldal, Anders Fuglevik, Atle Børje Rolland, Irene Huse, Erlend Langhelle, Marita Larsen, Yasmin Hunt, Egil Frøyen, Holly Ann Perryman, Erlend Astad Lorentzen, Trevor Charlton, Tatiana Prokhorova. Part 2 (19.9-29.9) Elena Eriksen (Cruise leader), Trevor Charlton, Tatiana Prokhorova, Louise Kiel Jensen, Berengere Husson, Atle Børje Rolland, Irene Huse, Erlend Langhelle, Marita Larsen, Yasmin Hunt, Egil Frøyen, Felicia Keulder-Stenevik, Lyubov Zakharova, Frederike Böhm, Martin Dahl, Inger Henriksen, Monica Martinussen, Marita Helgesen, Anders Fuglevik, Hilde Elise Heldal, Henry David Seal.
”*Johan Hjort*” (2 2 .08-04.10)	Part 1 (22.08-11.09) Jane Aanestad Godiksen (Cruise leader), Robert Andrè Johansen, Eirik Odland, Jarle Vedholm, Hildegunn Mjanger, Helene Sørensen, Trude Hauge Thangstad, Thomas Sivertsen, Fredrik Eugen Otterlei Madsen, Reidar Johannesen, Jaime Alvarez, Anne Liv Johnsen, Julio Erices, Jan Henrik Simonsen, Guri Nesje, Grethe Tveit, Natalia Zhuravliova, George McCallum, Jon Ford. Part 2 (13.09-04.10) Georg Skaret (Cruise leader), Natalia Zhuravliova, George McCallum, Andrey Voronkov, Arne Storaker, Janicke Skadal, Anja Helene Alvestad, Trude Hauge Thangstad, Frode Holen, Ove Misje Aakre, Bjarte Kvinge, Benjamin Marum, Jaime Alvarez, Justine Diaz, Eilert Hermansen, Jon Rønning, Hilde Arnesen, Jon Ford.
“*Helmer Hanssen*” (14.09-02.10)	Randi Ingvaldsen (Cruise leader), Natalia Strelkova, Heidi Gabrielsen, Grethe Hillersøy, Gunnar Langhelle, Else Holm, Gro van der Meeren, Gunnar Rikardsen, Arne Liaklev, Jarle Kristiansen, Sindre Nygård Larsen, Jostein Røttingen, Espen Bagøien, Jane Strømstad Møgster, Eirik Grønningsæter, Julie Brekkås, Edvin Fuglebakk.

2 Survey execution 2018

Text by: G.O. Johansen and D. Prozorkevich

Figures by: G.O. Johannesen and J. Alvarez

BESS 2018 was planned to progress according to the "standard scheme", from south to north. The survey map with planned stations and vessel tracks are presented in figure 2.1.

It was decided to keep all the main tasks of the survey similar to previous years. In addition, an extended part of the pollution monitoring was conducted on the Norwegian side, including sampling at the site of the sunken submarine "Komsomolets" (Fig 2.1). This monitoring is conducted every third year. The standard oceanography sections Vardø-Nord, Sørkapp-Vest, and a test section, Hinlopen strait, was sampled as part of the Norwegian survey effort and the standard Kola section as part of the Russian effort.

The BESS 2018 survey coverage was limited, leaving a large part of the Russian zone, as well as a smaller part between Bear Island and Svalbard (Spitsbergen) uncovered. This constitutes about 1/3 of the planned survey coverage (Fig. 2,2 and 2.3). There were several reasons for this lack of survey coverage. The Russian vessel "Vilnyus" had planned to work 52 vessel-days, but due technical problems, it had to return to port twice. Thus, the actual vessel-days was reduced to only 29 days and most of the south-eastern part of the survey area in REEZ was not covered. Bad weather conditions prevented the G.O. Sars in completely covering the survey area between Bear Island and Svalbard (Spitsbergen). In addition, "G.O. Sars" carried out additional pollution sampling, requiring more time than planned before the survey.

The effect of this coverage problems was dramatic and resulted in poor data for estimation of e.g. the 47-year long time series of 0-group indices, and the survey index for important 0- group species could not be calculated. All the other ecosystem monitoring time series is also hampered by this lack of survey coverage. However, the capelin distribution area was well covered in the last half of the survey and the stock assessment was successful.

The resulting survey coverage was; RV "Vilnyus" covered the Loophole and only the northern part of REEZ in the Barents Sea. The Norwegian RVs covered the NEZ of the Barents Sea, with "Johan Hjort" in south and northeast, "G.O. Sars" in the central parts, and "Helmer Hanssen" in the areas west, north and northeast of Svalbard (Spitsbergen). The effective vessel days in 2018 amounted to 110 days. The realized research vessel tracks and trawl stations for the 2018 ecosystem survey are shown in Figure 2.2. Hydrography and plankton stations are shown in Figure 2.3.

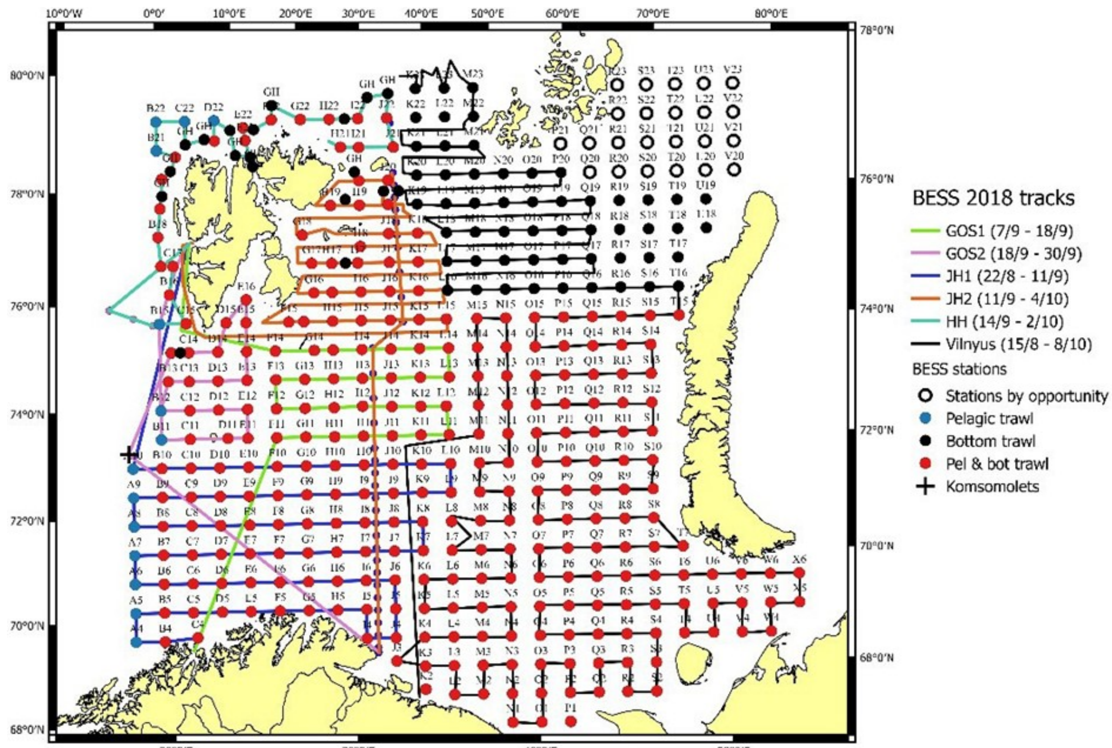

Figure 2.1 *BESS 2018, planned survey map with ecosystem stations and vessel tracks.*

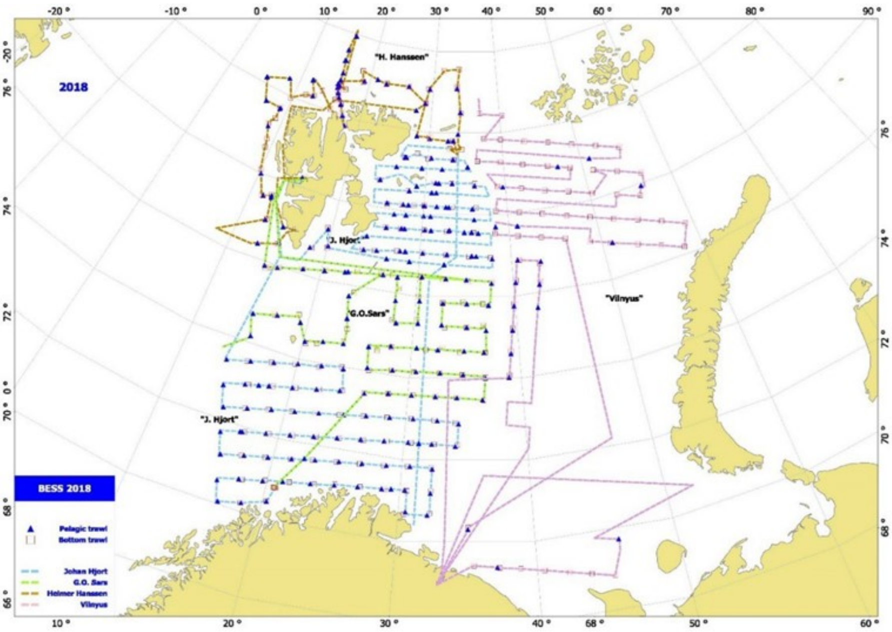

Figure 2.2 *BESS 2018, realized vessel tracks with pelagic and bottom trawl sampling stations, note that some trawl stations are taken in addition to the regular ecosystem stations.*

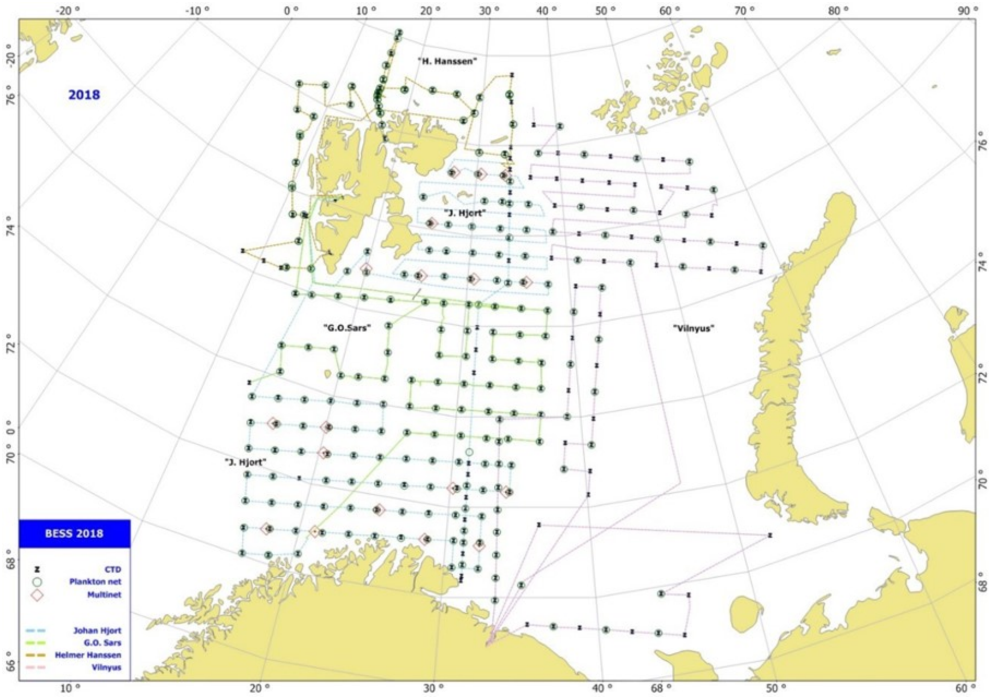

Figure 2.3 *BESS 2018, realized vessel tracks with hydrography and plankton samples at ecosystem stations.*

2.1 Sampling methods

The sampling manual for this survey has been developed since 2004 and published on the Ecosystem Survey homepage by specialist and experts from IMR and PINRO (http://www.imr.no/tokt/okosystemtokt_i_barentshavet/sampling_manual/nb-no).

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

The trawl rigging on both bottom trawl (Campelen-1800) and pelagic trawl (Harstad) at Norwegian vessels was changed in BESS 2017 and continued in 2018. All Norwegian vessels were equipped with semi-pelagic trawl doors of type "Tyborøn 7a". In addition, the sweeps were changed from steel wire to Dynema wire. This was done to standardize the rigging on all vessels and to accommodate the use of only one type of doors on each vessel. For the pelagic trawl, the sweep length was reduced, and the amount of flotation was increased, to ensure similar the same behaviour of the trawl as earlier. Russian vessels used the same equipment as previously. The Campelen-1800 trawl and Harstad trawl with semi-pelagic trawl doors "Sparrow" V=5.0 m^2.

There were some indications that the new rigging of the pelagic trawl led to problems positioning the trawl in the medium depth (20 m) during 0-group hauls. It was investigated at a gear technology survey in December 2018, after BESS 2018 is finished. The results of this work will be available as a survey report at IMR.

Contact: A. Engås, IMR (aril.engaas@hi.no) *and D. Prozorkevich,PINRO* (dvp@pinro.ru*).*

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 2018, with contact persons.

2.2.1 *Fish pathology research*

PINRO undertakes yearly investigations of fish diseases and parasites in the Barents Sea (mainly in REEZ). The main purpose of the fish pathology research is annual estimation of epizootic state of commercial fish species. The observations are entered into a database on fish and pathology. This investigation was started by PINRO in 1999. Results are available in the report of the ICES Working Group on Pathology and Diseases of Marine Organisms (WGPDMO).

Contact: Tatyana Karaseva, PINRO.(karaseva@pinro.ru)
Link to more information:
http://www.ices.dk/community/groups/Pages/WGPDMO.aspx
https://www.amazon.com/Barents-Sea-Ecosystem-Management-Cooperation/dp/8251925452 (pp. 743-749)

2.2.2 *Environmental DNA*

BESS 2018 provided water samples from CTD casts at ecosystem stations west and north of Svalbard (Spitsbergen). These samples are used for detecting eDNA from of snow crab in the western parts of the Barents Sea.
Contact: C. Hvingel IMR. (Carsten.Hvingel@hi.no)

2.2.3 *Samples of 0-group herring*

BESS 2018 provided frozen samples of 0-group herring from 7-8 selected areas distributed in the Norwegian part of survey area. The aim is to establish the presence of distinct groupings within the 0-group Norwegian spring-spawning herring using otolith micro- chemistry and micro-structure analysis. This is continued from 2017.

Contact: O. Kjesbu, IMR. (olav.kjesbu@hi.no)

2.2.4 *Isotope study of the Barents Sea food web*

This is part of an IMR coordinated project describing the food web of the Barents Sea. The aim is to collect isotope data from all parts of the ecosystem (fish, benthos, zooplankton, marine mammals etc.). At BESS 2018 we sampled selected macroplankton and benthos species, which will be used for establishing a base line for the food web.

*Contact: K. MacKenzie, IMR. (*Kirsteen.MacKenzie@hi.no *)*Invertebrate benthos for bioprospecting

BESS 2018 provided frozen samples of selected species and groups of benthos to MARBANK, IMR.

Contact: R. A. Johansen, IMR. (robertj@hi.no)

2.2.5 Hinlopen strait standard section

This is a continuation of the standard section established by the SI_ARCTIC project at IMR in the period 2014-2017. The section was taken from the Hinlopen strait an northwards into the Arctic Ocean. The sampling included CTD, plankton nets and fish trawls (Fig 1 and 2).

Contact: R. Ingvaldsen, IMR. (Randi.ingvaldsen@hi.no)

2.2.6 Macro-zooplankton trawl

A trawl for taking samples of krill, amphipods, mesopelagic fish, jellyfish etc. in the water column down to about 800-1000 m depth was tested at BESS 2018.

Contact: E. Bagøien, IMR. (espen.bagoien@hi.no)

2.2.7 Micro plastics

Sampling of micro plastics with Manta trawl in the surface was tested on Norwegian vessels only. The purpose is to establish standard monitoring of micro plastic in the Barents Sea.

Contact: B. E. Grøsvik, IMR. (bjoern.einar.groesvik@hi.no)

2.2.8 Optical species determination (DeepVision)

An optic system on the pelagic trawl to provide visual observations of fish in a vertical profile was tested out at RV Johan Hjort in the capelin area east of Svalbard (Spitsbergen). The purpose is to visually separate between capelin and polar cod and estimate their size composition to improve acoustic characterization of these two species.

Contact: G. Skaret, IMR. (georg.skaret@hi.no)
Link to more information: https://www.deepvision.no/

2.2.9 Pollutants in snow crab

Frozen samples of 25 individuals of snow crab of commercial size were provided to analyse the occurrence of pollutants.

Contact: M. Wiech, IMR. (Martin.Wiech@hi.no)

2.2.10 Micro plastics in the food web

Frozen samples of sediment living benthos, cod, shrimp, and zooplankton were provided to analyse the occurrence of micro plastic in the food web of the Barents Sea.

*Contact: B. E. Grøsvik, IMR (*bjoern.einar.groesvik@hi.no *)*

2.2.11 *Genetic studies of polar cod*

Frozen samples of polar cod were provided from Norwegian vessels in the areas around Svalbard (Spitsbergen) and in the capelin area. This was done to test population genetic structure of this species in the Barents Sea.

Contact: T. Johansen, IMR (torild.johansen@hi.no)

2.2.12 *Pollutants in deep water fish*

Frozen samples of Greenland halibut, deepwater redfish, and golden redfish from selected areas were provided from Norwegian vessels to analyse the occurrence of pollutants.

Contact: G. K. Bjørneset (geir.kristian.bjoerneset@hi.no) *and B. Nilsen, IMR*

2.2.13 *Genetic studies of Gadoid fish*

Tissue samples from cod, haddock, pollock, saith and whiting were provided for genetic analyses related to mapping of spawning and nursery areas for coastal commercial stocks.

Contact: S. Heiberg Espeland (Sigurd.heiberg.espeland@hi.no) *and I. K. Mellerud, IMR*

2.2.14 *Provenance studies of cod and haddock*

Frozen tissue samples from cod and haddock of commercial size were provided for a baseline isotopic determination of how commercial fishes from different areas look isotopically. This is part of an investigation into isotopic methods for determining the area of origin of commercial fish sold in the marked.

Contact: E. Olsen, IMR (erik.olsen@hi.no) *and C. Trueman, University of Southampton*

2.2.15 *Water samples for ocean acidification studies*

BESS 2018 provided water samples for analysis of ocean acidification from Norwegian vessels along the Vardø-Nord hydrographic section.

Contact: M. Chierici, IMR.(Melissa.Chierici@hi.no)

3 DATA MANAGEMENT

Text by: G.O. Johansen and D. Prozorkevich

3.1 Databases

A wide variety of data are collected during the ecosystem surveys. All data collected during the ecosystem survey are quality controlled and verified by specialists 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).

Age readings and fish stomach analyses will be finished by April 2019 and the data will be subsequently downloaded to the joint databases.

A joint database ("Sjømil") for aggregated time series is accessible as a web resource; http://www.imr.no/sjomil/index.html.

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 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 ICES working groups (AFWG, WGWIDE, NIPAG, WGCRAB, WGMME, WGIBAR, WGZE, WGOH and WGPDMO) as well as the Norwegian ecosystem status report on selected indicators from the Norwegian EEZ of the Barents Sea.

This survey report is based on joint data and contains the main results of the monitoring. The survey report is published on the BESS web page (https://www.hi.no/tokt/okosystemtokt_i_barentshavet/survey_reports/nb-no), and will be assembled into a complete pdf-report when the main components are completed. This web page is dedicated to collating all information from the BESS, including all the previous reports, maps, etc. It will also include post-survey information, not included in the written report (e.g. plankton and fish stomach samples which need longer processing time). These additional data will be included into the web-based report when ready.

3.3 Time series of distribution maps

Maps from this and previous year's surveys can be found at: https://www.hi.no/tokt/okosystemtokt_i_barentshavet/utbredelseskart/nb-no. Some groups are missing but will be published when available.

4 MARINE ENVIRONMENT

4.1 Hydrography

Text by: A. Trofimov and R. 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 are shown 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 1931–2010.

In August–September 2018, the surface temperature was on average 1.0°C higher than the long-term mean in most of the Barents Sea (Fig. 4.1.1.9). The largest positive anomalies (>2.0°C) were mainly observed in the south-eastern part of the sea as well as west and north of the Spitsbergen Archipelago. Small negative anomalies took place mostly in some areas in the south-western Barents Sea. Compared to 2017, the surface temperature was higher (by 1.0°C on average) in southern and northern parts of the surveyed area, especially north of the Spitsbergen Archipelago, and lower (by 0.7°C on average) in the western and central Barents Sea, especially west of the Spitsbergen Archipelago.

Arctic waters were, as usual, most dominant in the 50–100 m layer north of 77°N (Fig. 4.1.1.3 and 4.1.1.5). The temperatures at depths of 50 and 100 m were higher than the long-term mean (on average, by 1.1 and 0.7°C respectively) in most of the Barents Sea. Small negative anomalies were mainly found at 100 m depth in some small areas in the northern part of the surveyed area. Compared to 2017, the 50m temperature was higher (on average, by 0.9°C) in about two thirds of the surveyed area with the largest differences in the northernmost part of the sea; negative differences (on average –0.6°C) prevailed in the western Barents Sea. The 100m temperature was lower (on average, by 0.4°C) than in the previous year in about half the surveyed area, mainly in its western and eastern parts. The rest area was occupied by positive differences in 100 m temperature between 2018 and 2017 (on average, 0.4°C) with the largest values east of the Spitsbergen Archipelago.

The bottom temperature was in general 0.8°C above the average in most of the Barents Sea (Fig. 4.1.1.10). Negative anomalies (–0.4°C on average) were only observed east of the Spitsbergen Archipelago. Compared to 2017, the bottom temperature was on average 0.4°C lower in two thirds of the surveyed area. Bottom waters were warmer (on average, by 0.6°C) than in 2017 mainly in the northern sea, especially east of the Spitsbergen Archipelago. In August–September 2018, the area occupied by water with temperatures below zero was larger than in the previous year.

The surface salinity was on average 0.5 higher than the long-term mean in most of the Barents Sea with the largest positive anomalies (>0.8) in the northern part of the sea (Fig. 4.1.1.11). The positive anomalies decreased southwards. Negative anomalies (–0.1 on average) were mainly observed in the southernmost and southwestern parts of the sea. In August–September 2018, the surface waters were on average 0.5 saltier than in 2017 in two thirds of the surveyed area with the largest positive differences in the northern Barents Sea and north of the Spitsbergen Archipelago. Negative differences in salinity between 2018 and 2017 (lower than –0.1) were found in the central, northeastern, western and southwestern parts of the sea.

The bottom salinity was close to both the average and that in 2017 in most of the Barents Sea (Fig. 4.1.1.12). Positive anomalies of higher than 0.1 took place in shallow waters over the Spitsbergen Bank. Significant negative anomalies were mainly found in coastal waters in the southwestern and southern Barents Sea as well as in shallow waters east of the Spitsbergen Archipelago. As to differences in bottom salinity between 2018 and 2017, significant negative values were found in the area between the Spitsbergen Archipelago and Bear Island.

4.1.2 Standard sections

Table 4.1.2.1 (Appendix, Ch 4) 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. In 2018, the Vardø–North Section was sampled all the way to about 81º35’N, but unfortunately the part covering the main Atlantic inflow were not sufficient sampled to calculate mean values for Table 4.1.2.1. The mean Atlantic Water (50–200 m) temperature in the Fugløya–Bear Island Section was 0.1°C higher than the long-term mean for the period 1965–2018 (Table 4.1.2.1) and 0.4ºC lower than in 2017.

4.1.3

The Kola and Kanin Sections cover the flow of Coastal and Atlantic waters in the southern Barents Sea. In August–September 2018, the Kanin Section was not carried out. The mean temperature of Atlantic waters in the central part of the Kola Section (upper, intermediate and deeper layers) in August 2018 was 0.8–1.1°C higher than the average (for the period 1951–2010) that was typical of warm (upper layer) and anomalously warm (intermediate and deeper layers) years; the anomalies increased with depth. The mean temperature of Atlantic waters in the outer part of the section (upper, intermediate and deeper layers) in August 2018 was 1.2–1.4°C higher than the average (for the period 1951–2010) that was typical of anomalously warm years. Compared to 2017, the active layer (0–200 m) in 2018 was 0.2 and 0.6°C warmer in the central and outer parts of the section respectively. The mean salinity of Atlantic waters in the central part of the Kola Section (0–200 m) in August 2018 was 0.1 lower than the long-term (1951–2010) mean and close to that in the previous year. In the outer part of the section, the Atlantic water salinity was close to both the average and that in 2017.

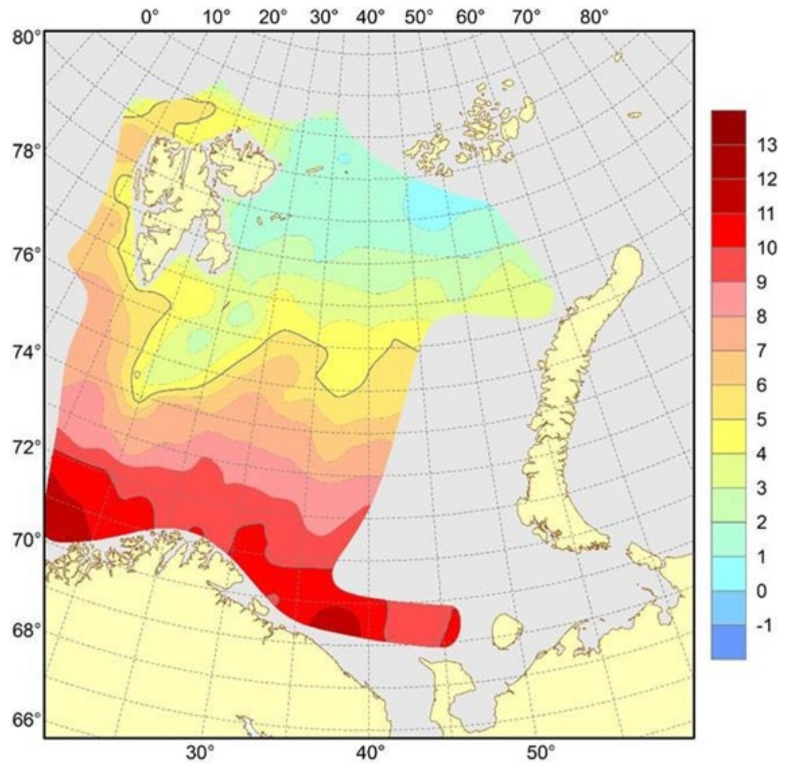

Figure 4.1.1.1 *Distribution of surface temperature (°C), August–September 2018.*

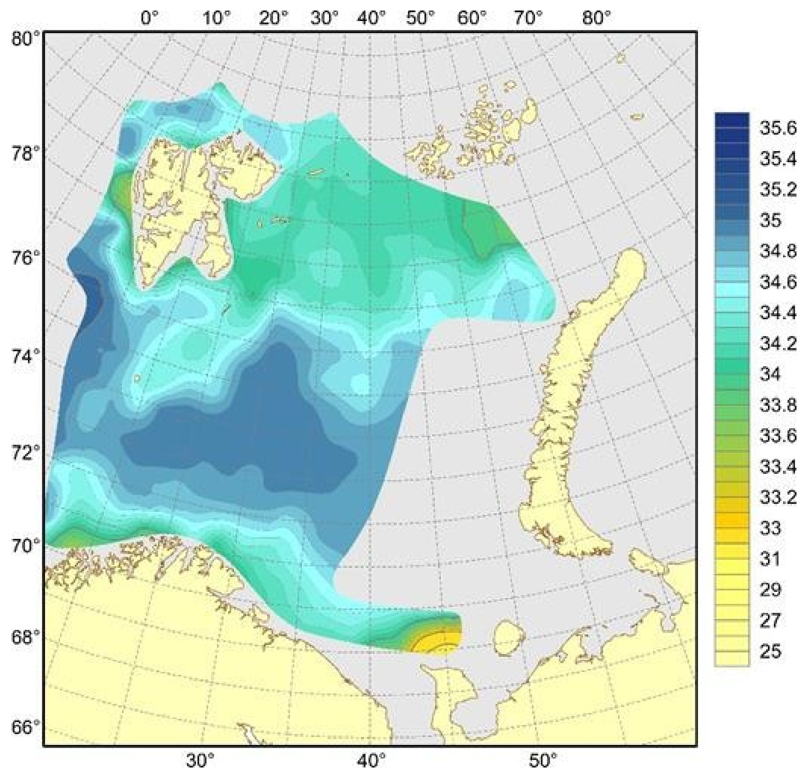

Figure 4.1.1.2. *Distribution of surface salinity, August–September 2018.*

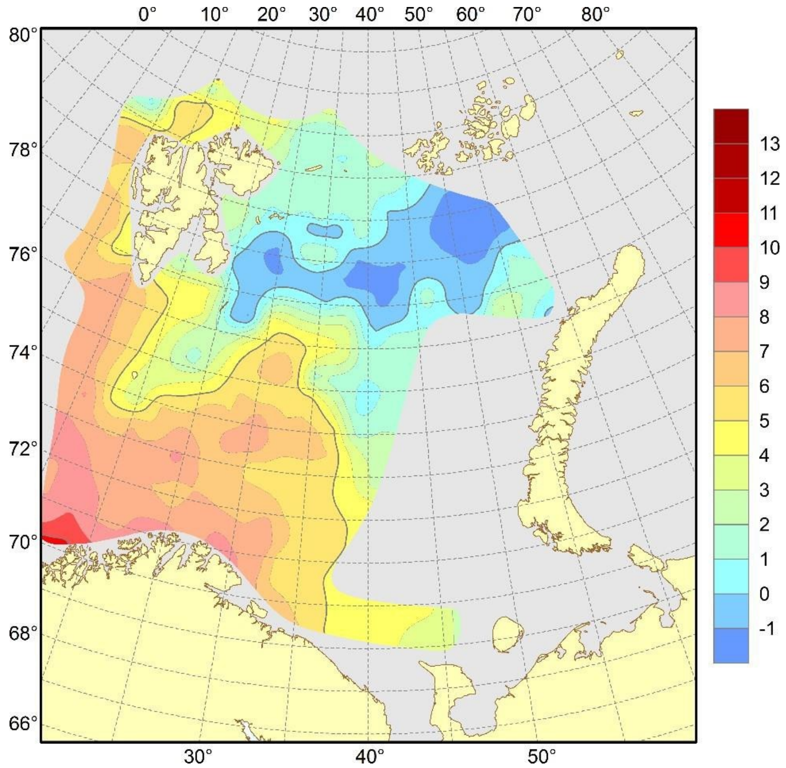

Figure 4.1.1.3. *Distribution of temperature (°C) at the 50 m depth, August–September 2018.*

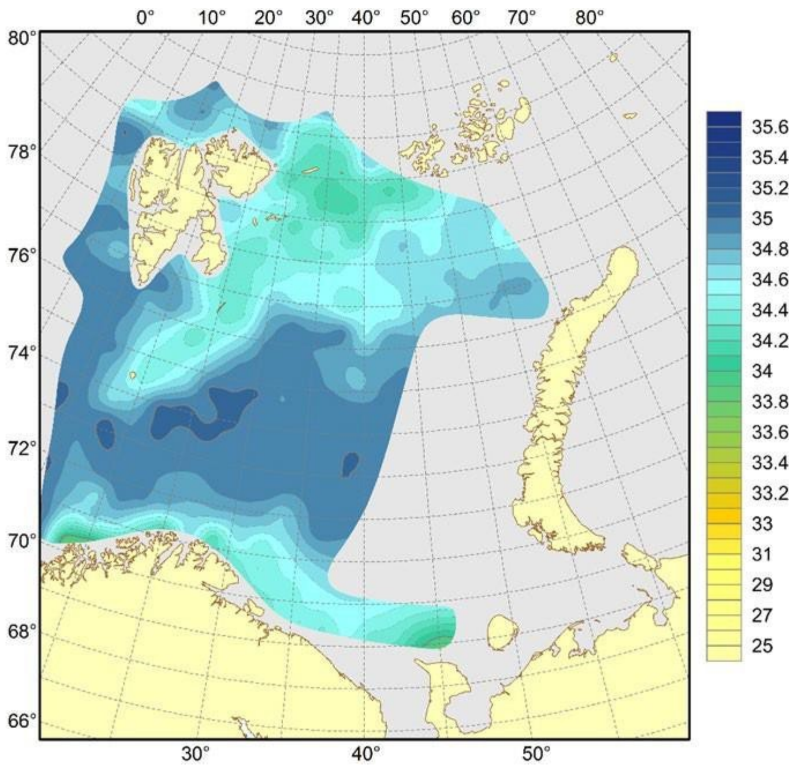

Figure 4.1.1.4. *Distribution of salinity at the 50 m depth, August–September 2018.*

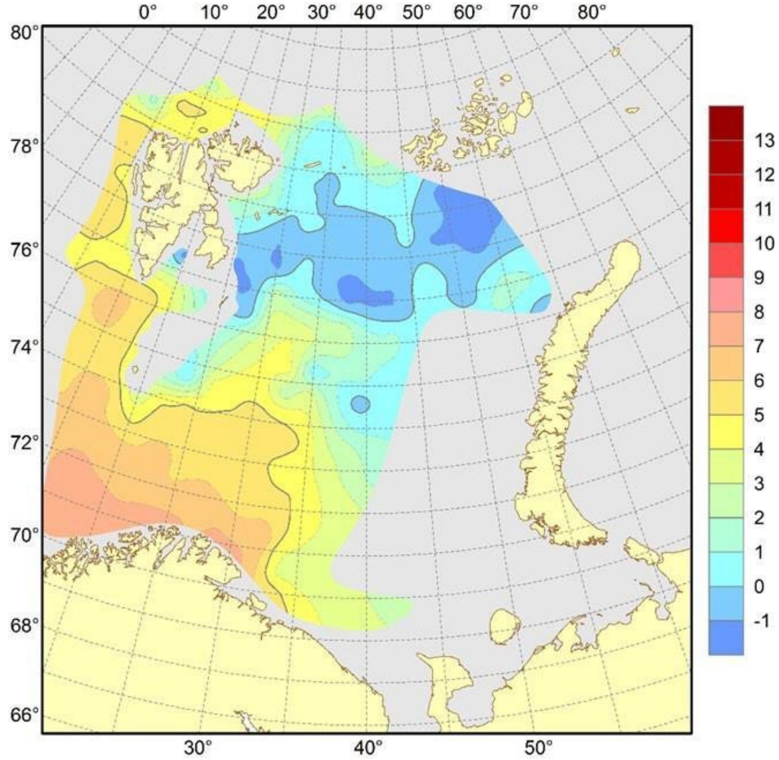

Figure 4.1.1.5. *Distribution of temperature (°C) at the 100 m depth, August–September 2018.*

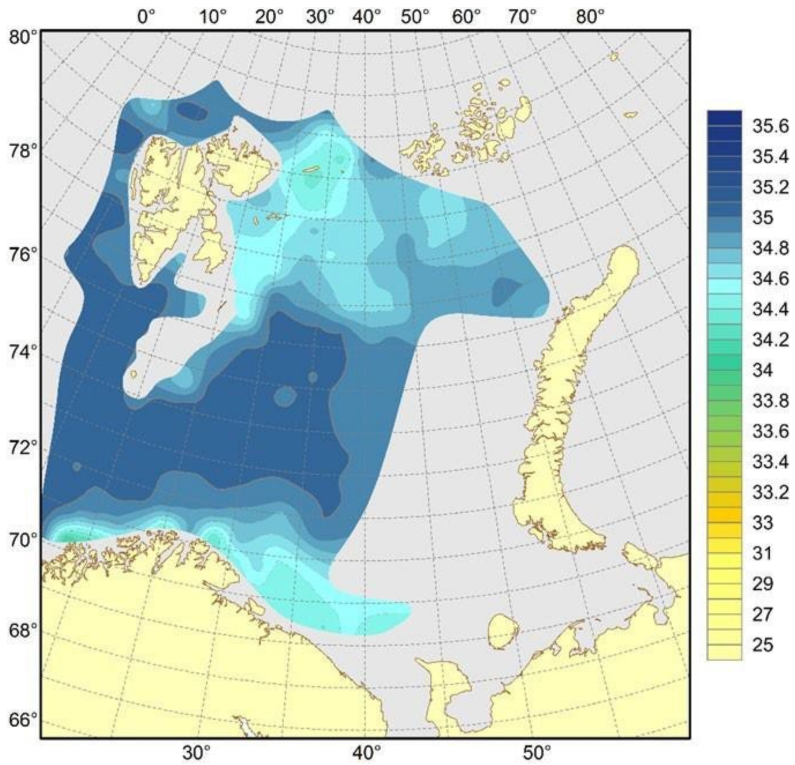

Figure 4.1.1.6. *Distribution of salinity at the 100 m depth, August–September 2018.*

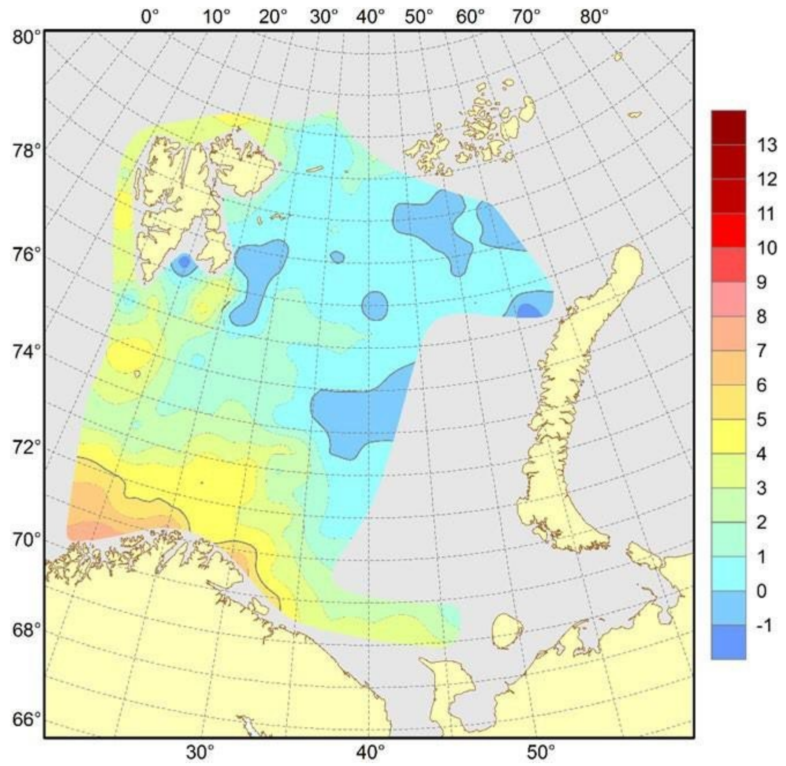

Figure 4.1.1.7. *Distribution of temperature (°C) at the bottom, August–September 2018.*

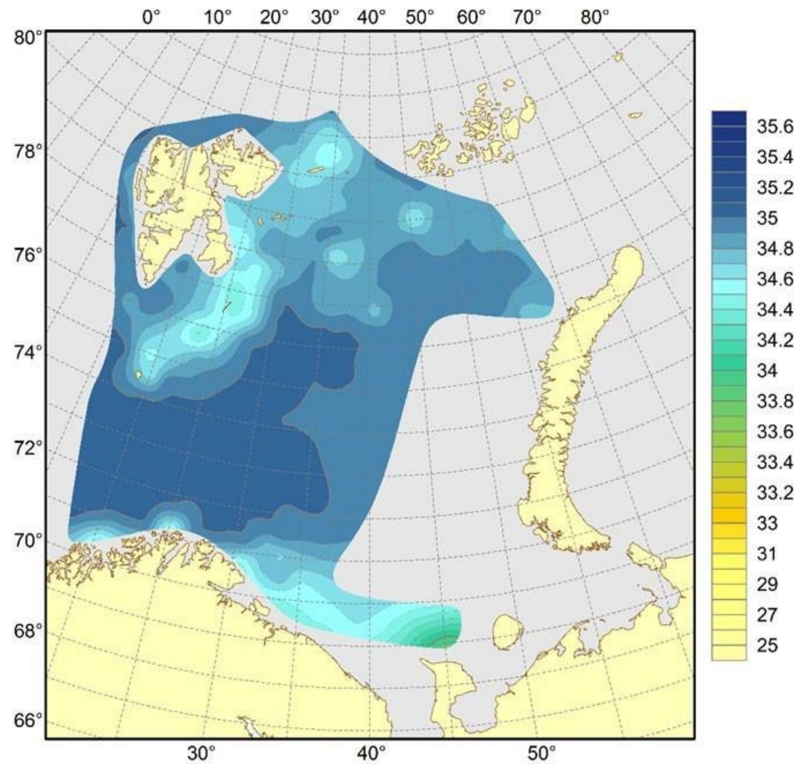

Figure 4.1.1.8. *Distribution of salinity at the bottom, August–September 2018.*

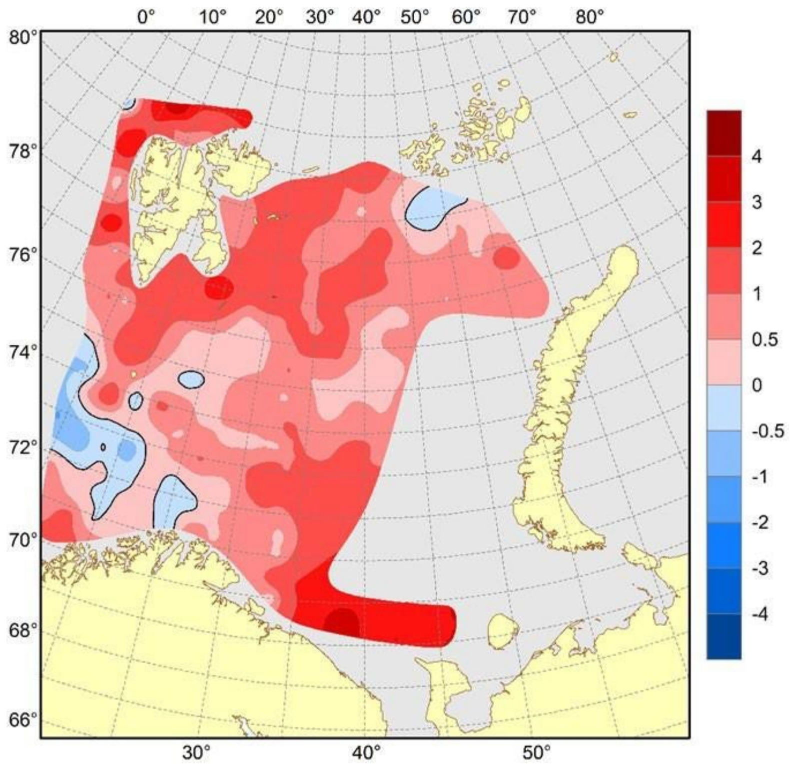

Figure 4.1.1.9. *Surface temperature anomalies (°C), August–September 2018.*

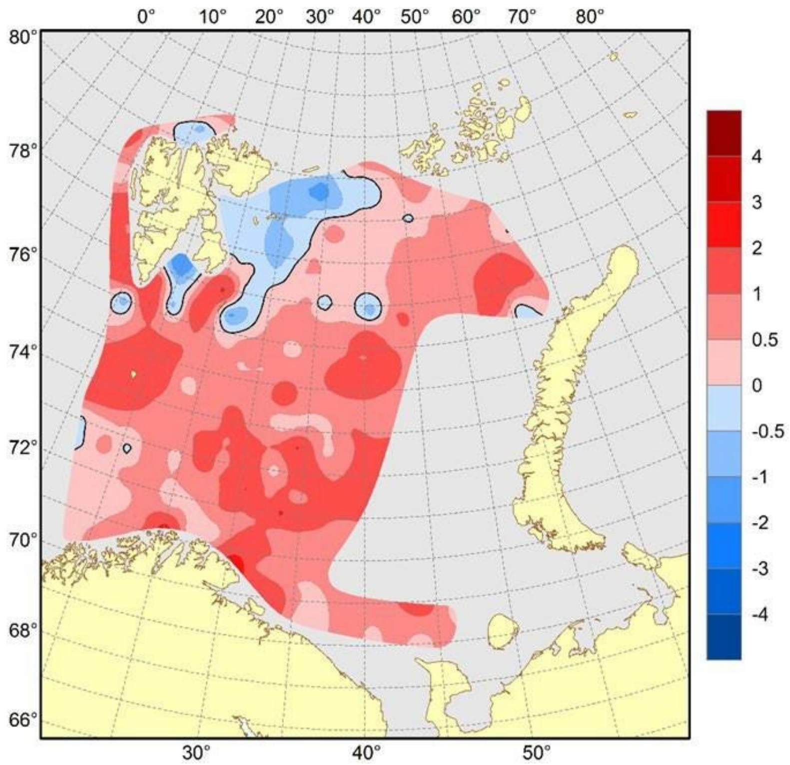

Figure 4.1.1.10. *Temperature anomalies (°C) at the bottom, August–September 2018.*

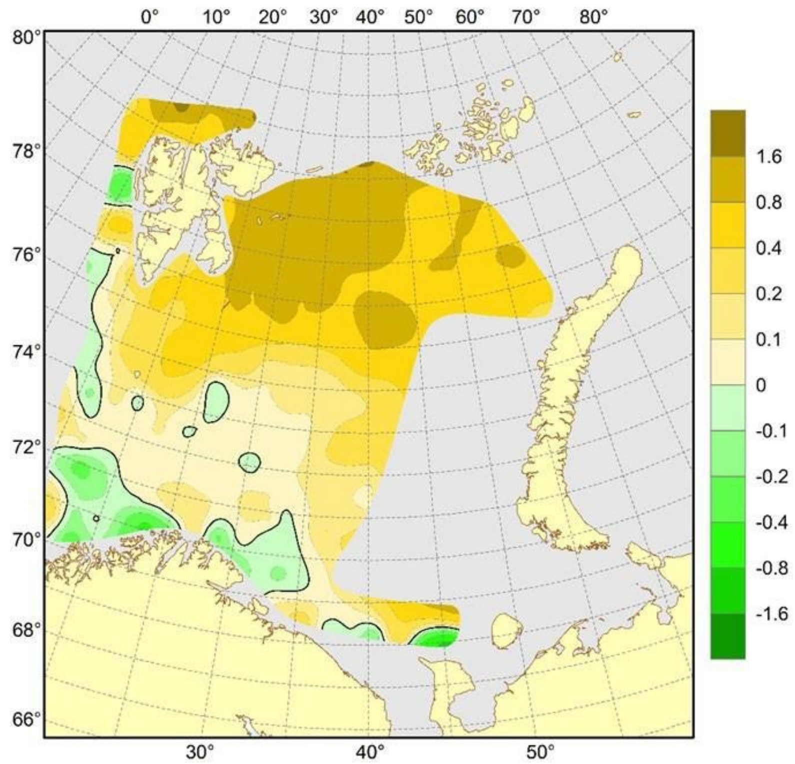

Figure 4.1.1.11. *Surface salinity anomalies, August–September 2018.*

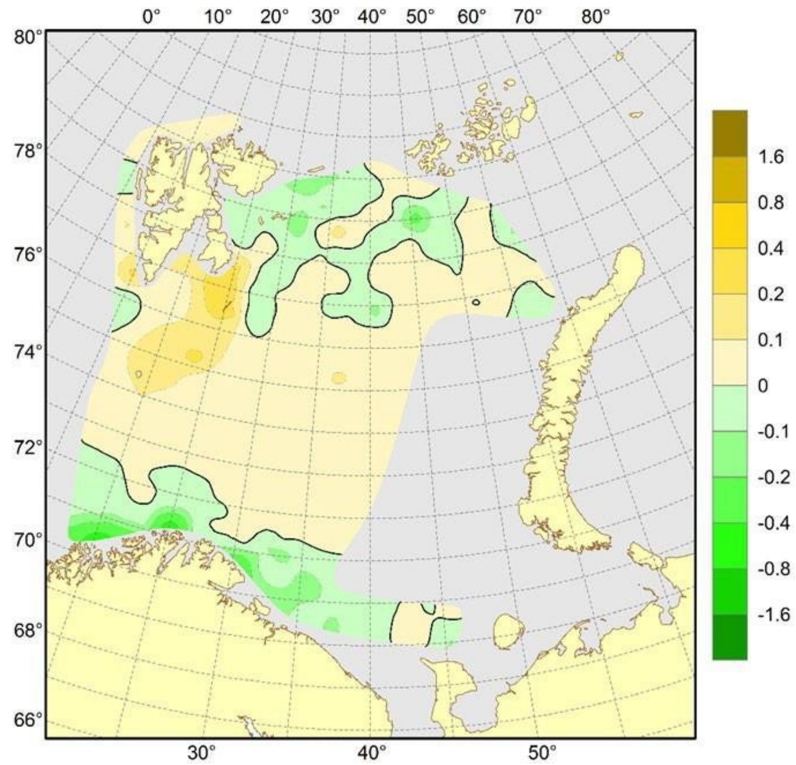

Figure 4.1.1.12. *Salinity anomalies at the bottom, August–September 2018.*

4.2 Antropogenic pollution

4.2.1 Marine litter

Text by: T. Prokhorova and B. E. Grøsvik
Figures by: Pavel Krivosheya

Anthropogenic litter on the surface (floating) and in trawls in 2018 was observed onboard all Russian and all Norwegian vessels. But due to poor coverage of the Russian zone by BESS in 2018, it is impossible to estimate distribution and some parameters, f.ex., average weight of litter in trawl. So, only maps of distribution on the observed area are present in the report, without comparison to previous years.

Plastic dominated among anthropogenic pollutants at the water surface (Fig. 4.2.1.1). Wood, paper and glass was observed singularly. Due to currents, recorded marine debris could be dumped directly in some areas and have been transported by currents from other areas.

Litter from fishery was recorded in 19.4 % of plastic litter observations at the surface (Figure 4.2.1.2). Fishery litter was represented by ropes (OSPAR code 31), string and cord (OSPAR code 32), pieces of nets (OSPAR code 115), floats/buoys (OSPAR code 37).

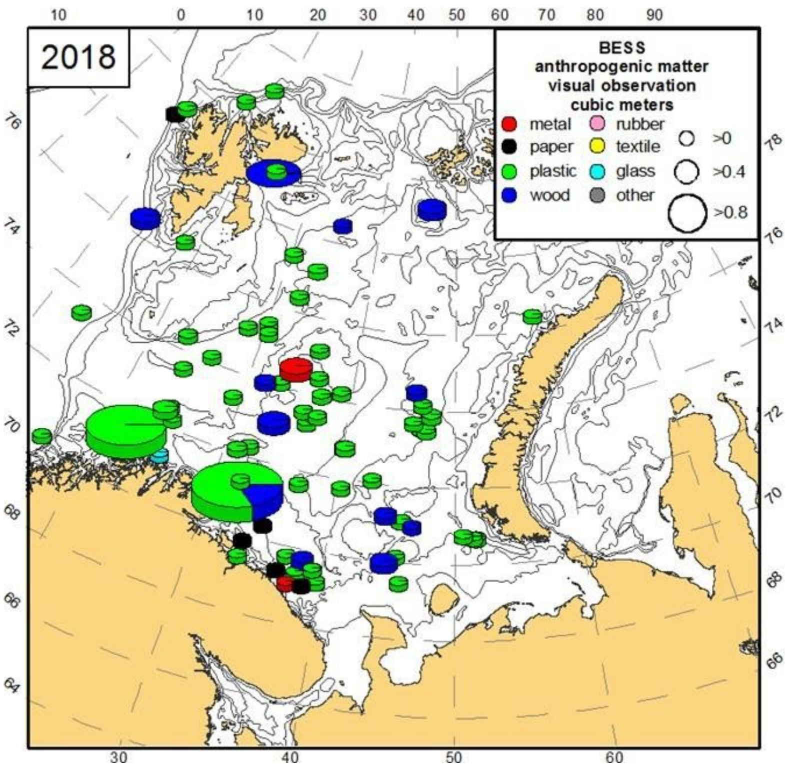

Figure 4.2.1.1 *Type of observed anthropogenic litter (m^3) at the surface in the BESS 2018.*

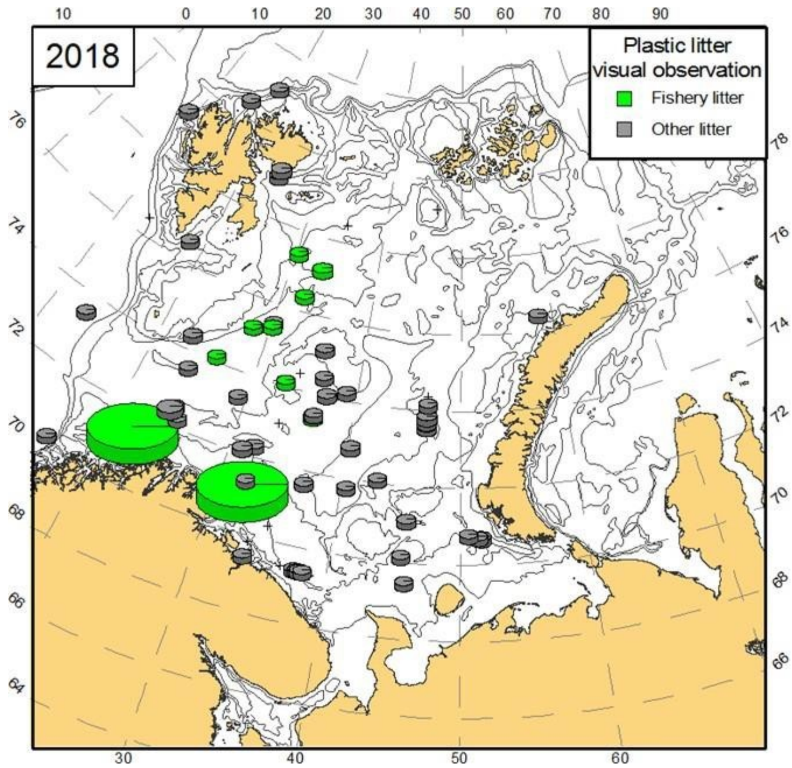

Figure 4.2.1.2 *Litter observations of plastic at the surface indicated as fishery related and other litter in the BESS 2018 (crosses – occurrences of anthropogenic litter).*

Anthropogenic litter was observed in the pelagic trawl stations, and plastic dominated from all anthropogenic matter in pelagic trawls (Fig. 4.2.1.3).

Litter was observed throughout the survey in the bottom trawl catches (Fig. 4.2.1.4). Plastic also dominated the litter content from the bottom trawls. Generally, catches of plastic litter in the bottom trawls were higher than in pelagic. Wood was registered in bycatch in the northern part of the observed area. Other types of litter were observed among the bottom trawl catches sporadically.

Litter from fishery was a significant part of plastic litter both in the pelagic and bottom trawls (Figure 4.2.1.5).

Microplastics at the surface were sampled by Manta trawl for some of the stations at the Norwegian part of BESS (Table 4.2.1).

Marine debris as bycatch in trawl. Photo: Erlend Astad Lorentzen, IMR.

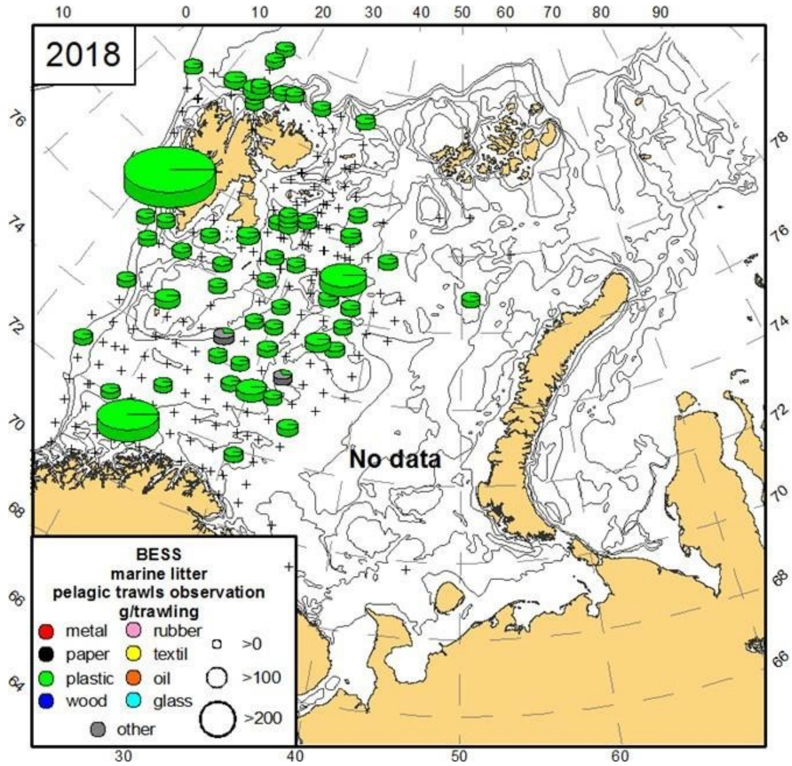

Figure 4.2.1.3 *Type of anthropogenic litter collected in the pelagic trawls (g) in the BESS 2018 (crosses – pelagic trawl stations).*

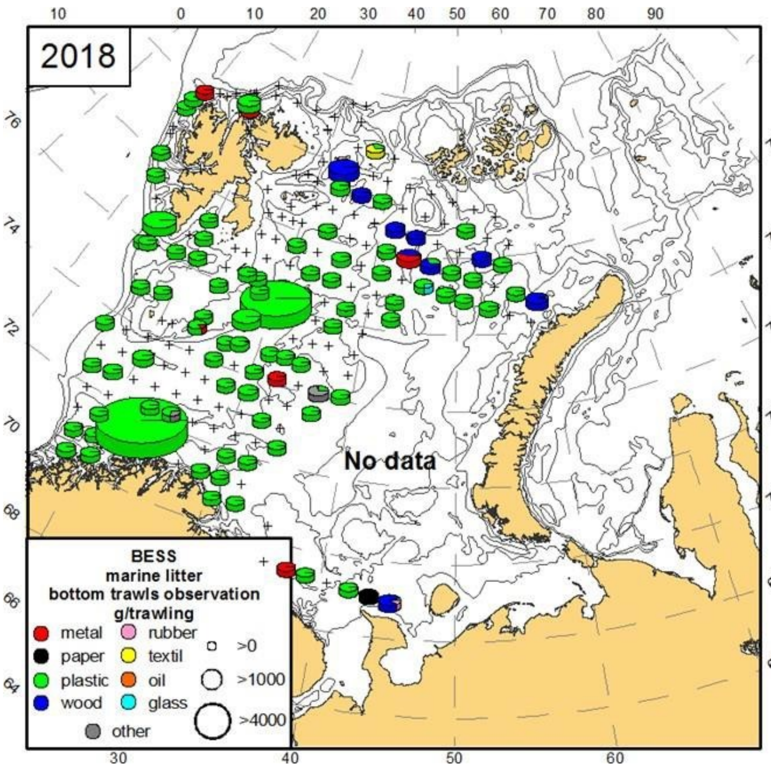

Figure 4.2.1.4 *Type of anthropogenic litter collected in the bottom trawls (g) in the BESS 2018 (crosses – bottom trawl stations).*

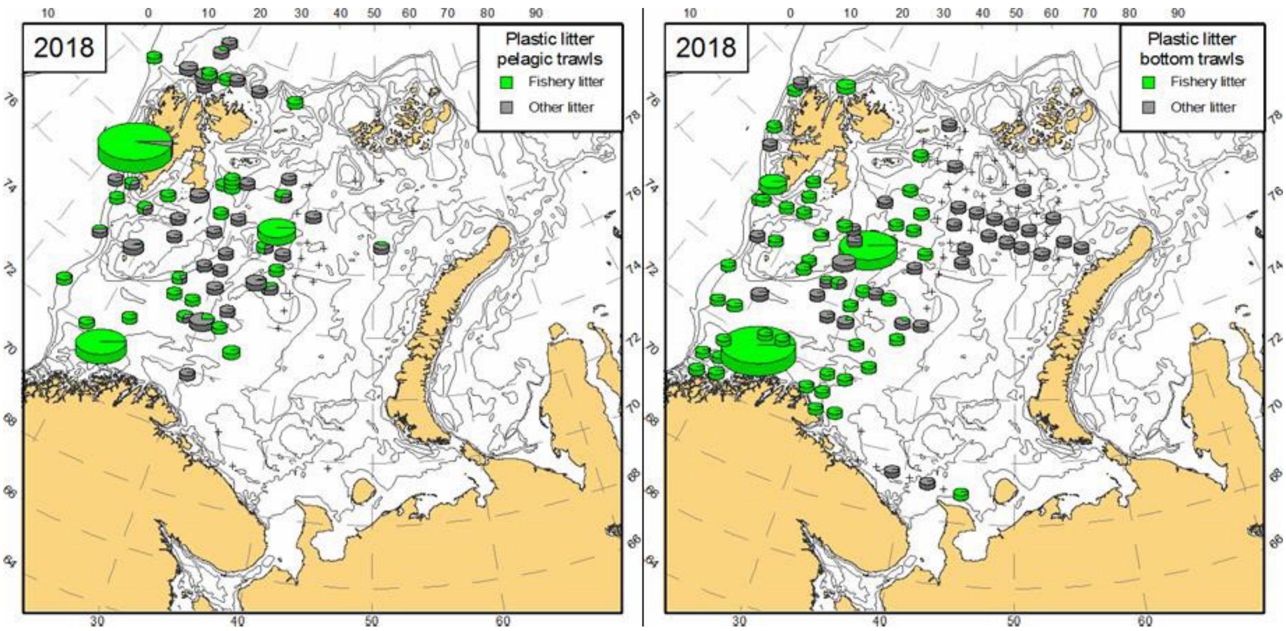

Figure 4.2.1.5 *Fishery plastic proportion among the plastic litter collected in the pelagic (to the left) and bottom trawls (to the right) in the BESS 2018 (crosses – trawl stations).*

Table 4.2.1. *Detail information of manta trawls sampling*

CruiseNo	Platform	Platform Name	Station	Year	Month	Day	Time	Latitude	Longitude	BottomDe	Equipme	EquipmentNa	SameMet	SameMet Name	MeshSize
2018838	1173	Jan Mayen/H elmer Hansen	75	2018	9	17	2205	78,0392	10,1227	178	2375	MANTA-net	101	Surface	335
2018838	1173	Jan Mayen/H elmer Hansen	77	2018	9	18	1033	79,1558	8,45217	380	2375	MANTA-net	101	Surface	335
2018838	1173	Jan Mayen/H elmer Hansen	98	2018	9	25	900	80,9387	18,9055	140	2375	MANTA-net	101	Surface	335
2018838	1173	Jan Mayen/H elmer Hansen	103	2018	9	27	800	81,156	33,7093	186	2375	MANTA-net	101	Surface	335
2018110	4174	G.O. Sars (2003-)	335	2018	9	9	1427	73,5898	30,4685	386	2375	MANTA-net	101	Surface	335
2018110	4174	G.O. Sars (2003-)	338	2018	9	10	1024	73,5112	36,6323	260	2375	MANTA-net	101	Surface	335
2018110	4174	G.O. Sars (2003-)	341	2018	9	11	706	74,1618	32,5577	268	2375	MANTA-net	101	Surface	335
2018110	4174	G.O. Sars (2003-)	345	2018	9	12	848	74,6883	25,9767	298	2375	MANTA-net	101	Surface	335
2018110	4174	G.O. Sars (2003-)	351	2018	9	14	926	75,2428	36,9943	180	2375	MANTA-net	101	Surface	335
2018110	4174	G.O. Sars (2003-)	355	2018	9	15	1026	75,8633	35,1207	204	2375	MANTA-net	101	Surface	335
2018110	4174	G.O. Sars (2003-)	362	2018	9	20	900	76,269	20,4623	252	2375	MANTA-net	101	Surface	335
2018110	4174	G.O. Sars (2003-)	368	2018	9	24	1015	75,341	30,39	365	2375	MANTA-net	101	Surface	335
2018110	4174	G.O. Sars (2003-)	372	2018	9	25	1120	76,432	26,1925	95	2375	MANTA-net	101	Surface	335
2018110	4174	G.O. Sars (2003-)	375	2018	9	26	830	74,6248	23,7573	165	2375	MANTA-net	101	Surface	335

4.2.2 Chemical pollution

Text by: H.E. Heldal, J. Klungsøyr and A. Zhilin

Every third year, Institute of Marine Research (IMR) carries out sample collection in the Barents Sea for monitoring of the levels of contaminants in sea water, sediments and marine biota. The analyses include different hydrocarbons, persistent organic pollutants (POPs) (e.g. PCBs, DDTs, HCHs, HCB) and radionuclides. Monitoring of radionuclides focuses on cesium-137 (Cs-137), but levels of strontium-90 (Sr-90), plutonium-238 (Pu-238), plutonium-239,240 (Pu-239,240), americium-241 (Am-241), radium-226 (Ra-226), radium- 228 (Ra-228) and lead-210 (Pb-210) are also determined in a selection of the samples. The three latter are natural radionuclides which are discharged in enhanced levels with produced water. The last monitoring was in 2018, when samples were collected from RV "Johan Hjort" and RV "G.O. Sars" in August and September. Samples of seawater, sediment and marine biota were collected from 7, 18 and 50 stations, respectively. Samples of marine biota include cod, haddock, saithe, Greenland halibut, redfish, herring, capelin, polar cod, long rough dab, blue whiting and shrimp. An overview of the sampling stations is given in Figures 4.2.2.1.1-4.2.1.3. The samples will be analysed during 2019, and results will be published in future reports.

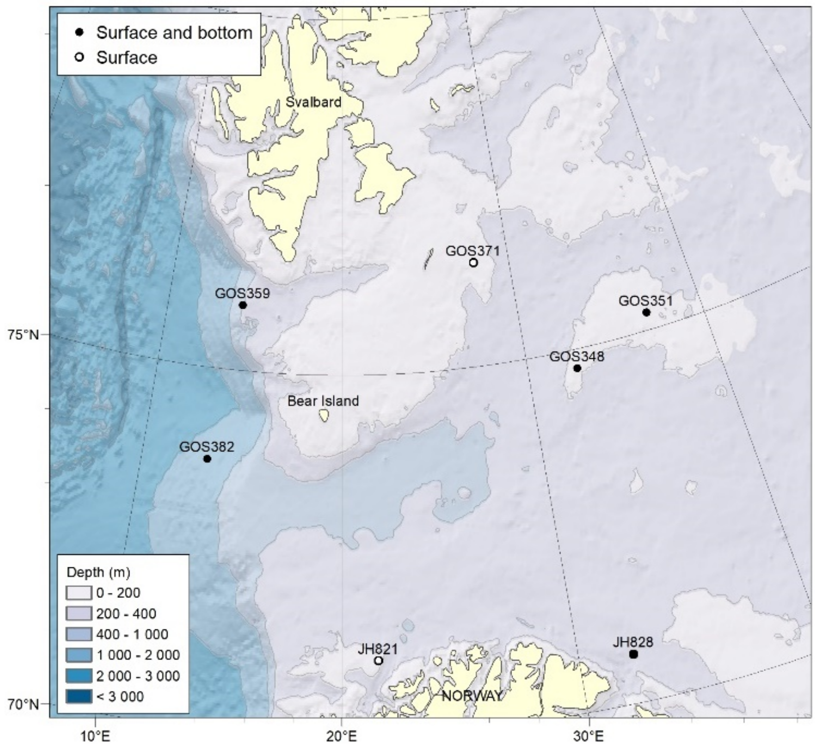

Figure 4.2.2.1.1 *Stations where samples of seawater were collected in 2018. Surface seawater was collected from all seven stations, while bottom seawater was collected from five of seven stations. The samples will be analysed for a range of radionuclides during 2019.*

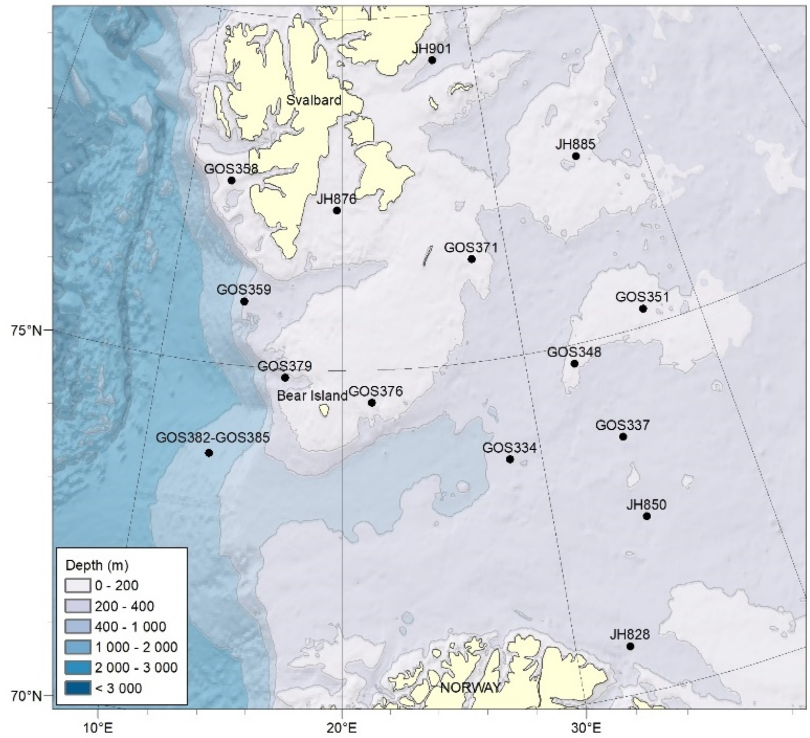

Figure 4.2.2.1.2
Stations where samples of sediment were collected in 2018. Four stations (GOS382-385) are localized close to the sunken nuclear submarine "Komsomolets" and are shown as one dot in the map. The samples will be analysed for PAH, Cs-137 and a selection of other radionuclides during 2019.

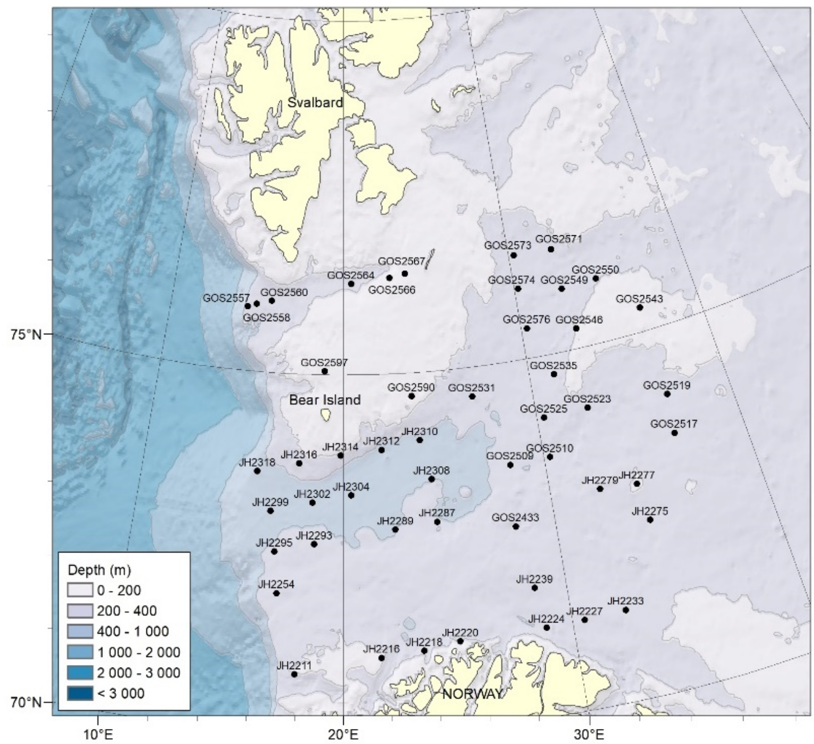

Figure 4.2.2.1.3 *Stations where samples of marine biota were collected in 2018. The samples include cod, haddock, saithe, Greenland halibut, redfish, herring, capelin, polar cod, long rough dab, blue whiting and shrimp. Liver samples will be analysed for PBDE, PCB, and chlorinated pesticides, and muscle samples will be analysed for Cs-137 during 2019.*

In addition to the sample collection every third year, samples of seawater and sediments are collected yearly close to the sunken nuclear submarine “Komsomolets” (Figure 4.2.2.2). Further, samples of cod are collected from the Bear Island area and along the coast of Finnmark twice a year for analyses of Cs-137. The Cs-137-levels in cod today are below 0.5 Bq/kg fresh weight (fw), far below the maximum permitted level for radioactive cesium in food set by the Norwegian authorities after the Chernobyl accident (600 Bq/kg fw).

Monitoring of radionuclides is performed in close cooperation with the Norwegian Radiation Protection Authority (NRPA) within the national monitoring program “Radioactivity in the Marine Environment” (RAME).

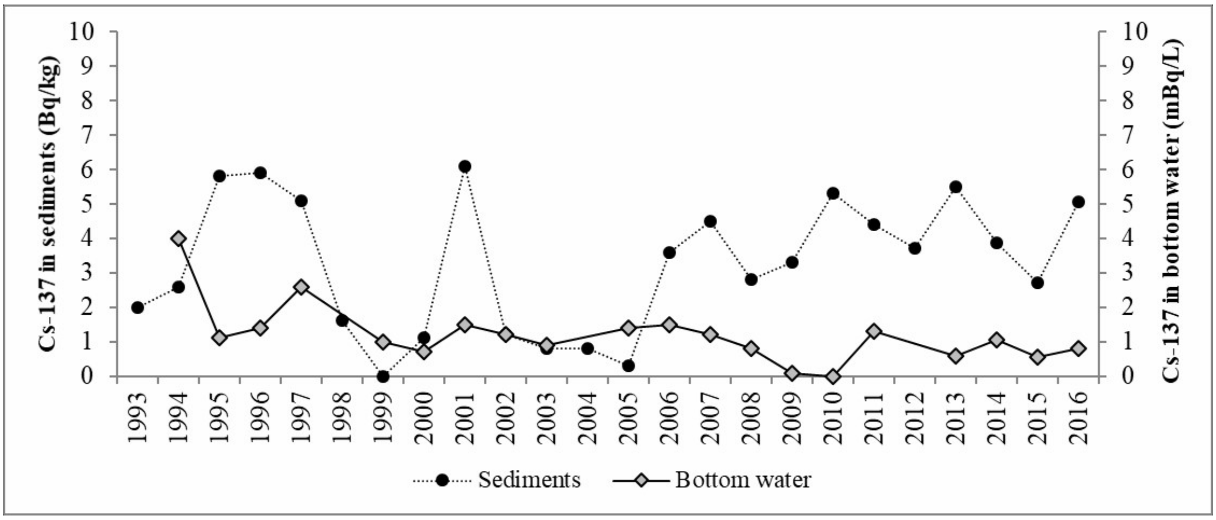

Figure 4.2.2.2. *Levels of Cs-137 in sediments (Bq/kg) and bottom seawater (mBq/L) close to the wreck of the nuclear submarine “Komsomolets” in the period 1993-2016. No samples were collected in 2017. Analyses of samples collected in 2018 are ongoing.*

In the autumn of 2018 PINRO continued the annual monitoring of pollution levels in the Barents Sea in accordance with the Russian national program. Samples of seawater, sediments and fish 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 from RV "Vilnius" in August and September from the southern, central and northern parts of the Barents Sea. The results from the chemical analyses will be reported during 2019.

Appendix: Ch 4

Marine environment; 4.1 Hydrography

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 1965–2018. The sections are: Kola (70º30´N – 72º30´N, 33º30´E), Kanin S (68º45´N – 70º05´N, 43º15´E), Kanin N (71º00´N – 72º00´N, 43º15´E), North Cape – Bear Island (NCBI, 71º33´N, 25º02´E– 73º35´N, 20º46´E), Bear Island – West (BIW, 74º30´N, 06º34´E – 15º55´E), Vardø – North (VN, 72º15´N – 74º15´N, 31º13´E) and Fugløya – Bear Island (FBI, 71º30´N, 19º48´E – 73º30´N, 19º20´E)*

Year	Section and layer (depth in metres)								
	Kola	Kola	Kola	Kanin S	Kanin N	NCBI	BIW	VN	FBI
	0–50	50–200	0–200	0–bot.	0–bot.	0–200	0–200	50–200	50–200
1965	6.7	3.9	4.6	4.6	3.7	5.1	-	3.8	5.2
1966	6.7	2.6	3.6	1.9	2.2	5.5	3.6	3.2	5.3
1967	7.5	4.0	4.9	6.1	3.4	5.6	4.2	4.4	6.3
1968	6.4	3.7	4.4	4.7	2.8	5.4	4.0	3.4	5.0
1969	6.7	3.1	4.0	2.6	2.0	6.0	4.2	3.8	6.3
1970	7.8	3.7	4.7	4.0	3.3	6.1	-	4.1	5.6
1971	7.1	3.2	4.2	4.0	3.2	5.7	4.2	3.8	5.6
1972	8.7	4.0	5.2	5.1	4.1	6.3	3.9	4.6	6.1
1973	7.7	4.5	5.3	5.7	4.2	5.9	5.0	4.9	5.7
1974	8.1	3.9	4.9	4.6	3.5	6.1	4.9	4.3	5.8
1975	7.0	4.6	5.2	5.6	3.6	5.7	4.9	4.5	5.7
1976	8.1	4.0	5.0	4.9	4.4	5.6	4.8	4.4	5.8
1977	6.9	3.4	4.3	4.1	2.9	4.9	4.0	3.6	4.9
1978	6.6	2.5	3.6	2.4	1.7	5.0	4.1	3.2	4.9
1979	6.5	2.9	3.8	2.0	1.4	5.3	4.4	3.6	4.7
1980	7.4	3.5	4.5	3.3	3.0	5.7	4.9	3.7	5.5
1981	6.6	2.7	3.7	2.7	2.2	5.3	4.4	3.4	5.3
1982	7.1	4.0	4.8	4.5	2.8	5.8	4.9	4.1	6.0
1983	8.1	4.8	5.6	5.1	4.2	6.3	5.1	4.8	6.1
1984	7.7	4.1	5.0	4.5	3.6	5.9	5.0	4.2	5.7
1985	7.1	3.5	4.4	3.4	3.4	5.3	4.6	3.7	5.6
1986	7.5	3.5	4.5	3.9	3.2	5.8	4.4	3.8	5.5
1987	6.2	3.3	4.0	2.7	2.5	5.2	3.9	3.5	5.1
1988	7.0	3.7	4.5	3.8	2.9	5.5	4.2	3.8	5.7
1989	8.6	4.8	5.8	6.5	4.3	6.9	4.9	5.1	6.2
1990	8.1	4.4	5.3	5.0	3.9	6.3	5.7	5.0	6.3
1991	7.7	4.5	5.3	4.8	4.2	6.0	5.4	4.8	6.2
1992	7.5	4.6	5.3	5.0	4.0	6.1	5.0	4.6	6.1
1993	7.5	4.0	4.9	4.4	3.4	5.8	5.4	4.2	5.8
1994	7.7	3.9	4.8	4.6	3.4	6.4	5.3	4.8	5.9
1995	7.6	4.9	5.6	5.9	4.3	6.1	5.2	4.6	6.1
1996	7.6	3.7	4.7	5.2	2.9	5.8	4.7	3.7	5.7
1997	7.3	3.4	4.4	4.2	2.8	5.6	4.1	4.0	5.4
1998	8.4	3.4	4.7	2.1	1.9	6.0	-	3.9	5.8
1999	7.4	3.8	4.7	3.8	3.1	6.2	5.3	4.8	6.1
2000	7.6	4.5	5.3	5.8	4.1	5.7	5.1	4.2	5.8
2001	6.9	4.0	4.7	5.6	4.0	5.7	4.9	4.2	5.9
2002	8.6	4.8	5.8	4.0	3.7	-	5.4	4.6	6.5
2003	7.2	4.0	4.8	4.2	3.3	-	-	4.7	6.2
2004	9.0	4.7	5.7	5.0	4.2	-	5.8	4.8	6.4
2005	8.0	4.4	5.3	5.2	3.8	6.7	-	5.0	6.2
2006	8.3	5.3	6.1	6.1	4.5	-	5.8	5.3	6.9
2007	8.2	4.6	5.5	4.9	4.3	6.9	5.6	4.9	6.5
2008	6.9	4.6	5.2	4.2	4.0	6.2	5.1	4.8	6.4
2009	7.2	4.3	5.0	-	4.3	-	-	5.2	6.4
2010	7.8	4.7	5.5	4.9	4.5	-	5.4	-	6.2
2011	7.6	4.0	4.9	5.0	3.8	-	-	5.1	6.4
2012	8.2	5.3	6.0	6.2	5.2	-	-	5.7	6.4
2013	8.8	4.6	5.6	5.5	4.6	-	5.6	5.0	6.3
2014	8.0	4.6	5.4	4.5	4.1	-	-	5.2	6.1
2015	8.5	4.8	5.7	6.1	4.6	-	-	5.6	6.6
2016	-	-	-	-	5.5	-	-	5.1	6.5
2017	7.9	4.8	5.6	-	-	-	-	5.2	6.4
2018	8.1	4.9	5.7	-	-	-	-	-	6.0
Average 1965–2018	7.6	4.1	4.9	4.5	3.6	5.8	4.8	4.4	5.9

5 PLANKTON COMMUNITY

5.1 Phytoplankton, chlorophyll a and nutrients

Text and figures by: S. Larsen

In 2018 two sets of data were analysed at Flødevigen by Marita Helgesen and Hege Mathisen using the Utermöhl sedimentation method for 50 ml water samples preserved in Lugols solution. The samples were obtained from CTD mounted water bottles.

The first samples were taken in spring, between the 22-25 of May on the Fugløya-Bjørnøya transect. The locations of these are shown in Figure 5.1.1, with the MODIS satellite imagery for May shown in Figures 5.1.2 and 5.1.3, and the phytoplankton numbers (grouped to Family level) given in Table 5.1 (Appendix Ch 5). The time frame shown in Figure 5.1.2 spans the period from a day before, to the day after the time that the samples were collected, however this is only a period of six days, and cloud cover limited the amount of satellite data able to be collected. In Figure 5.1.3 the mean chlorophyll concentration for all of May is shown. This mean pattern will be slightly different from the exact situation on the 22- 25 May, but it allows that period of limited data to be placed in context of the Barents Sea as a whole.

The second samples were from the Barents Sea ECOSYSTEM cruises and were collected between the 4th of September and the 3rd of October. The locations for these samples are shown in Figure 5.1.4, and the MODIS satellite imagery in Figure 5.1.5. At that time of the year the solar elevation is too low at higher latitudes for the satellite to obtain data and so complete satellite coverage for the Barents Sea is not possible. The results of the phytoplankton analysis are given in Table 5.2. (Appendix Ch 5). The locations of the samples chosen to be analysed were essentially the same as in previous years. The abundance of Cryptophyceae, Dinophyceae and Dictyophyceae were comparable with 2017.

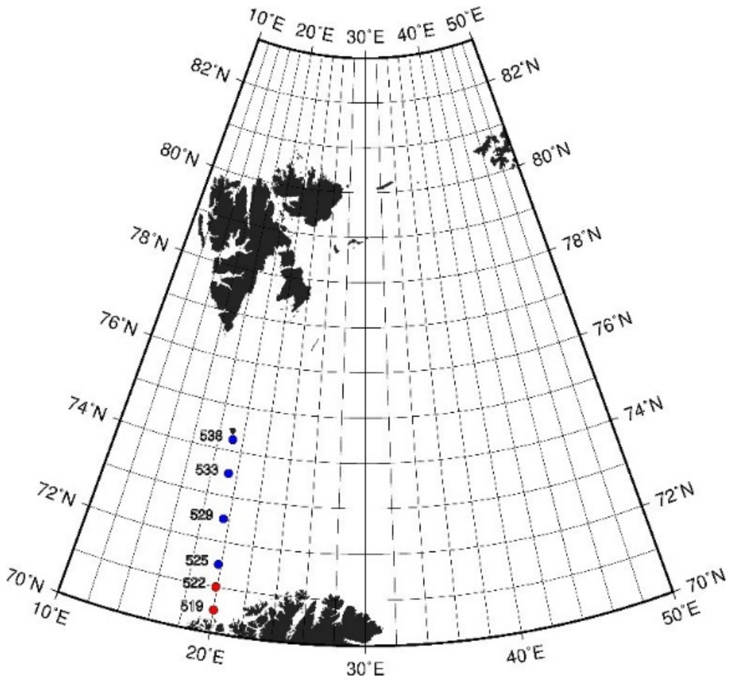

Figure 5.1.1. *Location and station numbers of the phytoplankton samples taken on the on the Fugløya-Bjørnøya transect, 22-25 May 2018. Red dots indicate 10 m samples only, blue dots indicate both 10 and 50 m samples were analysed.*

However, averaged over all the samples (just considering those taken at 10 m depth), the 2018 Barents Sea ECOSYSTEM cruise found much higher numbers of unidentified flagellates (averaging around 300000 l-1 this year compared to around 70000 l-1 in 2017). In contrast, there were fewer Diatoms (around 53000 l-1 in 2017 down to around 5700 l-1 in 2018). This year we also saw increased numbers of coccolithophores, all identified as *Emiliania huxleyi* with an average of around 11300 l-1 compared to 1070 l-1 in 2017.

Nutrient and chlorophyll samples were collected from various depths at roughly 170 CTD stations. The nutrient samples (20 ml) were preserved with chloroform (200 µl), and thereafter kept at about 4°C until subsequent chemical analysis on shore at IMR. The chlorophyll-samples were collected by filtering 263 ml of seawater through glass-fibre filters, which were then frozen at about -18°C until subsequent extraction of pigments in acetone and thereafter fluorometric analysis in the IMR laboratory on shore. Analysis of concentrations of nitrate, nitrite, silicate and phosphate, along with chlorophyll and phaeopigments for 2018 are stored in IMR databases.

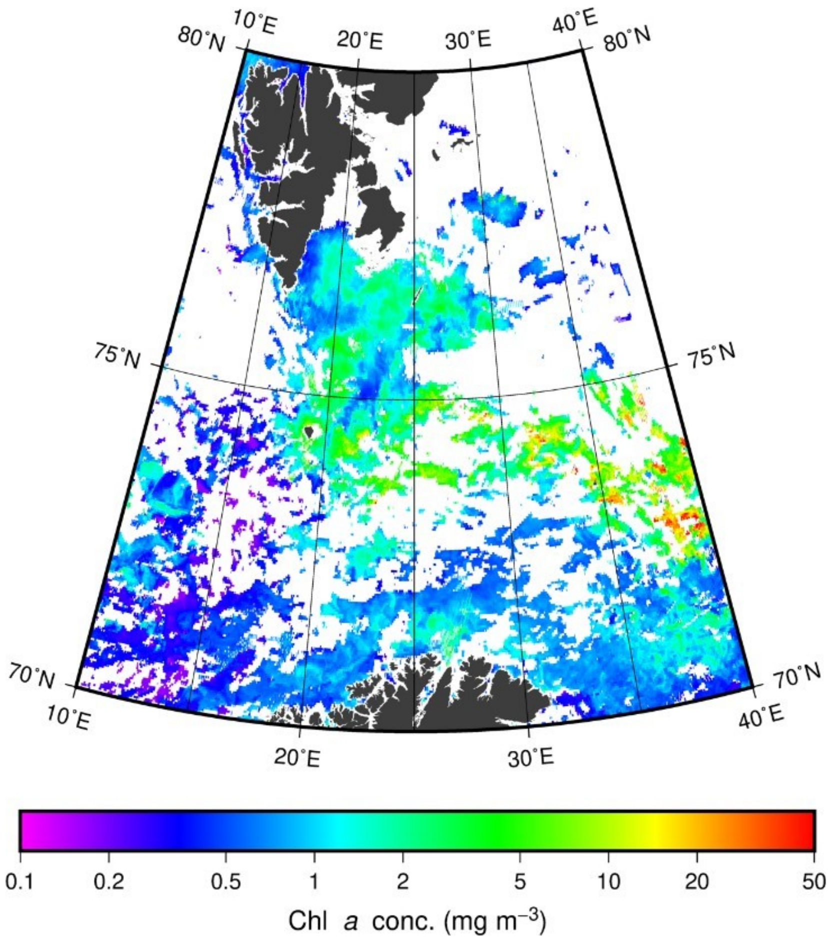

Figure 5.1.2. *Mean surface chlorophyll concentration from MODIS satellite imagery for the 21st to the 26th of May during which time the samples were taken on the Fugløya-Bjørnøya transect. White regions indicate missing data.*

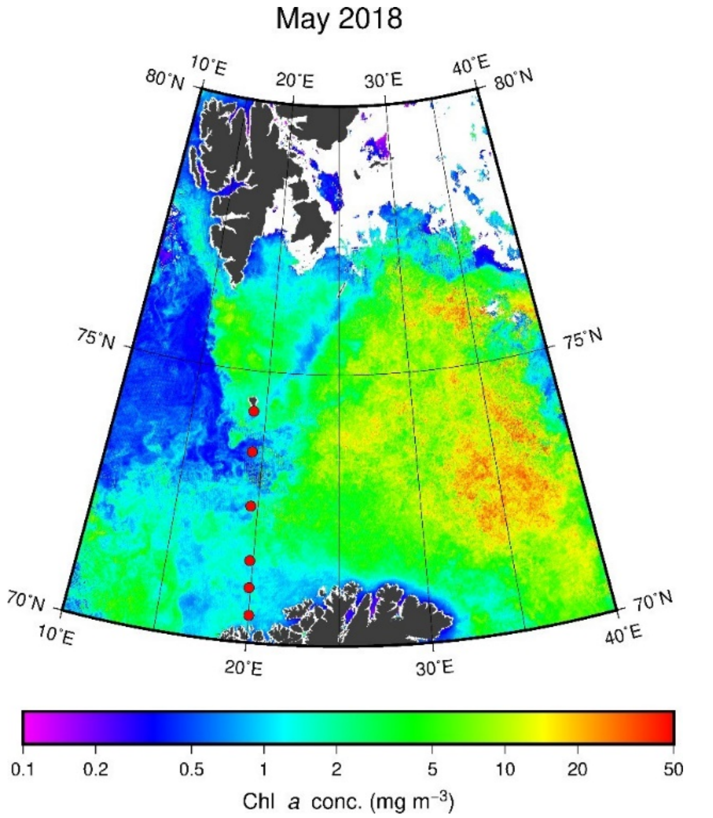

Figure 5.1.3. *Mean surface chlorophyll concentration obtained from daily MODIS satellite imagery for May 2018. Red dots indicate the locations of the stations sampled. White indicate regions of missing data.*

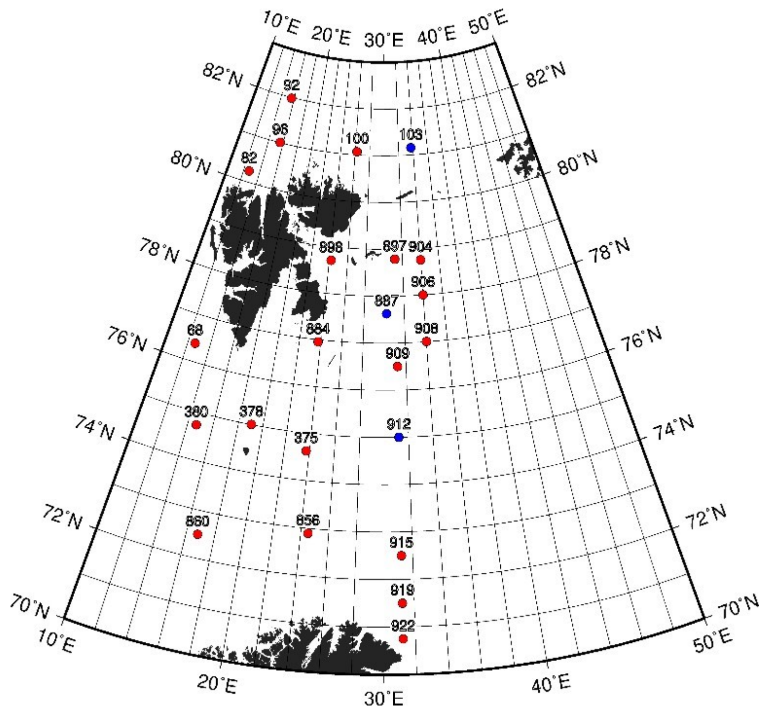

Figure 5.1.4. *Locations and station numbers for the phytoplankton samples analysed from the Barents Sea ECOSYSTEM cruises obtained between the 4th Sep. and 3rd October. Red dots indicate 10 m samples only were analysed, blues dots indicate both 10 and 50 m samples were analysed except for station 912 where the 10 m sample was missing.*

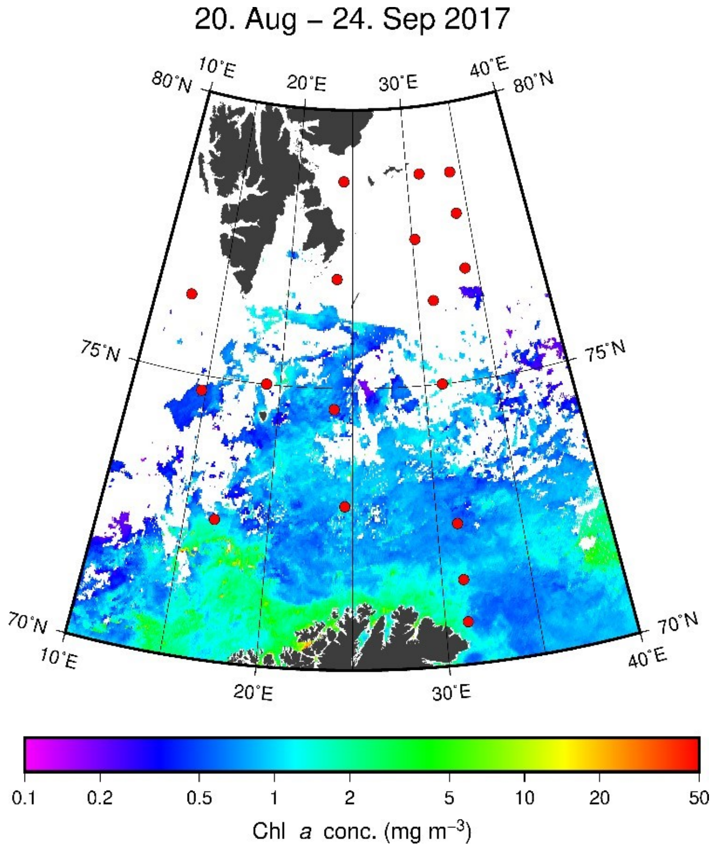

Figure 5.1.5. *MODIS satellite derived mean surface chlorophyll-a concentration during the Barents Sea Ecosystem Cruise (20. Aug – 24. Sep). White areas denote missing data due to cloud cover. Black dots indicate the locations sampled for phytoplankton abundance and taxonomy measurements. Note that due to spatial variations in cloud and satellite coverage over the period, sampling frequency and precision varies spatially.*

5.2 Mesozooplankton biomass and geographic distribution

Text by: E. Bagøien, I. Prokopchuk, V. Nesterova and A. Dolgov
Figure by: E. Bagøien

Mesozooplankton sampling stations during the joint Norwegian-Russian Barents Sea ecosystem cruise in 2018 are presented in Figure 2.3. 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. Previous investigations have shown that the total zooplankton biomass collected by the two gears are comparable. For logistical reasons, there was a reduced coverage in the Russian sector of the Barents Sea in 2018 compared to earlier years, which is discussed elsewhere in the cruise-report.

The horizontal distribution of total mesozooplankton biomass shown in Figure 5.2.1 is based on a total of 173 samples, of which 141 were located in the Norwegian sector and 32 in the Russian Sector. The zooplankton biomass averages and standard deviations within the Norwegian and Russian sectors were 7.2 (± 5.6) and 9.1 (± 6.1) g dry-weight m^{-2}, respectively. When combining the data for the Norwegian and Russian sectors, the overall average was 7.5 (± 5.7) g dry-weight m^{-2} – which is the arithmetic average for all stations shown in Figure 5.2.1. It is important to note that comparing average biomasses for different years is vulnerable to differing area coverages, which is well exemplified by the year 2018, when a large region in the south-eastern part of the Barents Sea was not sampled. 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 2018, a few randomly selected stations along the Hinlopen-section north of Svalbard (Spitzbergen) and the whole Vardø-North section (stations not included in Fig. 5.2.1), were omitted when calculating the average biomass. The purpose of this was to avoid weighting of areas with higher sampling density. Differences in survey coverages among years, as well as spatial variability in station density within the survey region, impact biomass estimates, and particularly so in an environment characterized by large-scale patches of biomass. Addressing such challenges will be a task for the ICES working-group WGIBAR, which in addition to the estimated average for national sectors, and the whole survey area, will make interannual biomass comparisons within-well defined and consistent spatial polygons.

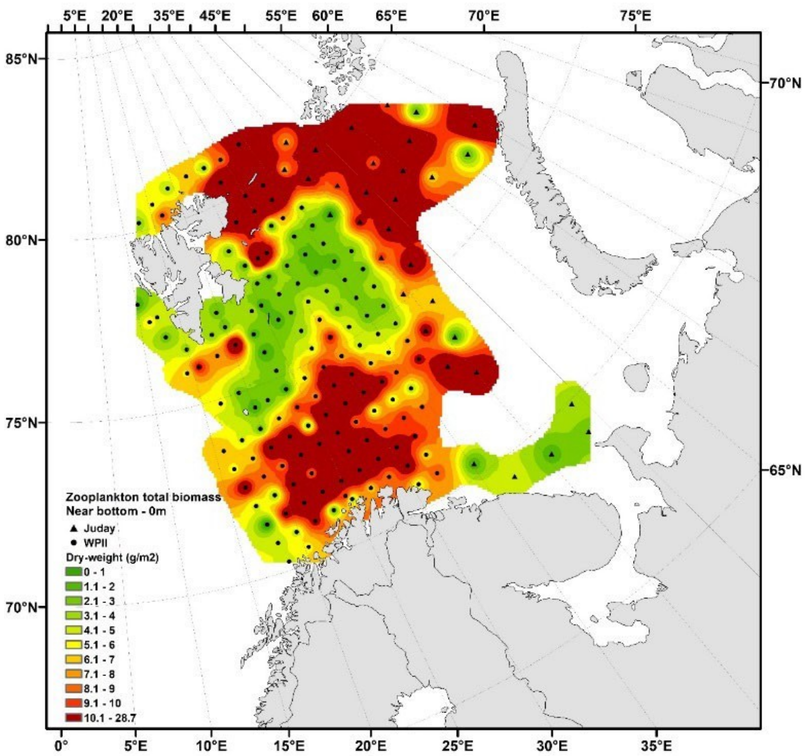

Figure 5.2.1. *Distribution of total zooplankton biomass (g dry-weight m^{-2}) in the near-bottom – 0 m layer of the Norwegian and Russian sectors of the Barents Sea during BESS 2018 - based on a total of 173 stations. The data visualized were collected by WP2 and Juday nets with mesh-size 180 μm. Interpolation was made in ArcGIS v.10.5, module Spatial Analyst, using inverse distance weighting (IDW).*

The overall distribution patterns show similarities across years, although some interannual variability is apparent. In 2018, we observed the familiar pattern of comparatively high biomasses (> 10 g dry-weight m^{-2}) in the southwestern region as well as north-northeast of Svalbard/Spitsbergen, along with relatively low biomasses in the central region as well as near the coast in the south-eastern corner of the Barents Sea (Fig. 5.2.1). The maximum of 28.7 g dry- weight m^{-2} was measured south of the Frantz Josef Land archipelago.

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

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

Spatial distributions of mesozooplankton biomass, and relationships with ecosystem components such as ocean currents, hydrography, and abundances/distributions of relevant predators will be evaluated in more detail in WGIBAR.

5.3 Macrozooplankton

5.3.1 Biomass indices and distribution of krill

Text by: E. Eriksen, P. Dalpadado and T. Prokhorova
Figure by: P. Krivosheya

Estimation of krill biomass for the whole Barents Sea was not possible due to lack of coverage in 2018 (see section "Survey execution 2018" in the report). Therefore, krill distribution is presented because no time-series assessments were done on this limited data.

In 2018, krill were widely distributed in the western Barents Sea (Figure 5.3.1.1). The biomass values in the upper 60 m are presented as g wet weight per square meter (g/m^2). The night catches in the west in 2018, (mean 5.76 g/m^2), were lower than long term mean (7.7 g/m^2).

The number of the night stations in 2018 was 74, while the day stations was 104. During the night, most of krill migrate to upper water layer for feeding and is therefore more available for the trawl. Higher catches (more than 50 g/m^2) were observed in the central area.

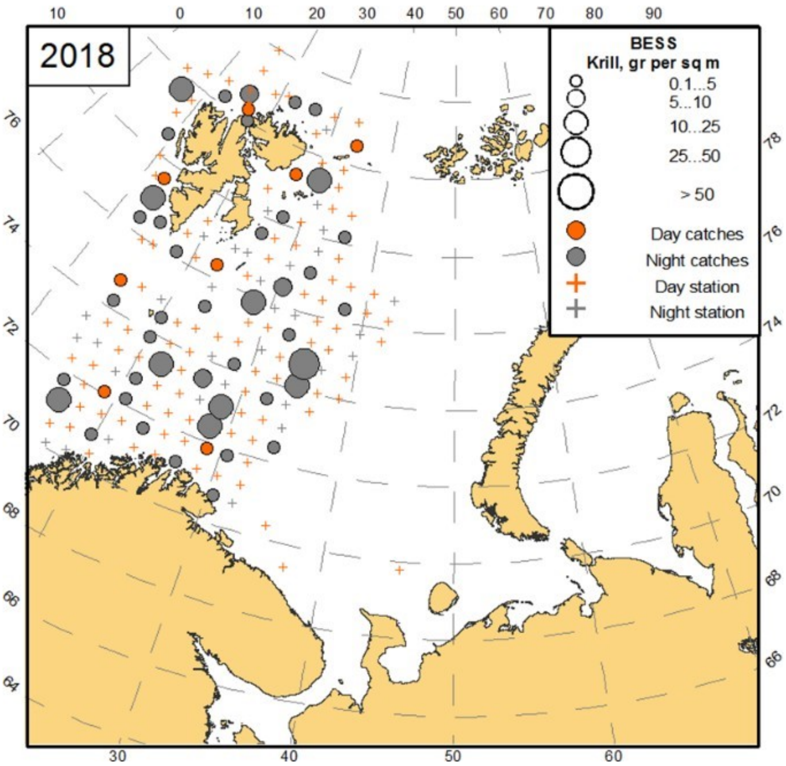

Figure 5.3.1.1 *Krill distribution, based on pelagic trawl stations covering the upper water layers (0-60 m), in the Barents Sea in August-October 2018.*

5.3.2 Biomass indices and distribution of amphipods (mainly Hyperiids)

Text by: E. Eriksen, P. Dalpadado and T. Prokhorova
Figure by: P. Krivosheya

Estimation of amphipods biomass for the Barents Sea as a whole was not possible due to lack of coverage in 2018 (see section "Survey execution 2018" in the report). Therefore, here amphipods distribution presented only.

In 2018, amphipods were found east off Svalbard/Spitsbergen archipelago (Figure 5.3.2.1).

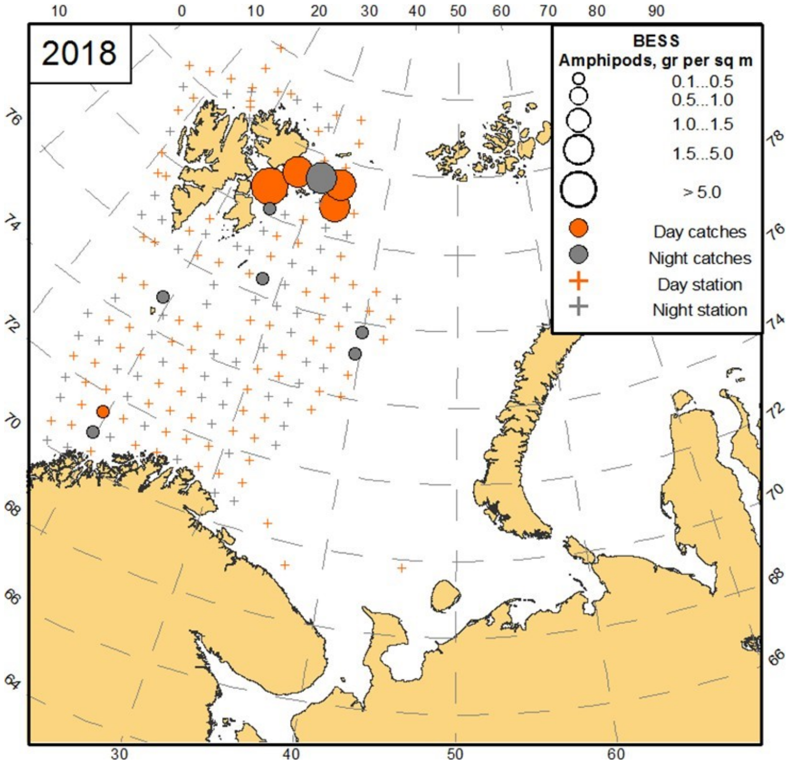

Figure 5.3.2.1. *Amphipods distribution, based on trawl stations covering the upper water layers (0-60 m), in the Barents Sea in August-October 2018.*

5.3.3 Biomass indices and distribution of jellyfish

Text by: E. Eriksen, T. Prokhorova and A. Dolgov
Figures by: P. Krivosheya

Estimation of abundance (biomass) of gelatinous zooplankton for the Barents Sea as a whole, was not possible due to lack of coverage in 2018 (see section "Survey execution 2018" in the report). Therefore, here gelatinous distribution presented only.

In August-October 2018, lion's mane jellyfish (*Cyanea capillata*; Scyphozoa) was the most common jellyfish species, both with respect to weight and occurrence (average catch of 39 kg, corresponding to 5.1 tonnes per sq nmi), widely distributed in the covered area (Fig. 5-3-3-1). High catches (> 10 tonnes per sq nmi) were made in the northcentral Barents Sea, a were higher than previous three years.

Single specimens of blue stinging jellyfish, *Cyanea lamarckii*, were found at three stations close to the northern Norwegian coast (Fig. 5.3.3.2). *C. lamarckii* has been observed regularly in the Barents Sea in recent years and the presence of this warm-temperate species may be linked to the inflow of Atlantic water masses. Single specimens of helmet jelly, *Periphylla periphylla*, was found at two stations only. *P. periphylla* were also found in previous years (Fig. 5.3.3.2).

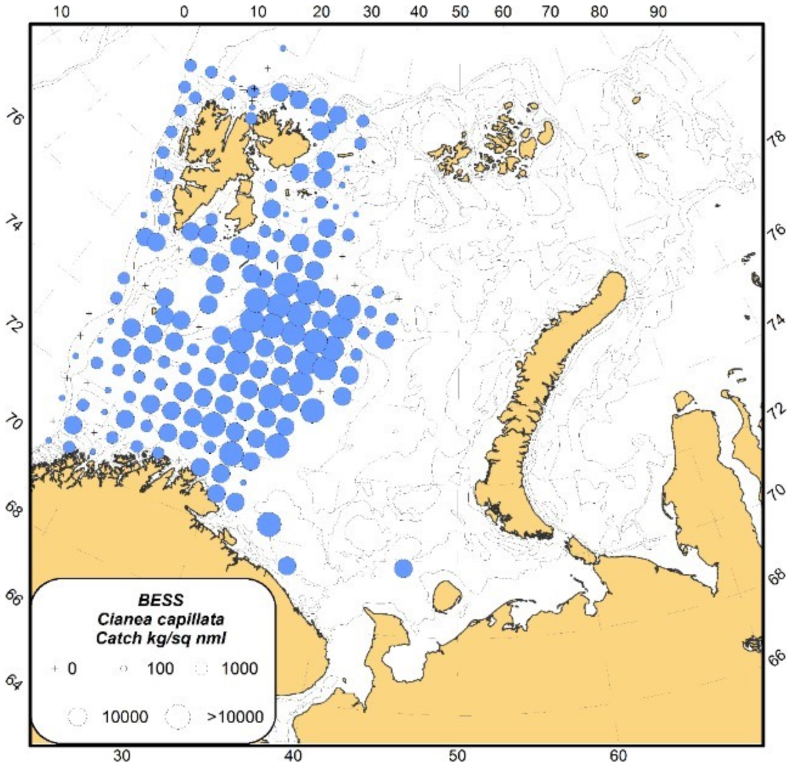

Figure 5.3.3.1. *Distribution of* Cyanea capillata *(wet weight; kg per sq nmi) in the Barents Sea, August-October 2018. Catches both day and night from standard pelagic trawl 0-60 m depth.*

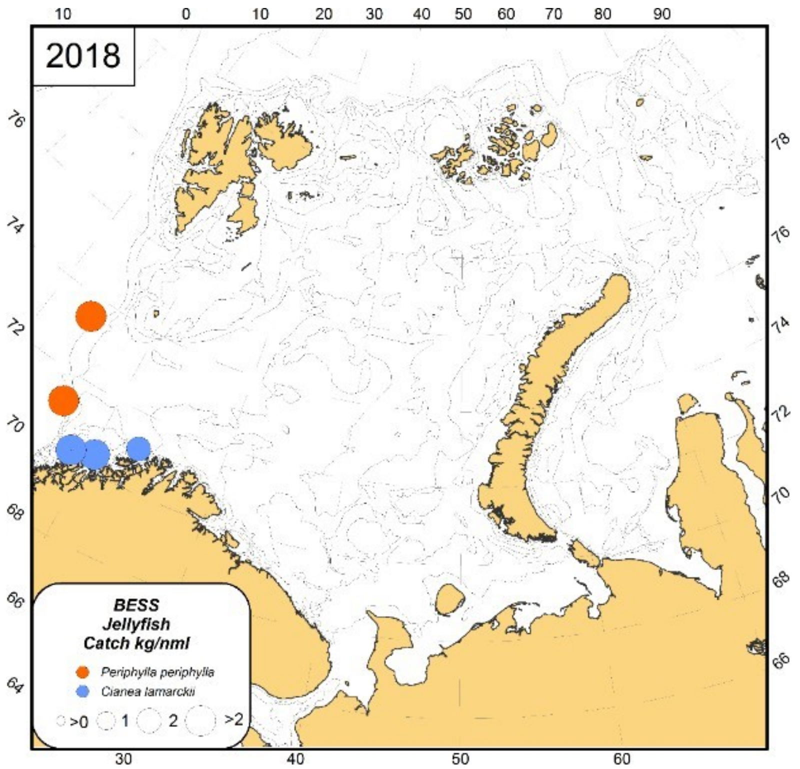

Figure 5.3.3.2. *Estimated total biomass of the jellyfish* Cyanea lamarckii *and* Periphylla periphylla *in the surveyed area in August-October 2018.*

Appendix: Ch 5

Plankton

Table 5.1.1 *Abundance of key phytoplankton on Fugløya-Bjørnøya transect, 22-25 May 2018*

				10 metre sample cell concentrations ($\times 1000$ cell l^{-1})							
Station	Lat.	Long.	dd-mm-yy	U.flag	Monader	Cryptophyceae	Dinophyta	Diatom	Dictyophyceae	Haptophyta	Ciliate
519	70.4495	20.0147	22-05-18	452.48	0.00	161.28	0.04	0.00	0.00	0.00	0.64
522	71.0042	19.8967	22-05-18	1025.90	0.00	212.26	2.91	0.00	0.00	0.00	0.32
525	71.5008	19.8040	22-05-18	336.00	0.00	22.40	1.53	0.56	0.00	0.00	0.08
529	72.5000	19.5683	23-05-18	448.00	0.00	0.00	0.68	2.00	0.00	416.64	0.76
533	73.4998	19.3308	24-05-18	255.36	0.00	0.00	1.73	4.56	0.00	0.00	0.48
538	74.2508	19.1645	25-05-18	1805.40	0.00	215.04	1.36	1.08	0.00	5239.20	1.60
				50 metre sample cell concentrations ($\times 1000$ cell l^{-1})							
Station	Lat.	Long.	dd-mm-yy	U.flag	Monader	Cryptophyceae	Dinophyta	Diatom	Dictyophyceae	Haptophyta	Ciliate
525	71.5008	19.8040	22-05-18	80.64	0.00	4.48	0.08	1.68	0.00	0.00	0.24
529	72.5000	19.5683	23-05-18	349.44	0.00	4.48	2.60	2.08	0.00	734.72	0.24
533	73.4998	19.3308	24-05-18	80.64	0.00	4.48	37.96	6.44	0.00	67.20	0.60
538	74.2508	19.1645	25-05-18	0.00	0.00	136.44	1.80	2.64	0.00	6195.00	2.20

Table 5.1.2. *Abundance of key phytoplankton on the 2018 Barents Sea ECOSYSTEM cruise*

				10 metre sample cell concentrations ($\times 1000$ cell l^{-1})							
Station	Lat.	Long.	dd-mm-yy	U.flag	Monader	Cryptophyceae	Dinophyta	Diatom	Dictyophyceae	Haptophyta	Ciliate
909	76.502	31.218	01-10-18	228.684	0.00	112.00	12.32	0.32	0.00	8.96	1.14
915	72.500	31.213	02-10-18	860.330	0.00	159.18	11.38	4.26	0.00	15.16	1.92
919	71.499	31.213	02-10-18	165.760	0.00	22.40	6.87	6.60	0.00	0.00	0.48
922	70.750	31.212	03-10-18	241.920	0.00	250.88	8.60	2.24	0.00	13.44	0.72
856	72.896	24.525	04-09-18	143.360	0.00	8.96	6.84	2.52	0.00	85.12	1.84
860	72.497	16.807	05-09-18	165.760	0.00	17.92	6.84	9.82	0.00	4.48	0.78
68	76.386	12.652	16-09-18	273.280	0.00	179.20	1.94	1.56	0.00	22.40	0.76
884	76.953	23.759	17-09-18	600.320	0.00	8.06	4.92	3.72	0.24	3.58	6.17
887	77.626	30.236	19-09-18	125.440	0.00	53.76	7.76	0.08	0.00	0.00	1.48
82	80.236	12.679	20-09-18	443.520	0.00	398.72	23.04	2.00	0.00	8.96	1.52
92	81.982	15.596	23-09-18	473.750	0.00	109.91	14.42	1.20	0.16	3.79	1.00
96	81.007	15.604	24-09-18	573.440	0.00	71.68	13.78	3.00	0.00	44.80	0.64
897	78.789	31.164	26-09-18	295.680	0.00	2.23	4.99	0.04	0.00	0.00	1.28
375	74.625	23.757	26-09-18	72.010	0.00	3.79	2.38	0.20	0.04	3.79	0.92
378	75.005	19.044	27-09-18	204.660	0.00	1.36	.42	0.60	0.28	18.95	1.72
380	74.733	14.697	27-09-18	107.520	0.00	31.36	8.82	22.95	0.00	0.00	1.32
898	78.709	24.202	27-09-18	58.240	0.00	13.44	11.07	6.52	0.00	0.00	0.68
100	81.070	26.238	27-09-18	117.490	0.00	22.74	21.00	1.60	0.56	11.37	0.84
103	81.156	33.709	27-09-18	83.380	0.00	3.79	2.36	55.58	0.08	3.79	0.76
904	78.750	33.995	30-09-18	380.292	0.00	17.69	5.33	0.00	0.00	0.00	0.80
906	78.000	34.000	30-09-18	885.000	0.00	1.86	8.26	0.00	0.00	0.00	0.34
908	77.004	34.006	30-09-18	156.800	0.00	13.44	7.18	0.36	0.02	0.00	1.38
				50 metre sample cell concentrations ($\times 1000$ cell l^{-1})							
Station	Lat.	Long.	dd-mm-yy	U.flag	Monader	Cryptophyceae	Dinophyta	Diatom	Dictyophyceae	Haptophyta	Ciliate
912	75.000	31.209	02-10-18	3540.00	0.00	60.64	20.72	0.24	0.00	22.74	4.80
915	72.500	31.213	02-10-18	792.11	0.00	136.44	12.08	3.92	0.00	0.00	9.60
887	77.626	30.236	19-09-18	295.68	0.00	0.00	2.55	0.12	0.00	0.00	4.00
103	81.156	33.709	27-09-18	170.55	0.00	15.16	7.90	71.32	0.04	0.00	2.80

6 FISH RECRUITEMENT (YOUNG-OF-THE-YEAR)

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

During this survey the main distribution of most of 0-group species were not covered due to lack of cover in the southeastern Barents Sea (see section "Survey execution 2018" in the report). Therefore, 0-group fish abundance indices were not calculated for the 2018 and distribution maps presented only (Figure 6.1.1-6.11.1). The density legend in the figure is based on the catches, measured as number of fish per square nautical mile. More intensive colouring indicates denser concentrations.

6.1 Capelin (Mallotus villosus)

In 2018, the highest concentrations of capelin were found in the north-central Barents Sea, and was similar to 2016-2017.

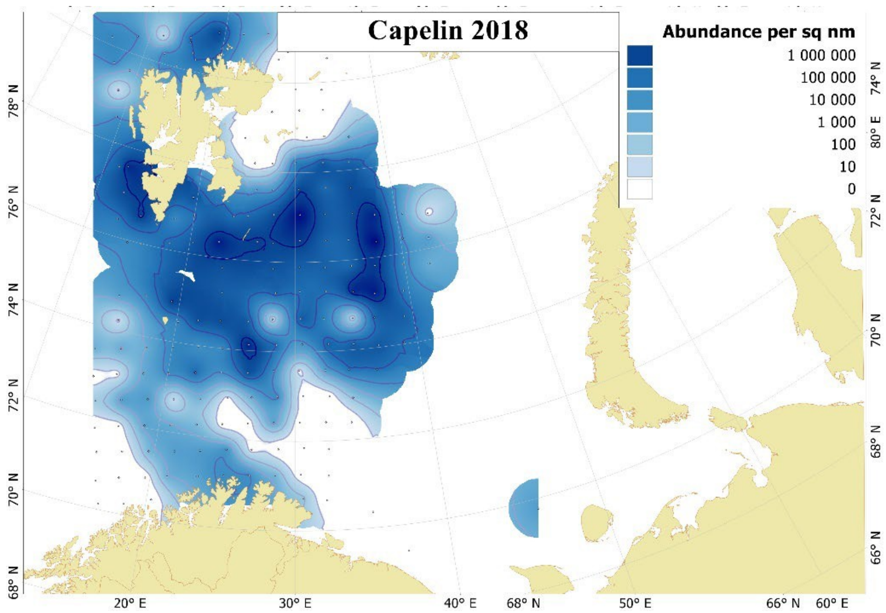

Figure 6.1.1. *Distribution of 0-group capelin, August-October 2018. Dots indicated sampling locations.*

6.2 Cod (Gadus morhua)

Cod of medium and low concentration were found within the covered area, west of Norwegian Russian boarder. The main dense concentrations were locally found in the central part of the sea (Fig. 6.2.1).

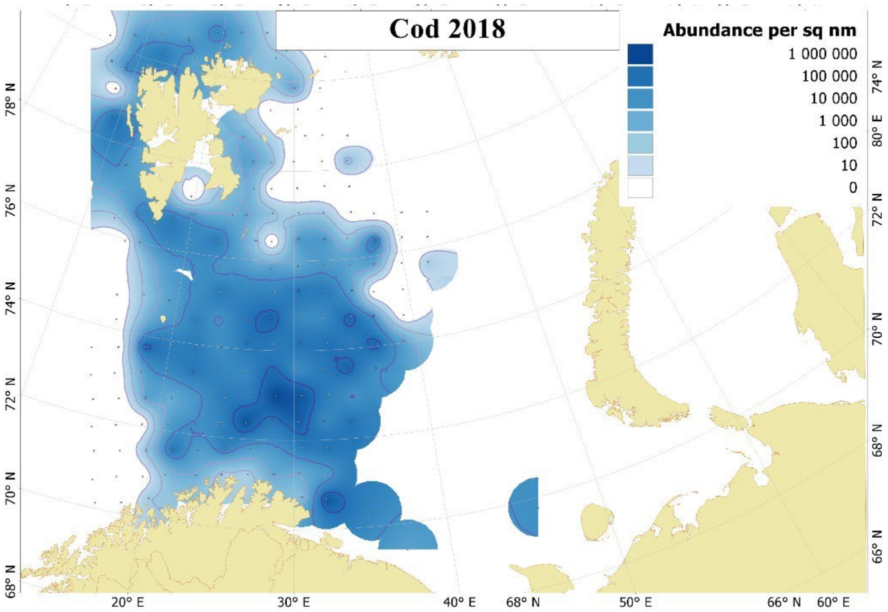

Figure 6.2.1. *Distribution of 0-group cod, August-October 2018. Dots indicated sampling locations.*

6.3 Haddock (Melanogrammus aeglefinus)

0-group haddock distributed widely in the western and central part of the survey area in 2018 (Figure 6.3.1). The main dense concentrations were found locally in the central Barents Sea.

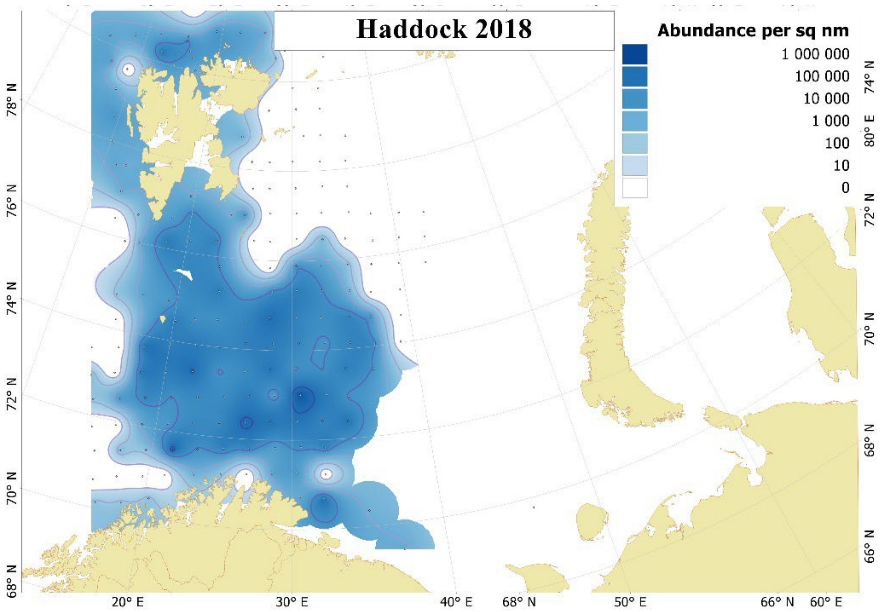

Figure 6.3.1. *Distribution of 0-group haddock, August- October 2018. Dots indicated sampling locations.*

6.4 Herring (Clupea harengus)

In 2018, herring were distributed in the central and north western Barents Sea. The dense concentrations of herring were found south from Svalbard (Spitsbergen) (Fig. 6.4.1).

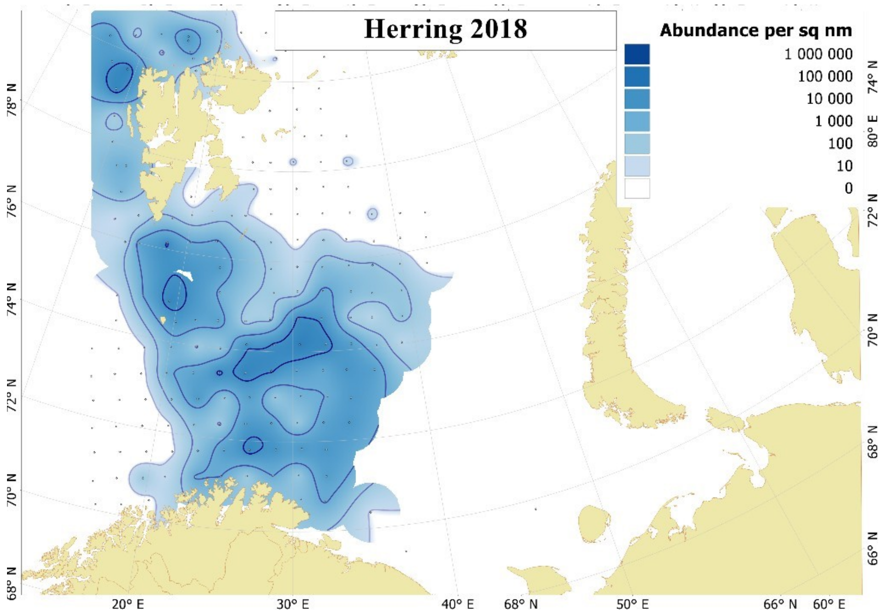

Figure 6.4.1. *Distribution of 0-group herring, August- October 2018. Dots indicated sampling locations.*

6.5 Polar cod (Boreogadus saida)

In 2018, the western component was covered only (Figure 6.5.1). Polar cod were widely distributed with denser concentration east of the Svalbard (Spitsbergen).

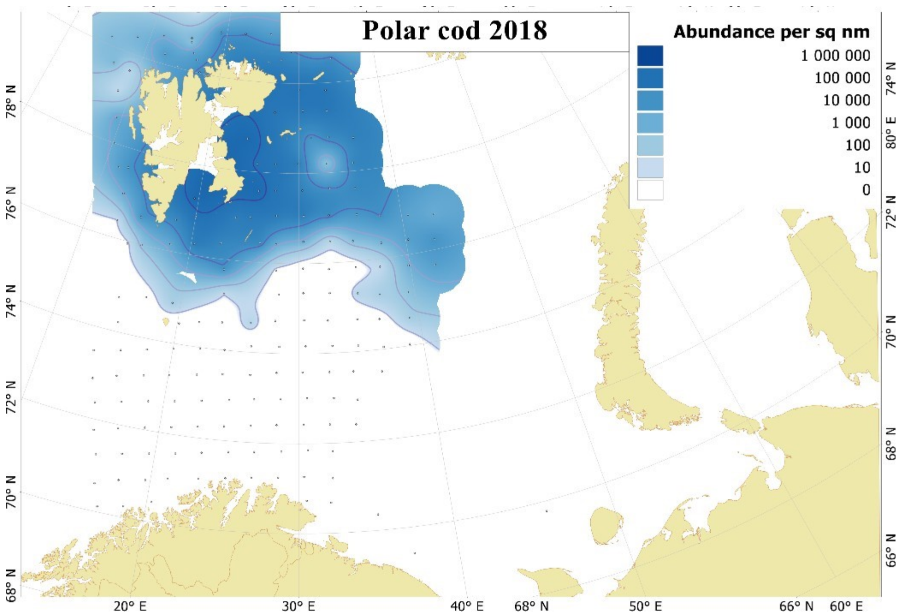

Figure 6.5.1. *Distribution of 0-group polar cod, August-October 2018. Dots indicated sampling locations.*

6.6 Saithe (Pollachius virens)

Saithe were found in the central and coastal (northern Norwegian and Russian coast) areas in 2018.

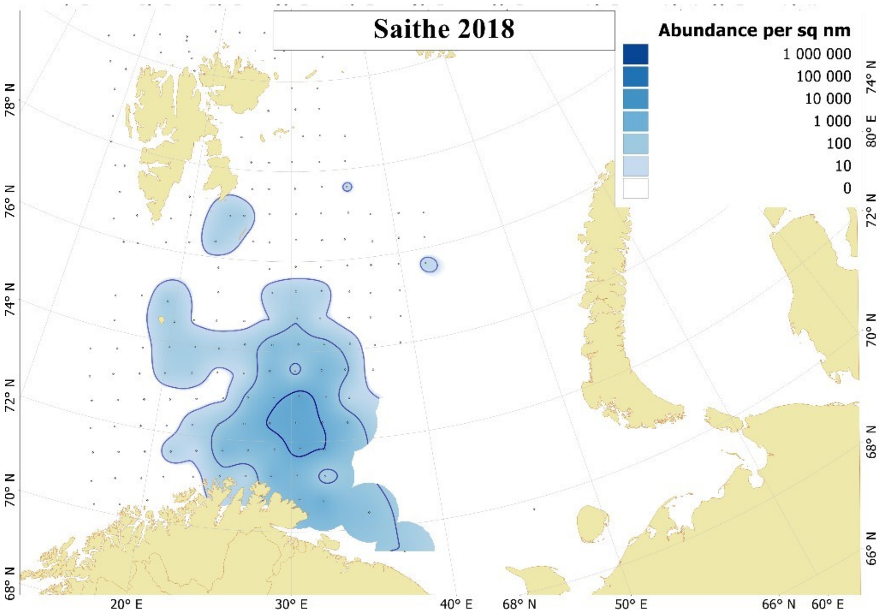

Figure 6.6.1. *Distribution of 0-group saithe, August-October 2018. Dots indicated sampling locations.*

6.7 Redfish (mostly *Sebastes mentella*)

0-group redfish was distributed north of Norwegian coast and south and west of Svalbard (Spitsbergen) in 2018 (Figure 6.7.1). The densest concentrations were found west of Svalbard (Spitsbergen).

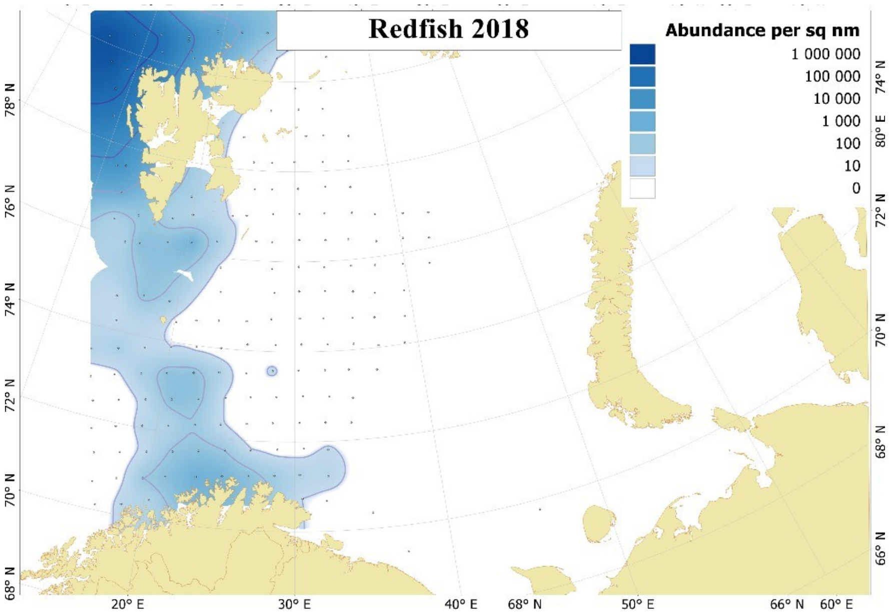

Figure 6.7.1. *Distribution of 0-group redfishes* **(***mostly Sebastes mentella***)***, August- October 2018. Dots indicated sampling locations.*

6.8 Greenland halibut (Reinhardtius hippoglossoides)

0-group Greenland halibut was distributed west, north and east of Svalbard (Spitsbergen) in 2018 (Figure 6.8.1).

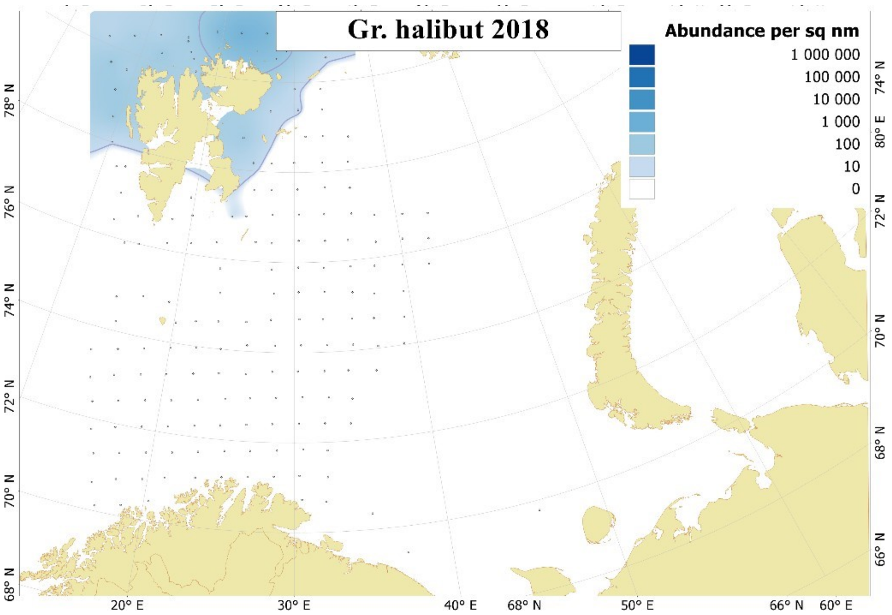

Figure 6.8.1. *Distribution of 0-group Greenland halibut, August-October 2018. Dots indicated sampling locations.*

6.9 Long rough dab (Hippoglossoides platessoides)

0-group long rough dab was found in the north part of the Norwegian EEZ, north of the 74 °N in 2018 (Figure 6.9.1).

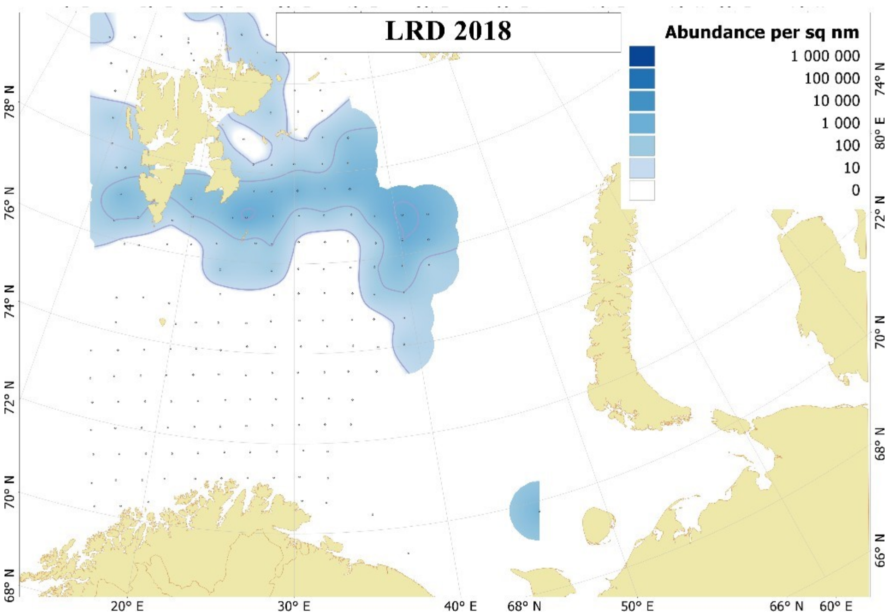

Figure 6.9.1. *Distribution of 0-group long rough dab, August-October 2018. Dots indicated sampling locations.*

6.10 Wolffishes (*Anarhichas sp.*)

There are three species of wolffish live in the Barents Sea: Atlantic wolffish (*Anarhichas lupus*), Spotted wolffish (*Anarhichas minor*) and Northern wolffish (*Anarhichas denticulatus*). 0-group of Atlantic wollfish and Spotted wolffish were found west, north and east of Svalbard (Spitsbergen) and in the central part of the Barents Sea in 2018 (Fig. 6.10.1). One specimen 0-group of Northern wolfish was found in the central part of the Barents Sea.

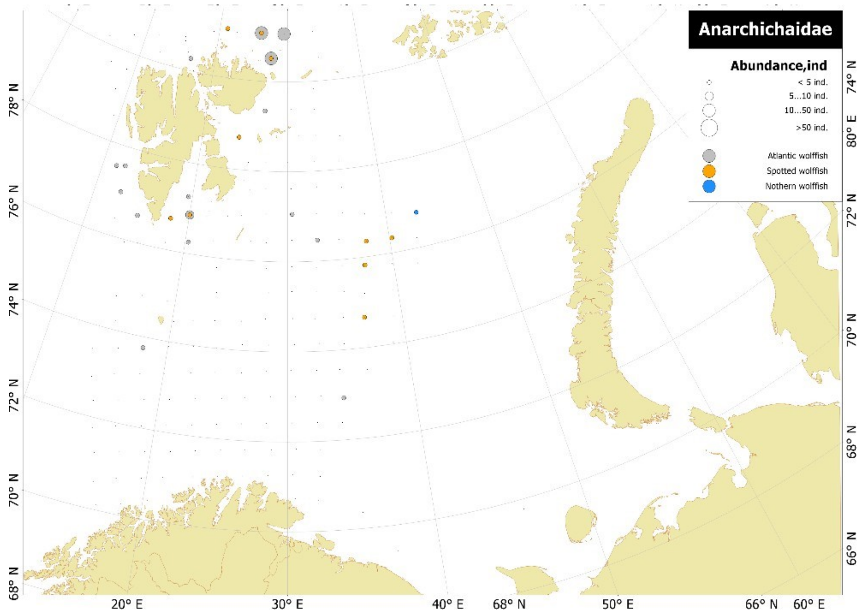

Figure 6.10.1. *Distribution of 0-group wolffishes, August-October 2018. Dots indicated sampling locations.*

6.11 Sandeel (Ammodytes marinus)

In 2018, 0-group sandeel were found in the western and central the Barents Sea (Figure 6.11.1).

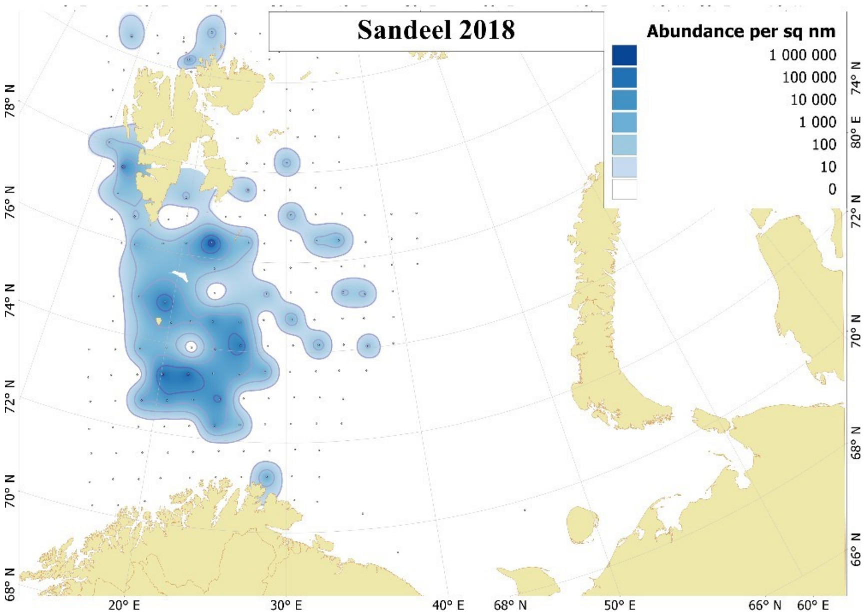

Figure 6.11.1. *Distribution of 0-group sandeel, August-October 2018. Dots indicated sampling locations.*

7 COMMERCIAL PELAGIC FISH

Text by: D. Prozorkevich, G. Skaret
Figures by: J. Alvarez, G. Skaret

7.1 Capelin (*Mallotus villosus*)

7.1.1 Geographical distribution

The geographical distribution of capelin recordings is shown in Figure 7.1.1.1. The main distribution area was along the western edges of the Great Bank, and little capelin was found in east and north.

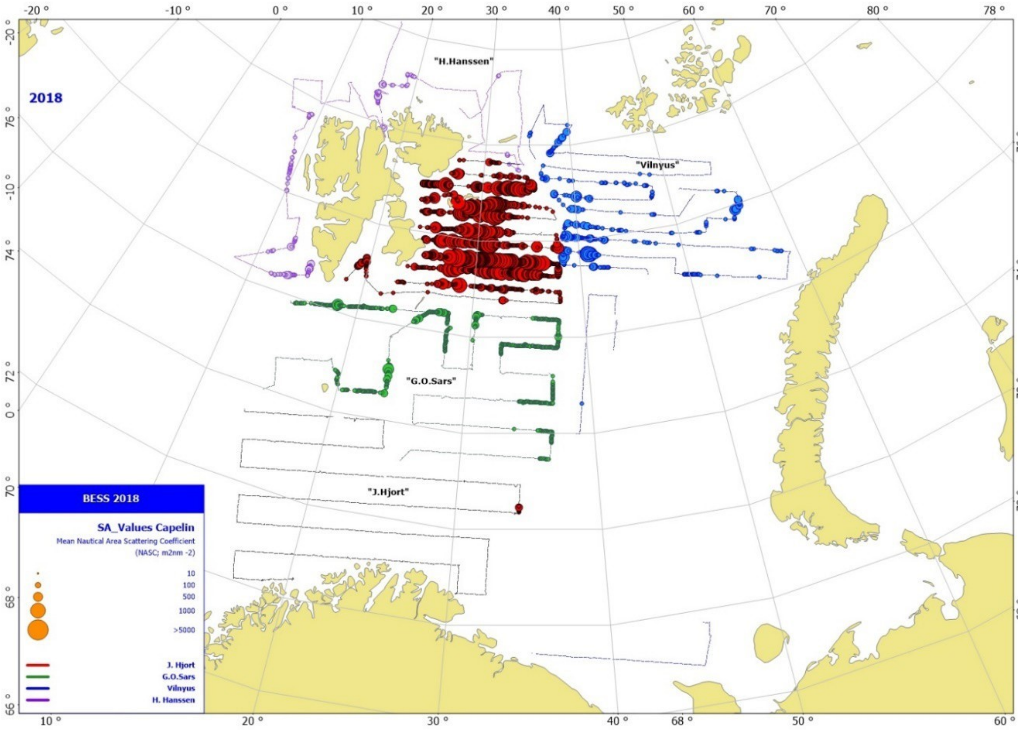

Figure. 7.1.1.1 *Estimated geographical distribution of capelin in autumn 2018. Circle sizes correspond to SA values per nautical mile.*

7.1.2 Abundance by size and age

A detailed summary of the acoustic stock estimate is given in Table 7.1.2.1, and the time series of abundance estimates is summarized in Table 7.1.2.2 (see Appendix Ch. 7). A comparison between the estimates in 2018 and 2017 is given in the table 7.1.2.3 with the 2017 estimate shown on a shaded background.

The total stock is estimated to about 1.6 million tonnes, which is below the long term mean level (ca. 2.9 million tonnes), and a 36% decrease from 2017. About 66 % (1.06 million tonnes) of the 2018 stock has length above 14 cm and is therefore considered to be maturing.

The average weight of age group 3+ decreased slightly compared to last year while weight of 2+ was equal (figure 7.1.2.2).

A more detailed description of biology and stock development of the Barents Sea capelin can be found in the reports of the ICES Working Group on integrated assessment of the Barents Sea (WGIBAR). The work concerning assessment and quota advice for capelin is dealt with in a separate report that will form part of the ICES Arctic Fisheries Working Group report for 2019.

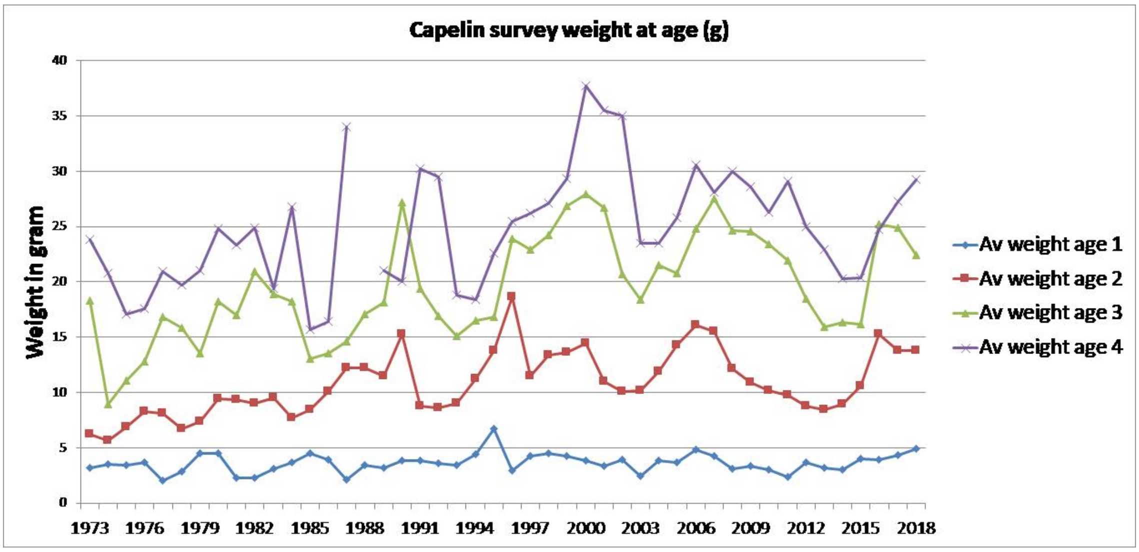

Figure 7.1.2.1. *Weight at age (grams) for capelin from capelin surveys (prior to 2003) and BESS*

*Capelin (*Mallotus villosus*), Photo: Monica von Minden, IMR.*

7.2 Polar cod (*Boreogadus saida*)

7.2.1 Geographical distribution

The main concentrations of polar cod were found in the north-eastern parts of the survey area, which is typical (Fig.7.2.1.1). Overall, polar cod abundance was low, but the survey coverage in the east was considered to be too low to conduct an abundance estimate (Table 7.2.2.1; Appendix Ch. 7).

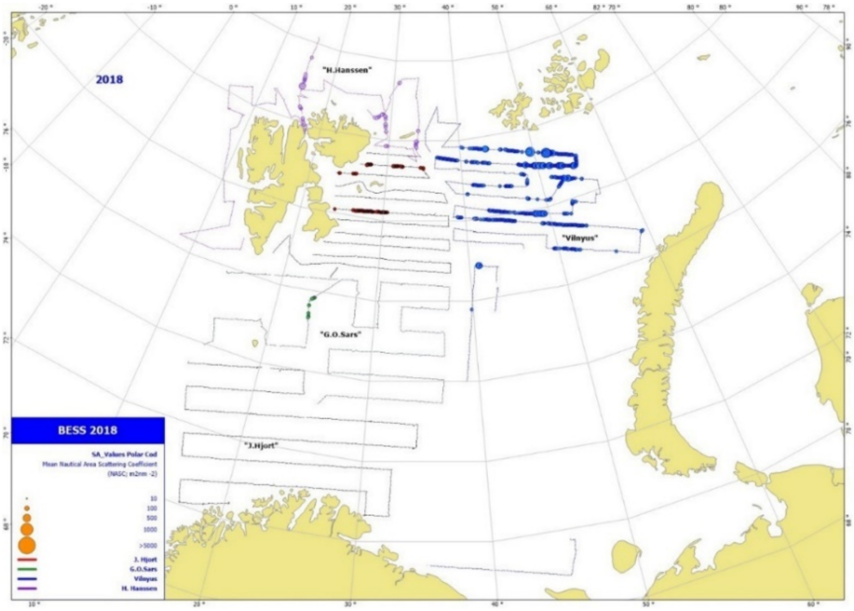

Figure 7.2.1.1 *Estimated geographical distribution of polar cod in autumn 2018. Circle sizes correspond to SA values per nautical mile.*

*Polar cod (*Boreogadus saida*). Photo: Monica von Minden, IMR.*

7.3 Herring (*Clupea harengus*)

7.3.1 Geographical distribution

Most young Norwegian spring spawning herring (NSSH) were distributed close to the Norwegian coast in 2018 (Figure 7.3.1.1), and recordings from the completed transect in the eastern Barents Sea suggests high abundance also here (Table 7.3.2.2; Appendix Ch. 7). However, the coverage in the eastern part was very limited.

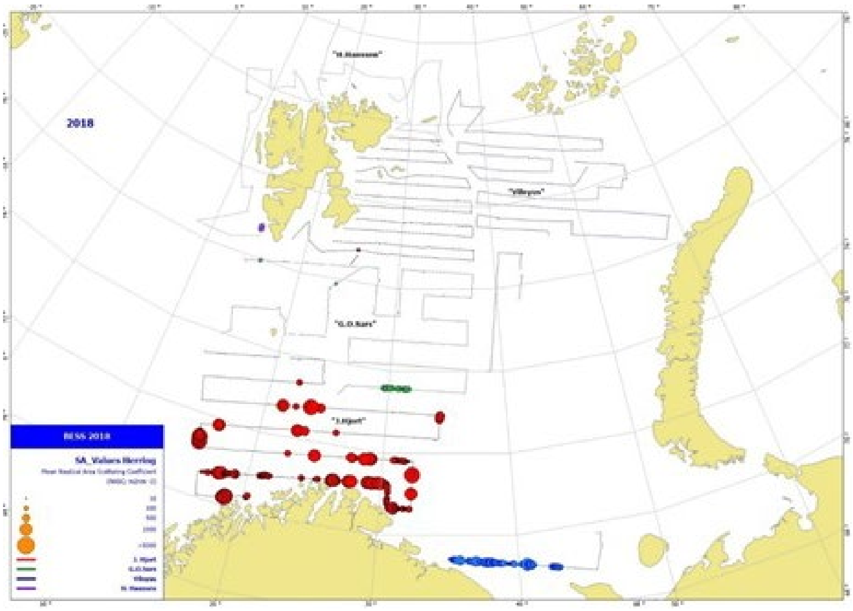

Figure 7.3.1.1 *Estimated geographical distribution of herring in autumn 2018. Circle sizes correspond to SA values per nautical mile.*

*Herring (*Clupea harengus*). Photo: Monica von Minden, IMR.*

7.4 Blue whiting (*Micromesistius poutassou*)

7.4.1 Geographical distribution

Blue whiting is an important component of the Barents Sea ecosystem, and changes in the stock of blue whiting in the Norwegian Sea are also observed in the Barents Sea.

As in previous years, blue whiting was observed in the western part of the Barents Sea, in particular along the continental shelf slope (Figure 7.4.1.1).

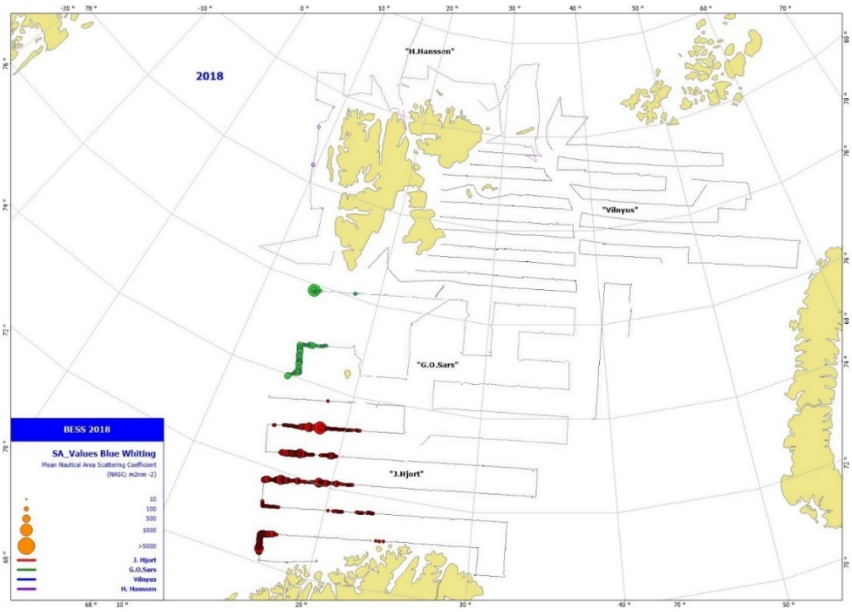

Figure 7.4.1.1. *Estimated geographical distribution of blue whiting in autumn 2018. Circle sizes correspond to SA values per nautical mile.*

7.4.2 Abundance by size and age

In previous BESS biomass estimates of blue whiting in the Barents Sea, the conversion from acoustic backscatter to biomass has been through the equation TS = 21.8 log (L) - 72.8 dB based on measurements of juvenile cod (Nakken and Olsen, 1977).

The formula was revised based on target strength measurements (Pedersen et al., 2011) and incorporated in the blue whiting assessment. The new equation is TS=20 log (L) - 65.2.

Prior to previous BESS report, the Barents Sea time series of blue whiting was recalculated by StoX software and the new TS-formula was used. As part of the recalculation, the coverage area was also standardised, and the western border was defined along the 500 m depth contour on the shelf edge. This was done to avoid annual variability due to differences in survey coverage from year to year. This method was used also for the present years' estimate.

From 2004-2007 estimated biomass of blue whiting in the Barents Sea was between 200 000 and 350 000 tons (Table 7.4.2.1, in appendix). 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, and this year the biomass was the lowest since 2011 and clearly slightly below the long term average.

The 4-year olds (2014 year class) dominated in terms of both number and biomass as expected based on the high abundance of 3-year-olds last year and 2-year-olds the year before (Table 7.4.2.2 and 7.4.2.3, in appendix).

*Blue whiting (*Micromesistius poutassou*). Photo: Erlend Astad Lorentzen, IMR*

References

Nakken O, Olsen K (1977) Target strength measurements of fish. Rapp Proc-Verb Réun Cons Int Explor Mer 170: 52–69.

Pedersen, G. Godø, O.R., Ona, E., Macaulay, G.J. (2011). A revised target strength–length estimate for blue whiting (*Micromesistius poutassou*): implications for biomass estimates. *ICES Journal of Marine Science*, Volume 68, Issue 10.

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Appendix: Ch 7

Pelagic fish

Ch 7.1 Capelin

Table 7.1.2.1 *Barents Sea capelin. Summary of results from the acoustic estimate in August-October 2018*

	Age/year class						
Length (cm)	1 2017	2 2016	3 2015	4 2014	Sum (10^9)	Biomass (10^3t)	Mean weight (g)
8 - 8.5	5.339	0	0	0	5.339	11.851	2.22
8.5 - 9	4.869	0	0	0	4.869	12.75	2.62
9 - 9.5	4.731	0	0	0	4.731	14.332	3.03
9.5 - 10	5.055	0.059	0	0	5.114	18.205	3.56
10 - 10.5	6.698	0.005	0	0	6.729	27.847	4.15
10.5 - 11	6.672	0.007	0	0	6.679	32.805	4.91
11 - 11.5	11.324	0.231	0	0	11.555	64.646	5.59
11.5 - 12	7.089	0.498	0.054	0	7.641	49.553	6.49
12 - 12.5	4.011	2.631	0	0	6.642	49.951	7.52
12.5 - 13	1.511	3.914	0.103	0	5.528	48.887	8.84
13 - 13.5	0.716	8.715	0.486	0	9.917	102.195	10.31
13.5 - 14	0.325	8.66	0.266	0	9.252	107.955	11.67
14 - 14.5	0.25	10.565	1.992	0	12.807	168.835	13.18
14.5 - 15	0.015	10.184	1.88	0	12.079	183.33	15.18
15 - 15.5	0	6.689	3.091	0	9.78	169.342	17.31
15.5 - 16	0	3.434	3.258	0	6.693	129.738	19.39
16 - 16.5	0	2.466	2.47	0.066	5.002	110.521	22.10
16.5 - 17	0	0.524	2.027	0.054	2.604	65.651	25.21
17 - 17.5	0	0.773	2.117	0.049	2.939	84.987	28.91
17.5 - 18	0	0.149	1.517	0.051	1.717	57.199	33.24
18 - 18.5	0	0.065	0.881	0.082	1.028	35.546	34.57
18.5 - 19	0	0.032	0.939	0.005	0.975	35.787	36.69
19 - 19.5	0	0	0.137	0.008	0.144	6.56	45.46
19.5 - 20	0	0	0.176	0	0.176	8.142	46.18
TSN(10^9)	58.603	59.602	21.392	0.316	139.913		
TSB(10^3t)	285	821.9	480.3	9.3		1596.5	
Mean length (cm)	10.28	14.00	15.83	17.13			
Mean weight (g)	4.86	13.79	22.45	29.28			
SSN (10^9)	0.265	34.881	20.486	0.315	55.944		
SSB (10^3t)	3.52	574.64	468.05	9.314		1055.638	

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

Table 7.1.2.2. *Barents Sea capelin. Acoustic estimates of the stock by age in autumn 1973-2018. Biomass (B) in 106 tonnes and average weight (AW) in grams. All estimates based on TS = 19.1 log (L) -74.0 Db*

Year	Age										
	1		2		3		4		5		Sum
	B	AW	B	AW	B	AW	B	AW	B	AW	B
1973	1.69	3.2	2.32	6.2	0.73	18.3	0.41	23.8	0.01	30.1	5.16
1974	1.06	3.5	3.06	5.6	1.53	8.9	0.07	20.8	+	25	5.72
1975	0.65	3.4	2.39	6.9	3.27	11.1	1.48	17.1	0.01	31	7.80
1976	0.78	3.7	1.92	8.3	2.09	12.8	1.35	17.6	0.27	21.7	6.41
1977	0.72	2	1.41	8.1	1.66	16.8	0.84	20.9	0.17	22.9	4.80
1978	0.24	2.8	2.62	6.7	1.20	15.8	0.17	19.7	0.02	25	4.25
1979	0.05	4.5	2.47	7.4	1.53	13.5	0.10	21	+	27	4.15
1980	1.21	4.5	1.85	9.4	2.83	18.2	0.82	24.8	0.01	19.7	6.72
1981	0.92	2.3	1.83	9.3	0.82	17	0.32	23.3	0.01	28.7	3.90
1982	1.22	2.3	1.33	9	1.18	20.9	0.05	24.9			3.78
1983	1.61	3.1	1.90	9.5	0.72	18.9	0.01	19.4			4.24
1984	0.57	3.7	1.43	7.7	0.88	18.2	0.08	26.8			2.96
1985	0.17	4.5	0.40	8.4	0.27	13	0.01	15.7			0.85
1986	0.02	3.9	0.05	10.1	0.05	13.5	+	16.4			0.12
1987	0.08	2.1	0.02	12.2	+	14.6	+	34			0.10
1988	0.07	3.4	0.35	12.2	+	17.1					0.42
1989	0.61	3.2	0.20	11.5	0.05	18.1	+	21.0			0.86
1990	2.66	3.8	2.72	15.3	0.44	27.2	+	20.0			5.82
1991	1.52	3.8	5.10	8.8	0.64	19.4	0.04	30.2			7.30
1992	1.25	3.6	1.69	8.6	2.17	16.9	0.04	29.5			5.15
1993	0.01	3.4	0.48	9.0	0.26	15.1	0.05	18.8			0.80
1994	0.09	4.4	0.04	11.2	0.07	16.5	+	18.4			0.20
1995	0.05	6.7	0.11	13.8	0.03	16.8	0.01	22.6			0.20
1996	0.24	2.9	0.22	18.6	0.05	23.9	+	25.5			0.51
1997	0.42	4.2	0.45	11.5	0.04	22.9	+	26.2			0.91
1998	0.81	4.5	0.98	13.4	0.25	24.2	0.02	27.1	+	29.4	2.06
1999	0.65	4.2	1.38	13.6	0.71	26.9	0.03	29.3			2.77
2000	1.70	3.8	1.59	14.4	0.95	27.9	0.08	37.7			4.32
2001	0.37	3.3	2.40	11.0	0.81	26.7	0.04	35.5	+	41.4	3.62
2002	0.23	3.9	0.92	10.1	1.04	20.7	0.02	35.0			2.21
2003	0.20	2.4	0.10	10.2	0.20	18.4	0.03	23.5			0.53
2004	0.20	3.8	0.29	11.9	0.12	21.5	0.02	23.5	+	26.3	0.63
2005	0.10	3.7	0.19	14.3	0.04	20.8	+	25.8			0.33
2006	0.29	4.8	0.35	16.1	0.14	24.8	0.01	30.6	+	36.5	0.79
2007	0.93	4.2	0.85	15.5	0.10	27.5	+	28.1			1.88
2008	0.97	3.1	2.80	12.1	0.61	24.6	0.05	30.0			4.43
2009	0.42	3.4	1.82	10.9	1.51	24.6	0.01	28.6			3.76
2010	0.74	3.0	1.30	10.2	1.43	23.4	0.02	26.3			3.50
2011	0.50	2.4	1.76	9.7	1.21	21.9	0.23	29.1			3.71
2012	0.54	3.7	1.37	8.8	1.62	18.5	0.06	25.0			3.59
2013	1.04	3.2	1.81	8.4	0.94	15.9	0.16	23.2	+	29.1	3.96
2014	0.32	3.0	0.95	8.9	0.64	16.3	0.04	20.3			1.95
2015	0.14	4.0	0.40	10.6	0.20	16.2	0.09	20.4	+	28.1	0.84
2016	0.12	3.9	0.12	15.3	0.08	25.2	0.004	24.7			0.33
2017	0.37	4.3	1.7	13.8	0.42	24.5	0.011	27.3			2.51
2018	0.29	4.9	0.8	13.8	0.48	22.5	0.009	29.3			1.60
Average	0.63	3.62	1.31	10.83	0.82	19.53	0.19	24.86	0.06	28.13	2.88

Table 7.1.2.3. *Table on summary of acoustic stock size estimates for capelin in 2017-2018. A comparison between the estimates this year and the previous year (shaded background)*

Year class		Age	Numbers (10^9)		Mean weight (g)		Biomass (10^3 t)	
2017	2016	1	58.6	86.4	4.86	4.28	285	369.7
2016	2015	2	59.6	123.74	13.79	13.8	821.9	1708.1
2015	2014	3	21.4	16.77	22.45	24.9	480.3	417.4
2014	2013	4	0.32	0.41	29.28	27.3	9.3	11.1
Total stock in:								
2018	2017	1-4	139.91	227.32	11.54	11.03	1598	2506.2

Ch. 7.2 Polar cod

Table 7.2.2.2 *Barents Sea polar cod. Summary of acoustic estimates by age in August-October. TSN and TSB is total stock numbers (10^9) and total stock biomass (10^3 tonnes) respectively*

Year	Age 1		Age 2		Age 3		Age 4+		Total	
	TSN	TSB	TSN	TSB	TSN	TSB	TSN	TSB	TSN	TSB
1986	24.038	169.6	6.263	104.3	1.058	31.5	0.082	3.4	31.441	308.8
1987	15.041	125.1	10.142	184.2	3.111	72.2	0.039	1.2	28.333	382.8
1988	4.314	37.1	1.469	27.1	0.727	20.1	0.052	1.7	6.562	86
1989	13.54	154.9	1.777	41.7	0.236	8.6	0.06	2.6	15.613	207.8
1990	3.834	39.3	2.221	56.8	0.65	25.3	0.094	6.9	6.799	127.3
1991	23.67	214.2	4.159	93.8	1.922	67	0.152	6.4	29.903	381.5
1992	22.902	194.4	13.992	376.5	0.832	20.9	0.064	2.9	37.79	594.9
1993	16.269	131.6	18.919	367.1	2.965	103.3	0.147	7.7	38.3	609.7
1994	27.466	189.7	9.297	161	5.044	154	0.79	35.8	42.597	540.5
1995	30.697	249.6	6.493	127.8	1.61	41	0.175	7.9	38.975	426.2
1996	19.438	144.9	10.056	230.6	3.287	103.1	0.212	8	33.012	487.4
1997	15.848	136.7	7.755	124.5	3.139	86.4	0.992	39.3	28.012	400.7
1998	89.947	505.5	7.634	174.5	3.965	119.3	0.598	23	102.435	839.5
1999	59.434	399.6	22.76	426	8.803	286.8	0.435	25.9	91.463	1141.9
2000	33.825	269.4	19.999	432.4	14.598	597.6	0.84	48.4	69.262	1347.8
2001	77.144	709	15.694	434.5	12.499	589.3	2.271	132.1	107.713	1869.6
2002	8.431	56.8	34.824	875.9	6.35	282.2	2.322	143.2	52.218	1377.2
2003*	32.804	242.7	3.255	59.9	15.374	481.2	1.739	87.6	53.172	871.4
2004	99.404	627.1	22.777	404.9	2.627	82.2	0.51	32.7	125.319	1143.8
2005	71.675	626.6	57.053	1028.2	3.703	120.2	0.407	28.3	132.859	1803.3
2006	16.19	180.8	45.063	1277.4	12.083	445.9	0.698	37.2	74.033	1941.2
2007	29.483	321.2	25.778	743.4	3.23	145.8	0.315	19.8	58.807	1230.1
2008	41.693	421.8	18.114	522	5.905	247.8	0.415	27.8	66.127	1219.4
2009	13.276	100.2	22.213	492.5	8.265	280	0.336	16.6	44.09	889.3
2010	27.285	234.2	18.257	543.1	12.982	594.6	1.253	58.6	59.777	1430.5
2011	34.46	282.3	14.455	304.4	4.728	237.1	0.514	36.7	54.158	860.5
2012	13.521	113.6	4.696	104.3	2.121	93	0.119	8	20.457	318.9
2013	2.216	18.1	4.317	102.2	5.243	210.3	0.18	9.9	11.956	340.5
2014	0.687	6.5	4.439	110	3.196	121	0.08	5.3	8.402	243.2
2015	10.866	97.1	1.995	45.1	0.167	5.3	0.008	0.5	13.036	148
2016	95.919	792.7	6.38	139.1	0.207	6.9	0.023	0.7	102.529	939.4
2017	13.81	121.82	8.269	200.8	1.112	34.29	0.0032	0.14	23.195	357.05
2018	-	-	-	-	-	-	-	-	-	-
Average	30.91	247.32	14.08	322.38	4.74	178.57	0.50	27.07	50.26	777.07

Ch. 7.3 Spring-spawning herring

Table 7.3.2.2 *Norwegian spring spawning herring. Summary of acoustic estimates by age in autumn 1999-2017. TSN and TSB are total stock numbers (10^9) and total stock biomass (10^3t) respectively*

Age	1		2		3		4+		Sum	
Year	TSN	TSB	TSN	TSB	TSN	TSB	TSN	TSB	TSN	TSB
1999	48.759	716	0.986	31	0.051	2	0	0	49.795	749
2000	14.731	383	11.499	560	0	0	0	0	26.230	943
2001	0.525	12	10.544	604	1.714	160	0	0	12.783	776
2002	**No data**	–	–	–	–	–	–	–	–	–
2003	99.786	3090	4.336	220	2.476	326	0	0	106.597	3636
2004	14.265	406	36.495	2725	0.901	107	0	0	51.717	3252
2005	46.38	984	16.167	1055	6.973	795	0	0	69.520	2833
2006	1.618	34	5.535	398	1.620	211	0	0	8.773	643
2007	3.941	148	2.595	218	6.378	810	0.25	46	13.164	1221
2008	0.03	1	1.626	77	3.987**	287**	3.223**	373**	8.866**	738**
2009	0.002	48	0.433	52	1.807	287	1.686	393	5.577	815
2010	1.047	35	0.215	34	0.234	37	0.428	104	2.025	207
2011	0.095	3	1.504	106	0.006	1	0	0	1.605	109
2012	2.031	36	1.078	66	1.285	195	0	0	4.394	296
2013	7.657	202	5.029	322	0.092	13	0.057	9	12.835	546
2014	4.188	62	1.822	126	6.825	842	0.162	25	13.011	1058
2015	1.183	6	9.023	530	3.214	285	0.149	24	13.569	845
2016	7.760	131	1.573	126	3.089	389	0.029	6	12.452	652
2017	34.95	820	2.138	141	3.465	412	0.982	210	41.537	1583
2018	-	-	-	-	-	-	-	-	-	-
Average	16.053	395	6.255	411	2.451	287	0.387	66	25.247	1161

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

Ch. 7.4 Blue whiting abundance

Table 7.4.2.1 *Blue whiting. Acoustic estimate in the Barents Sea in August-October 2018.*

Length (cm)	age group/year-class											Sum (10^6)	Biomass (10^3 t)	Mean weight (g)
	2 2016	3 2015	4 2014	5 2013	6 2012	7 2011	8 2010	9 2009	10 2008	12 2006	Unknown			
20.5-21.0											1.5	1.5	0.1	50.2
21.0-21.5											2.2	2.2	0.1	46.0
21.5-22.0											4.0	4.0	0.2	52.9
22.0-22.5											4.0	4.0	0.2	55.4
22.5-23.0	9.0											9.0	0.5	58.2
23.0-23.5											8.3	8.3	0.5	65.2
23.5-24.0	4.2	0.2										4.4	0.3	67.2
24.0-24.5	4.1	5.5										9.7	0.7	74.7
24.5-25.0		12.9	6.4									19.3	1.6	84.1
25.0-25.5		14.9										14.9	1.4	93.6
25.5-26.0	0.7		24.4									25.0	2.5	100.1
26.0-26.5		20.8	2.9									23.7	2.5	105.5
26.5-27.0		2.2	31.9									34.1	3.8	112.1
27.0-27.5			28.0									28.0	3.3	119.6
27.5-28.0			29.1									29.1	3.7	128.0
28.0-28.5		0.6	19.1	5.3								25.0	3.4	137.2
28.5-29.0		16.9	2.3									19.2	2.8	144.3
29.0-29.5			5.9	6.6								12.5	1.9	149.2
29.5-30.0				18.6								18.6	2.9	156.6
30.0-30.5				7.3	0.8							8.1	1.4	173.3
30.5-31.0			0.1	5.6								5.7	1.0	178.4
31.0-31.5											1.8	1.8	0.3	169.4
31.5-32.0				3.0								3.0	0.6	183.1
32.0-32.5		0.1		0.1	0.5		4.6					5.4	1.0	192.6
32.5-33.0				3.7				0.6				4.3	0.9	206.0
33.0-33.5				0.8								0.8	0.2	214.0
33.5-34.0					0.2		1.6					1.7	0.4	225.5
34.0-34.5											1.7	1.7	0.4	234.9
34.5-35.0											0.3	0.3	0.1	207.5
35.0-35.5				0.1		0.2	0.7					0.9	0.3	270.1
35.5-36.0									1.1			1.1	0.2	231.9
36.0-36.5							2.2			0.7		2.9	0.7	258.1
36.5-37.0														
37.0-37.5							0.1					0.1	0.0	291.3
37.5-38.0							0.5		0.3	0.1		0.9	0.3	323.7
38.0-38.5											0.2	0.2	0.1	364.0
38.5-39.0											0.1	0.1	0.0	380.5
39.5-40.0											0.2	0.2	0.1	287.0
TSN(1000)	18.0	74.0	150.1	51.1	1.5	0.2	9.7	0.6	1.4	0.7	24.4	331.9		
TSB(1000)	1.2	7.9	17.8	8.4	0.3	0.1	2.2	0.1	0.4	0.2	2.1		40.6	
Mean length	21.1	24.5	25.4	27.7	31.3	31.5	31.5	36.9	37.0	36.0	21.3			
Mean weight	50.9	86.3	97.6	129.2	189.6	190.5	209.0	285.5	289.5	258.5	52.1			122.3

***Table 7.4.2.2** Blue whiting. Acoustic estimates by age in autumn 2004-2018. TSN and TSB are total stock numbers (10^6) and total stock biomass (10^3 tons)*

Age	1		2		3		4+		Sum	
Year	TSN	TSB	TSN	TSB	TSN	TSB	TSN	TSB	TSN	TSB
2004	669	26	439	33	1056	98	1211	159	3575	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	637	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	0	349	28	135	13	175	42	664	84
2014	111	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	269	38	1143	115
2018			18	1	74	8	215	29	332	40
Average	277	11	255	19	363	34	409	101	1328	129

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

***Table 7.4.2.3** Summary of stock size estimates for Blue whiting in 2017-2018*

Year class		Age	Number (10^9)		Mean weight (g)		Biomass (10^3 t)	
2017	2016	1	0	43	-	50.9	0	2
2016	2015	2	18	253	65.4	86.3	1	22
2015	2014	3	74	503	106.5	97.6	8	49
2014-	2013-	4+	215	269	136.6	142.2	29	38
Total stock in								
2018	2017	1-4+	332	1143	122	100.8	40	115

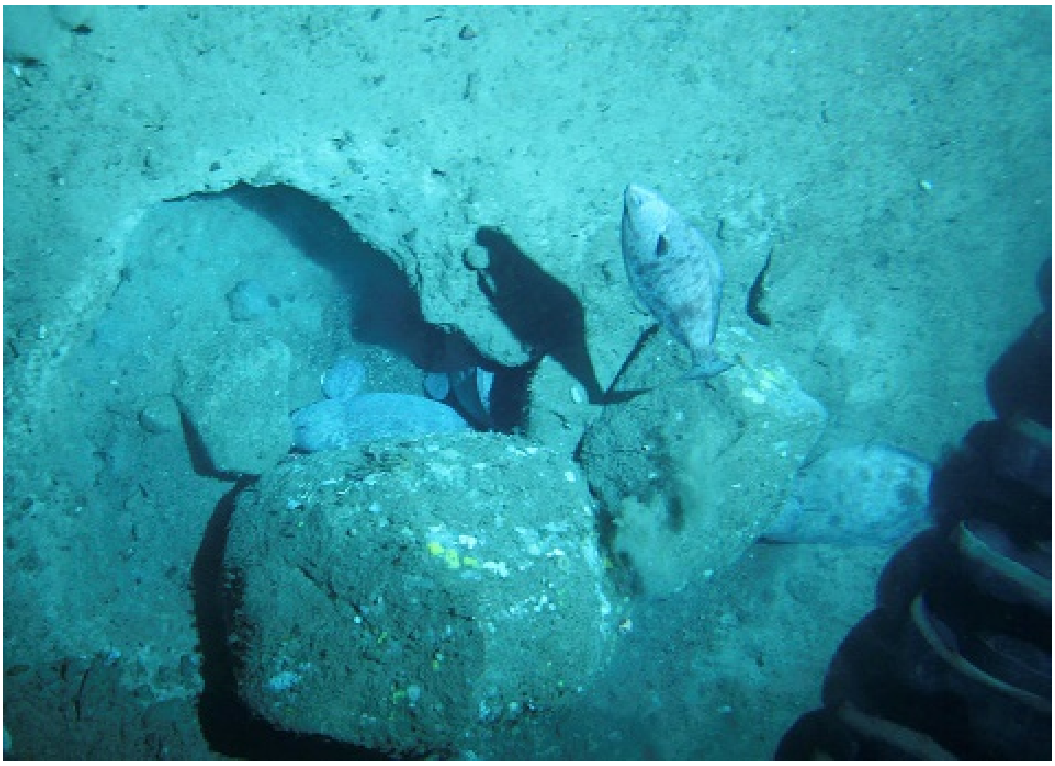
8 COMMERCIAL DEMERSAL FISH

Text by: B. Bogstad, E. H. Hallfredsson, H. Höffle, D. V. Prozorkevitch
Figures by: P.Krivosheya

This section provides data on the distribution and BESS stock indices for the main commercial fish species.

In 2018 the area covered decreased considerably compared to 2017, as a large area in the southeastern Barents Sea was not covered. Thus, in this report we mainly provide maps and some comments on geographical distribution. For some stocks (redfishes and saithe), for which the geographical coverage was considered to be close to complete, indices for 2018 have been calculated. Estimates of the abundance and biomass of demersal fish for previous years are given in Table 8.1. Stock indexes for previous years were calculated by the swept area method (Jakobsen, 1997) which are described in the Survey manual:

http://www.imr.no/tokt/okosystemtokt_i_barentshavet/nb-no and in AFWG 2014 (WD02).



*Greenland halibut (*Reinhardtius hippoglossoides*) and northen wolfish (*Anarhichas denticulatus*). Photo: IMR.*

*Mixed haul of redfish (*Sebastes sp*). Photo: Erlend Astad Lorentzen, IMR*

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. 8.1.1), and the distribution pattern was fairly similar to last year. However, cod was hardly found in the area close to the western part of Frans Josef Land, where large catches have been found in previous years. Overall, the cod abundance in the area surveyed was slightly lower in 2018 than in 2017.

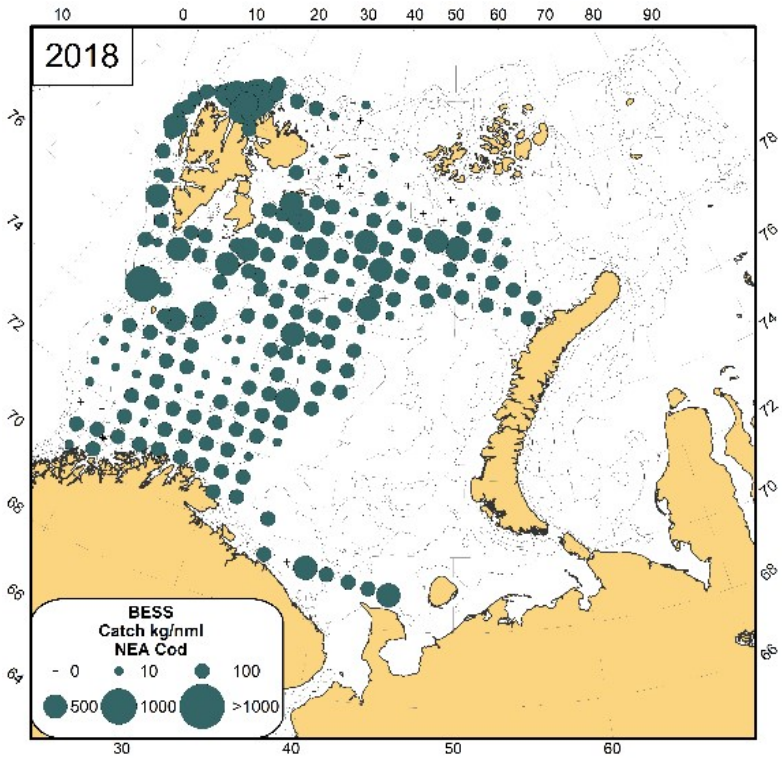


Figure 8.1.1 *Distribution of cod (*Gadus morhua*), August-October 2018.*

8.2 Haddock (*Melanogrammus aeglefinus*)

Within the area surveyed, the haddock distribution in 2018 was similar to that found in 2017 (Fig. 8.2.1). However, haddock was absent from some stations in the central Barents Sea where low catches have been taken in previous years. Overall, the haddock abundance in the area surveyed about the same in 2018 as in 2017. A large part of the haddock stock is usually found in the area which was not covered this year, so the survey should not be used as any indication of the trend in stock abundance.

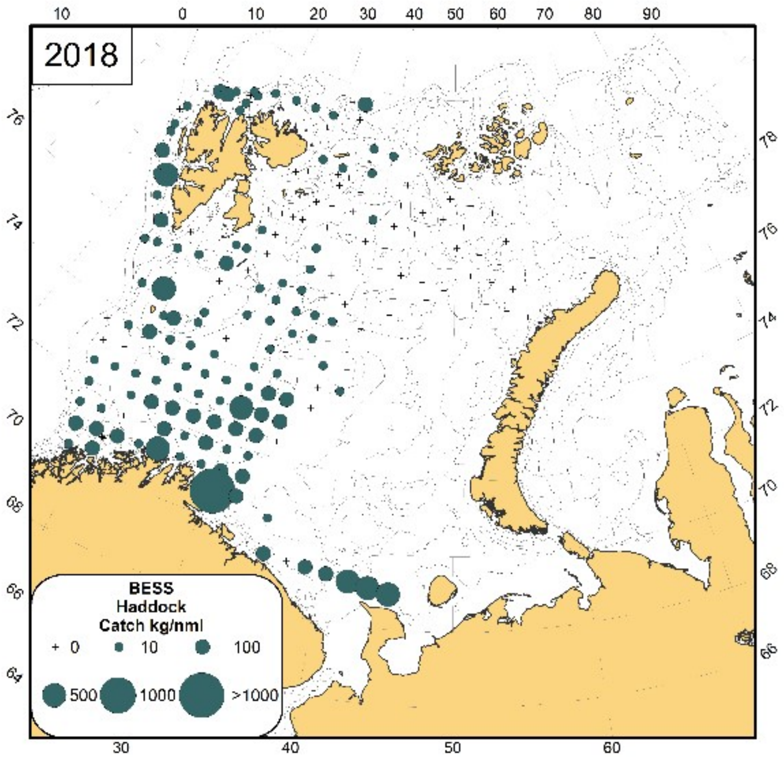


Figure 8.2.1 *Distribution of haddock (*Melanogrammus aeglefinus*), August-October 2018.*

8.3 Saithe (*Pollachius virens*)

This survey covers only a minor part of the total Northeast arctic saithe stock distribution. As in previous years, the main concentrations of saithe were distributed along the Norwegian coast (Fig. 8.3.1). The abundance of saithe in 2018 seems lower than in 2017. The incomplete coverage did probably not affect the coverage of the saithe distribution.

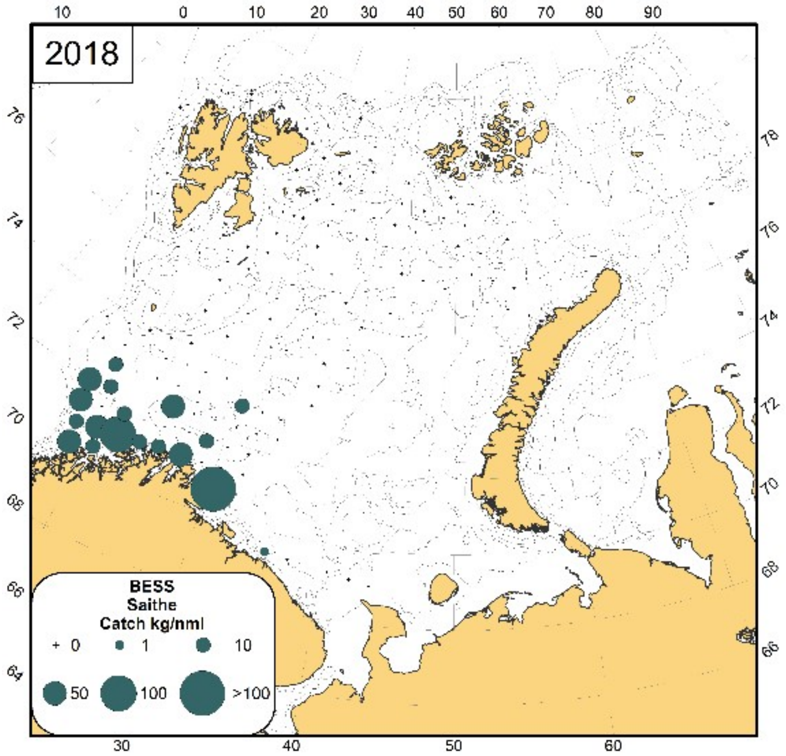


Figure 8.3.1 *Distribution of saithe (*Pollachius virens*), August-October 2018.*

8.4 Greenland halibut (*Reinhardtius hippoglossoides*)

BESS covers mainly an area where young Greenland halibut is found, including nursery area in the northern most 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.

G. halibut indices that are used in the assessment in ICES AFWG are calculated in a different way than here. The BESS registrations are divided into northern (nursery) area 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. 8.4.1). Compared to last year the distribution pattern has not changed, but the catches decreased in the northern part of the area surveyed. The main concentrations of G. halibut were observed around Svalbard (Spitsbergen), to the west of Franz Josef Land, and in the Bear Island Trench.

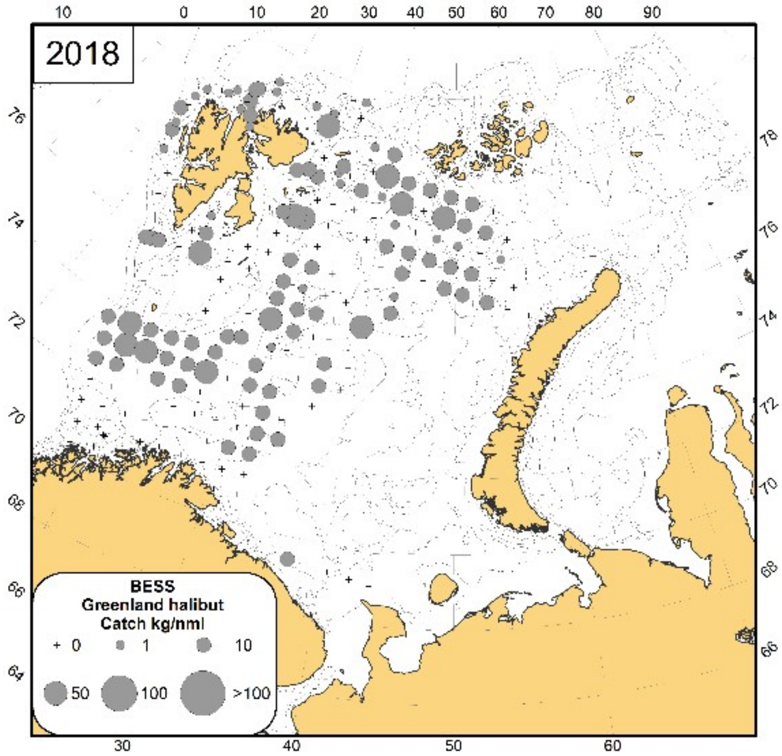


Figure 8.4.1 *Distribution of Greenland halibut (*Reinhardtius hippoglossoides*), August-October 2018.*

8.5 Golden redfish (*Sebastes norvegicus*)

In 2018, golden redfish was mainly observed along the Norwegian coast and to the west of Spitsbergen. (Fig. 8.5.1). The abundance of golden redfish west of Spitsbergen increased compared to 2017, while it was absent along the shelf break west of Bear Island and abundance along the Murman coast was back at similar levels to 2015 and 2016.

8.6 Deep-water redfish (*Sebastes mentella*)

Deep-water redfish was widely distributed in almost the entire area surveyed. The distribution and abundance in 2018 was quite similar to that in 2017 (Fig. 8.6.1). Highest catches of deep-water redfish were concentrated in the area southeast of Bear Island, particularly along the northern edge of the Bear Island Trench.

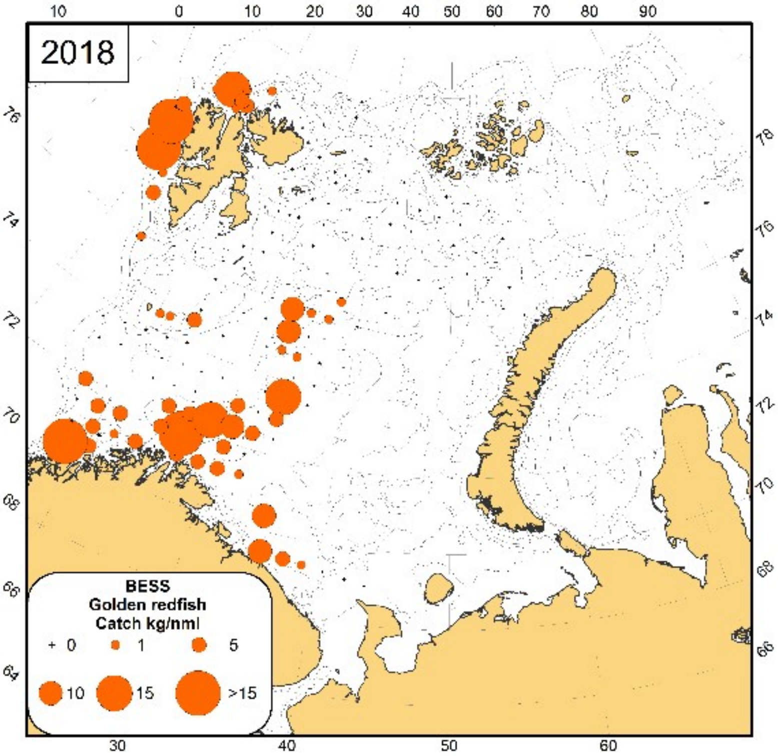


Figure 8.5.1 *Distribution of golden redfish (*Sebastes norvegicus*), August-October 2018.*

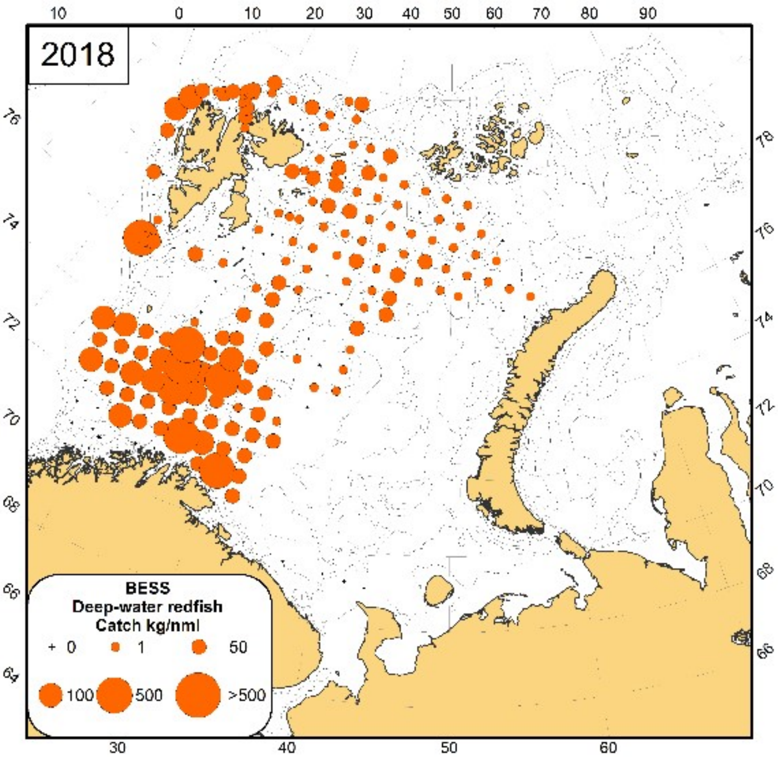


Figure 8.6.1 *Distribution of deep-water redfish (*Sebastes mentella*), August-October 2018.*

8.7 Long rough dab (*Hippoglossoides platessoides*)

As usual, long rough dab were found in the entire area surveyed (Fig. 8.7.1). The distribution and abundance in 2018 was quite similar to that in 2017.

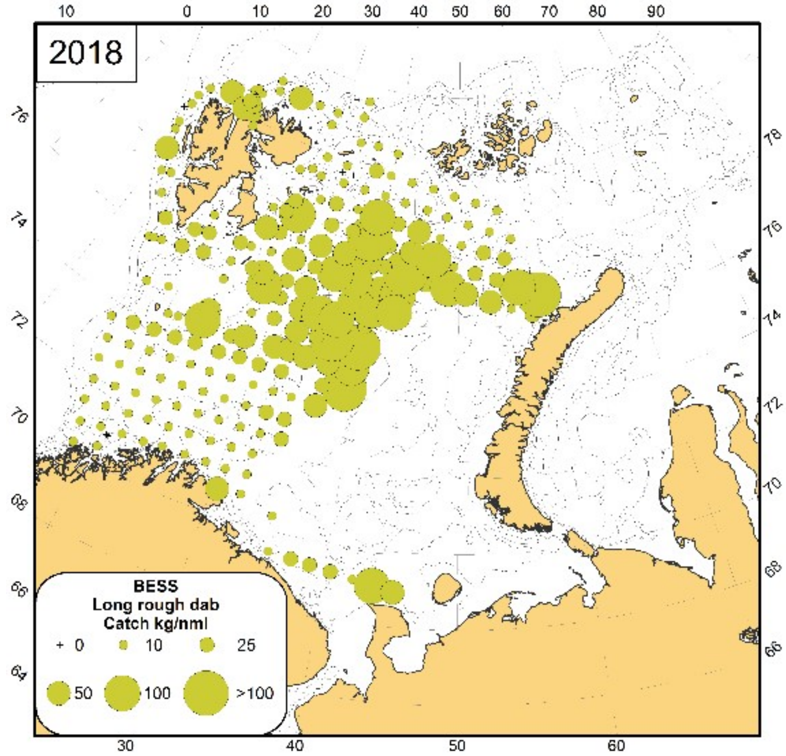


Figure 8.7.1 *Distribution of long rough dab (*Hippoglossoides platessoides*), August-October 2018.*

8.8 Atlantic wolffish (*Anarhichas lupus*)

Atlantic wolffish is the most numerous of the three species of wolffishes inhabiting the Barents Sea, while it has the lowest biomass of the three species. Abundance and distribution of Atlantic wolffish in 2018 (Fig 8.8.1) was generally similar to last year.

8.9 Spotted wolffish (*Anarhichas minor*)

Spotted wolffish is the most valuable commercial wolffish species. In 2018 the abundance and distribution of spotted wolffish was almost the same as in previous years (Fig. 8.9.1).

8.10 Northern wolffish (*Anarhichas denticulatus*)

In 2018 the abundance and distribution of northen wolffish was almost the same as in previous years (Fig. 8.10.1).

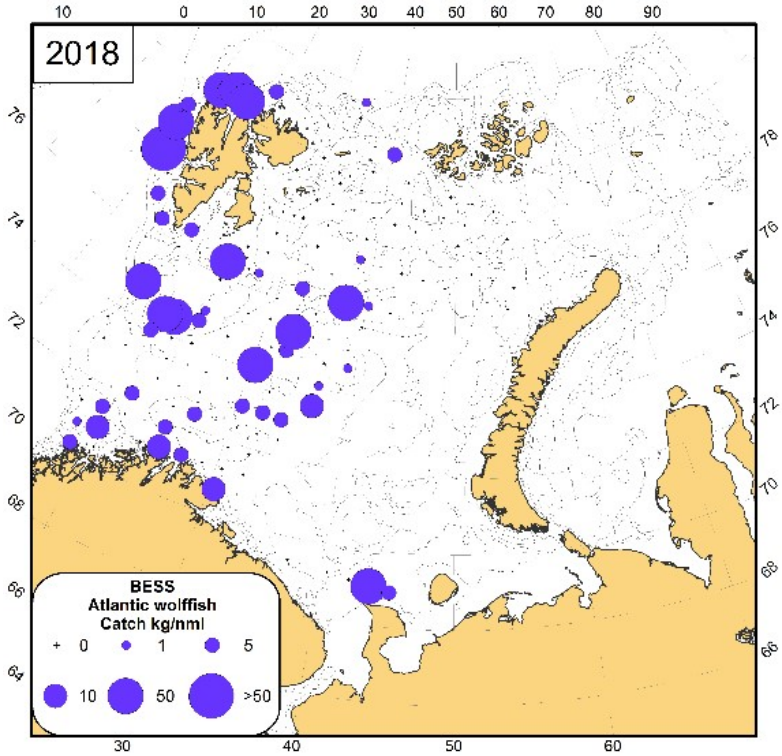


Figure 8.8.1 *Distribution of Atlantic wolffish (*Anarhichas lupus*), August-October 2018.*

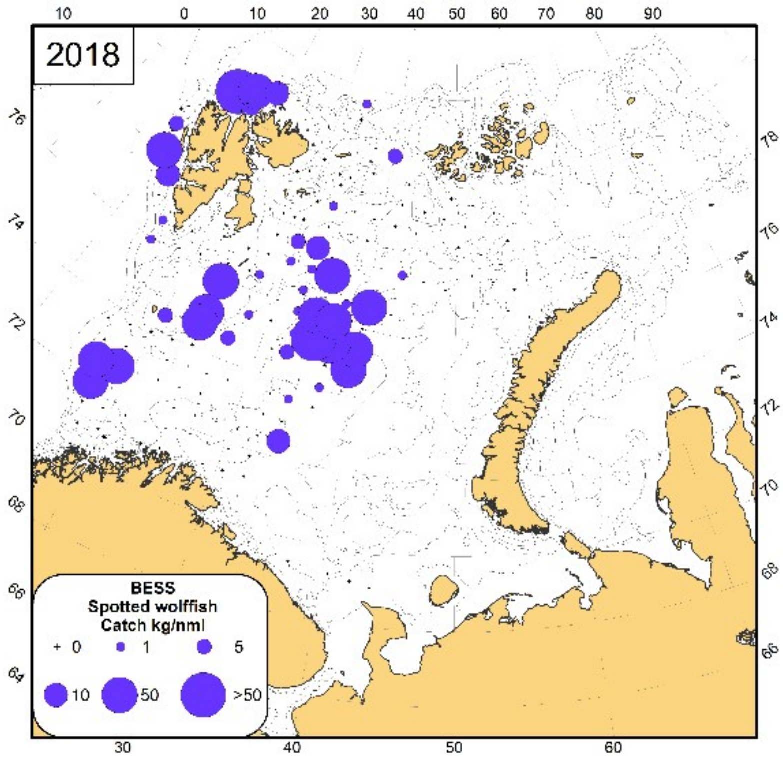


Figure 8.9.1 *Distribution of spotted wolffish (*Anarhichas minor*), August-October 2018.*

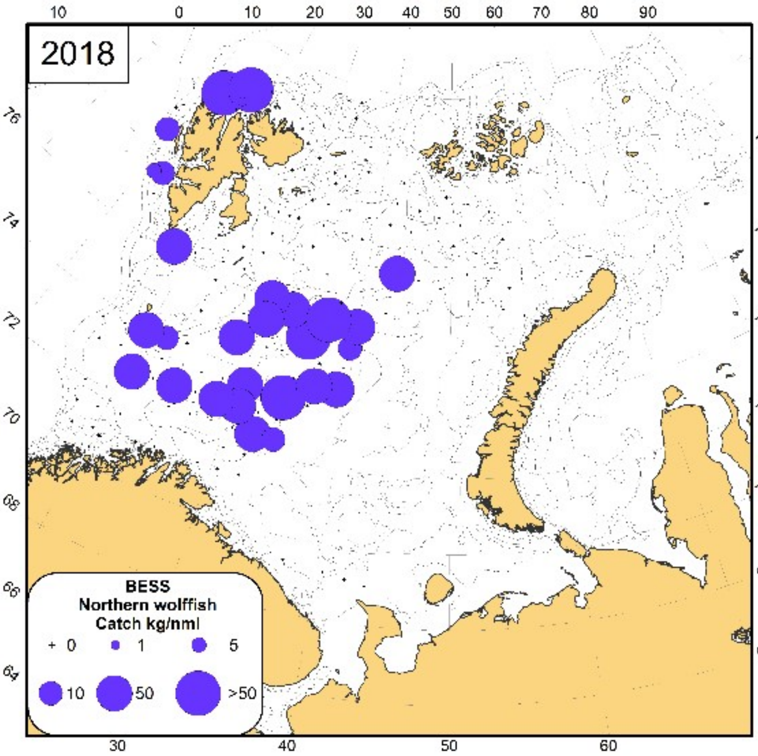


Figure 8.10.1 *Distribution of northern wolffish (*Anarhichas denticulatus*), August-October 2018.*

8.11 Plaice (*Pleuronectes platessa*)

Only a minor part of the distribution area of plaice was covered in 2018 (Fig. 8.11.1), so no conclusions about the state of this stock can be drawn based on the 2018 ecosystem survey.

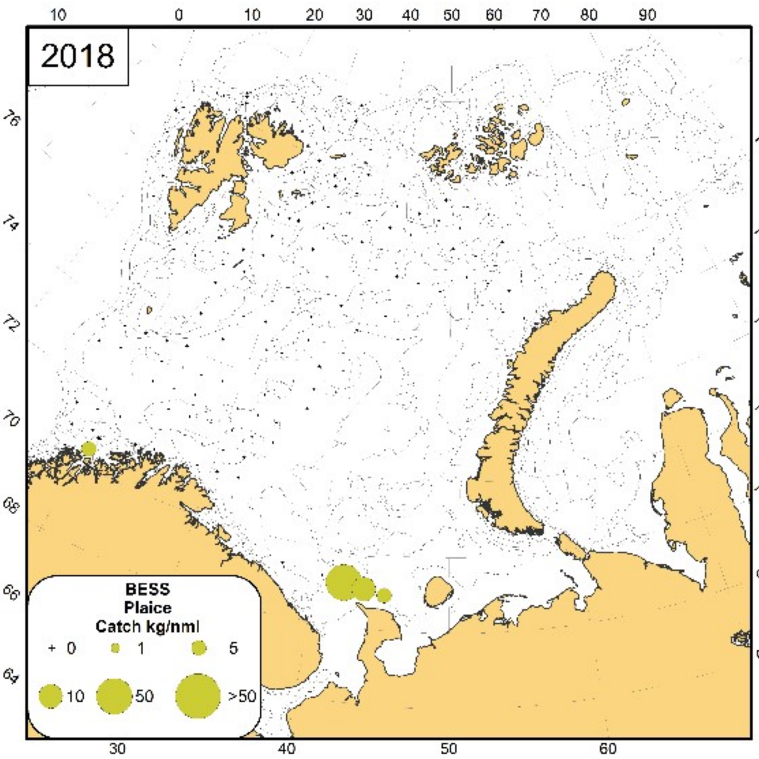


Figure 8.11.1 *Distribution of plaice (*Pleuronectes platessa*), August-October 2018..*

Appendix Ch 8

Demersal fish

Table 8.1. *Abundance (N, million individuals) and biomass (B, thousand tonnes) of the main demersal fish species in the Barents Sea (not including 0-group)*

Species		Year											
			2007	2008	2009	2010	2011	2012	2013	2014	2015	2016*	2017	2018*
Atlantic wolffish	N	26	42	25	20	17	20	22	27	12	33	40	30	
	B	11	11	14	8	17	13	9	30	12	37	24	29	
Spotted wolffish	N	12	12	13	9	7	9	13	13	8	12	13	14	
	B	46	42	51	47	37	47	83	84	51	86	40	63	
Northern wolffish	N	2	3	3	3	3	6	8	12	6	9	8	8	
	B	19	25	22	31	25	42	45	52	34	63	51	63	
Long rough dab	N	3705	5327	3942	2600	2520	2507	4563	4932	3046	3624	3369	4604	
	B	378	505	477	299	356	322	584	565	413	438	402	538	
Plaice	N	36	120	57	21	34	36	21	36	170	107	37	17	
	B	19	55	29	13	21	26	13	29	121	79	29	19	
Golden redfish	N	16	20	42	12	22	14	32	75	45	9	34	34	73
	B	16	11	17	11	4	5	8	20	13	5	24	18	21
Deep-water redfish	N	526	796	864	1003	1076	1271	1587	1608	927	894	1527	1705	1298
	B	219	183	96	213	112	105	196	256	208	214	319	212	260
Greenland halibut	N	430	296	153	191	186	175	209	160	43	79	82	134	
	B	77	86	76	90	150	88	86	94	53	52	40	74	
Haddock	N	3518	4307	3263	1883	2222	1068	1193	734	1110	1135	1604	1321	
	B	659	1156	1246	1075	1457	890	697	570	630	505	836	303	
Saithe	N	28	70	3	33	5	9	14	18	3	105	58	282	30
	B	49	98	7	29	9	10	13	33	6	153	54	193	24
Cod	N	1539	1724	1857	1593	1651	1658	2576	2379	1373	1694	1767	1880	
	B	810	882	1536	1345	2801	2205	1837	2132	1146	1425	1087	1397	

*survey coverage was incomplete in the central part of the Barents Sea.

*not full coverage of the survey area

9 FISH BIODIVERSITY

9.1 Fish biodiversity in the pelagic compartment

Responsible: E. Eriksen, T. Prokhorova, and A. Dolgov

No estimation could be made for pelagic fish biodiversity due to limited cover of the survey area.

9.2 Fish biodiversity in the demersal compartment

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

9.2.1 Norway pout (Trisopterus esmarkii).

Despite of poor coverage of the Russian Zone, the estimation of distribution, abundance and biomass of Norway pout in August-October 2018 is quite reliable since this species traditionally distributes in the south-western Barents Sea. Only a very small part of the population can distribute in the south-eastern part, which wasn't investigated in 2018.

The distribution of Norway pout in 2018 was similar to last year (Fig. 9.2.1). Main concentrations were found in the south-western part of the Barents Sea along the Norwegian coast. The maximum catch ant the average catch of Norway pout (303.2 kg/nautical mile and

3.57 kg/nautical mile respectively) in 2018 were higher than in 2017 (142.7 kg/nautical mile and 1.3 kg/nautical mile). Total biomass of Norway pout (50800 tonnes) and total abundance (1687.2 million individuals) was higher in 2018 than in 2017 (21600 tonnes, and 1260.6 million individuals) (Table 9.2.1).

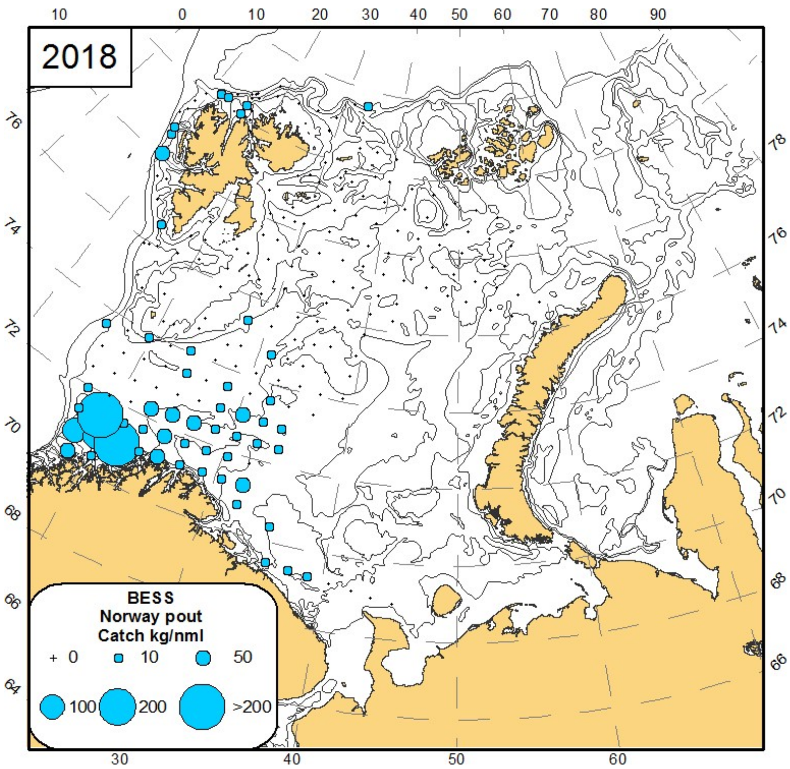


Figure 9.2.1 *Distribution of Norway pout (*Trisopterus esmarkii*), August-October 2018.*

9.2.2 Norway redfish (Sebastes viviparus).

As the previous species, to the estimation of distribution, abundance and biomass of Norway redfish in August-October 2018 are reliable. This species traditionally distributes also in the south-western part of the Barents Sea. Only a very small part of the population can distribute in the south-eastern part, which wasn't investigated in 2018.

In 2017 Norway redfish were mainly observed in the south-western area of the survey along the Norwegian coast, similar to 2017 (Fig. 9.2.2). The maximum catch of Norway redfish in 2018 was 481.9 kg/nautical mile with average of 3.33 kg/nautical mile, and it is higher than in 2017 (156.5 kg/nautical mile and 0.7 kg/nautical mile respectively). Total abundance and biomass indices in 2018 (202.9 million individuals and 25300 tonnes) were higher than in 2017 (133.7 million individuals and 14300 tonnes) (Table 9.2.1; Appendix: Ch. 9).

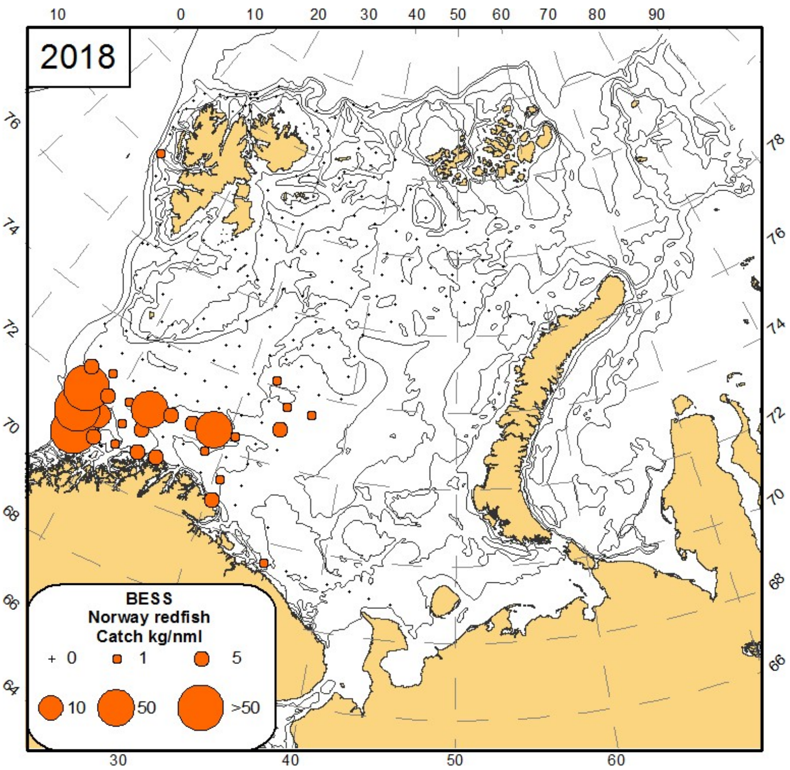


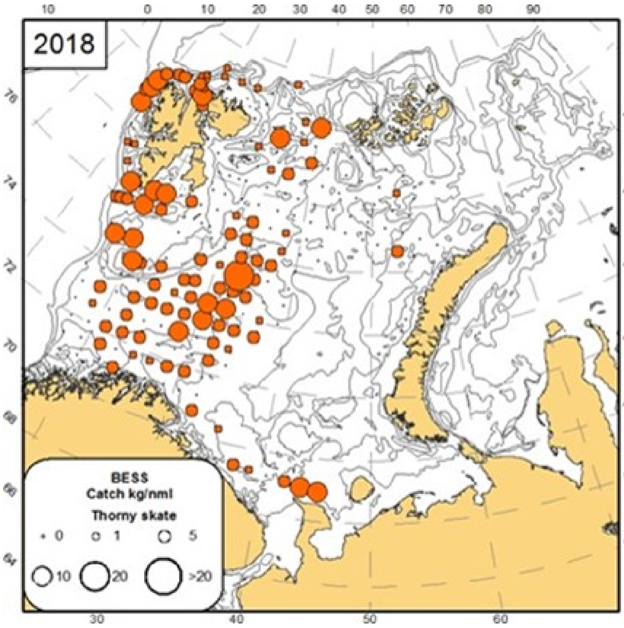
Figure 9.2.2 *Distribution of Norway redfish (*Sebastes viviparus*), August-October 2018.*

9.2.3 Thorny skate (Amblyraja radiata) and Arctic skate (Amblyraja hyperborea)

Thorny and Arctic skates 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 are widely distributed in the Barents Sea except the most north- eastern areas, while Arctic skate belongs to the Arctic zoogeographic group and are distributed in the cold water of the northern area.

Due to poor coverage of the Russian Zone by BESS in 2018 it is impossible to estimate distribution, abundance and biomass of skates. So, only maps of distribution on the observed area are present in the Report, without comparison to previous years.

Thorny skate was widely distributed in the Norwegian Zone, from the southwest to the northwest where warm Atlantic and Coastal Waters dominate (Figure 9.2.3). Arctic skate was observed on the small number of stations in the northern part of observed area (Figure 9.2.3).



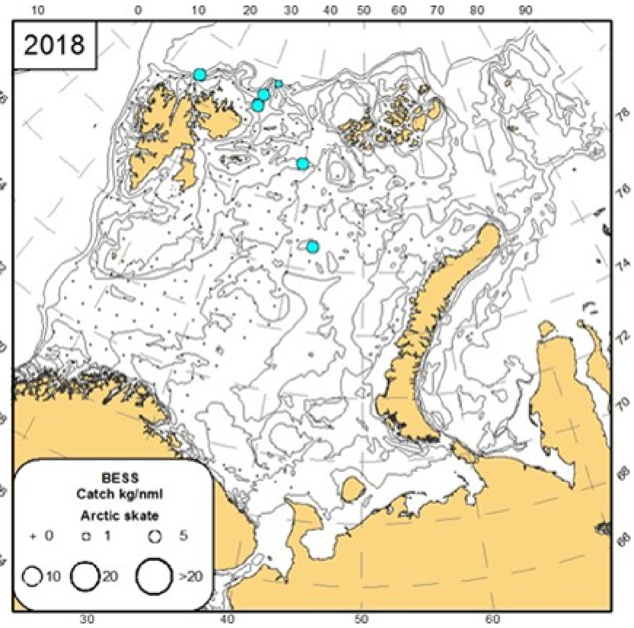


Figure 9.2.3 *Distribution of thorny skate (*Amblyraja radiata*) (land Arctic skate (*Amblyraja hyperborea*), August-October 2018.*

9.3 Uncommon or rare species

by T. Prokhorova, E. Johannesen, A. Dolgov and R. Wienerroither
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 observed in the Barents Sea during the ecosystem survey in 2018 (Figure 9.3.1). E.g. Atlantic salmon *Salmo salar* is anadromous and sporadically found in the Barents Sea. Arctic cod *Arctogadus glacialis* and Lutken's eelpout *Lycodes luetkenii* are distributed in the Arctic polar basin. Roughhead grenadier *Macrourus berglax* is found in deeper, Atlantic Water.

Photo: Monica von Minden, IMR.

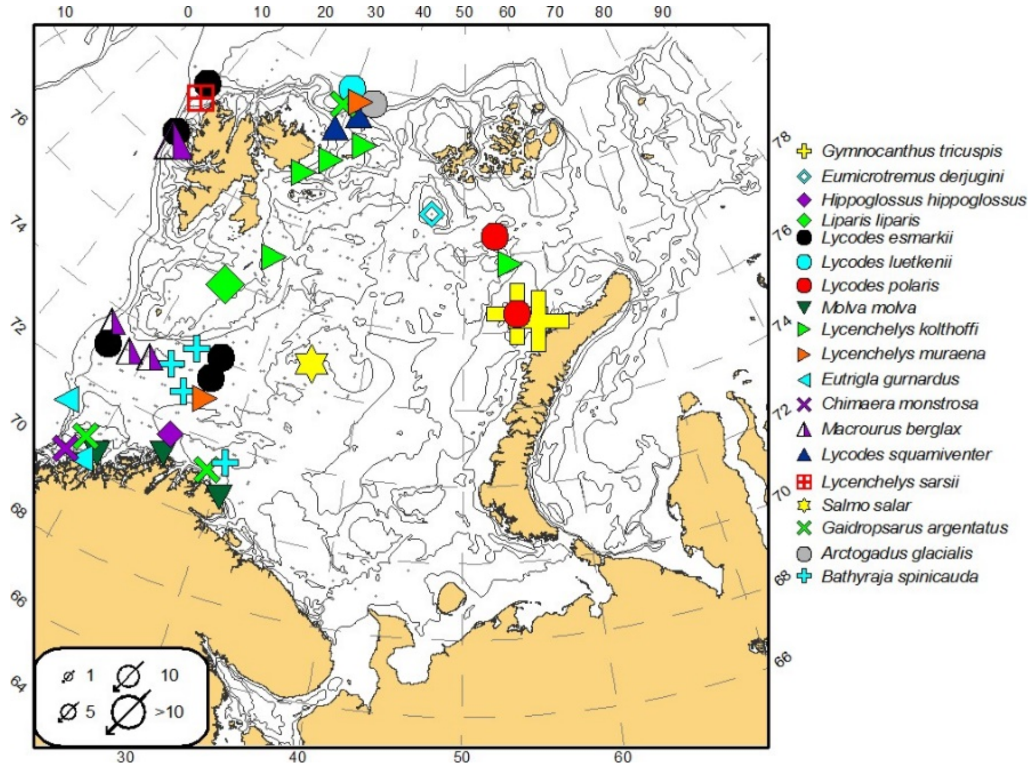


Figure 9.3.1 *Distribution of species which are rare in the Barents Sea and which were found in the survey area in 2018. Size of symbol corresponds to abundance (individuals per nautical mile, both bottom and pelagic trawls were used).*

9.4 Zoogeographic groups

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

During the 2018 ecosystem survey 83 fish species from 28 families were recorded in the catches, and some taxa were only recorded at genus or family level (Appendix 2). We observed fewer number of species compared to previous years due to poor coverage of the Russian Zone. 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 geographical 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 were included (Andriashev and Chernova, 1994, Parin, 1968, 1988).

Due to poor coverage of the Russian Zone by BESS in 2018 it is impossible to estimate distribution, abundance and biomass of each zoogeographic group species. So, a only map of the distribution from the observed area is presented in the Report, without comparison to previous years (Figure 9.4.1).

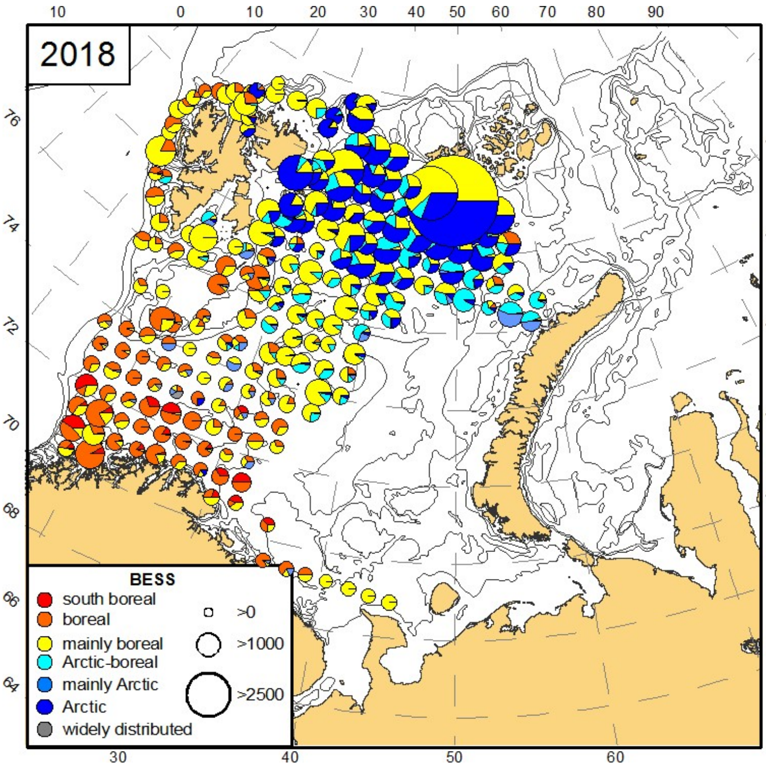


Figure 9.4.1 *Distribution of non-commercial fish species from different zoogeographic groups during the ecosystem survey 2018. The size of circle corresponds to abundance (individuals per nautical mile, only bottom trawl stations were used, both pelagic and demersal species are included).*

Appendix: Ch 9

Fish biodiversity

Table 9.2.1 *Total abundance (N, million individuals) and biomass (B, thousand tonnes) of Norway pout and Norway redfish in the Barents Sea in August-October 2006-2018 (not including 0-group).*

Year	Species			
	Norway pout		Norway redfish	
	N	B	N	B
2006	1838	32	219	19
2007	2065	61	64	10
2008	3579	97	24	4
2009	3841	131	17	2
2010	3530	103	26	2
2011	5976	68	83	9
2012	3089	105	114	12
2013	2267	40	233	25
2014	1254	37	105	6
2015	943	33	168	20
2016	797	28	125	13
2017	1260.6	21.6	133.7	14.3
2018	1687.2 ↑	50.8 ↑	202.9 ↑	25.3 ↑

10 COMMERCIAL SHELLFISH

10.1 Northern shrimp (*Pandalus borealis*)

Text by: D.V. Zakharov and T. Hauge Thangstad
Figures by: D.V. Zakharov and T. Hauge Thangstad

During the survey in 2018 217 trawls were made. Northern shrimp was found in the catches of 160 trawls. The biomass of shrimp varied from several grams to 128.9 kg/nml with an average catch of 10.2±1.4[1] kg nml (Table 10.1.1; Appendix: Ch 10).

In 2017 the densest concentrations of the shrimp were registered in central part of the Barents Sea, around Spitsbergen and in the Franz Victoria Trough, in 2018 survey has not cover all area distribution of shrimp, but as 2017 bulk concentration has been found in the same areas (Figure 10.1.1). In 2017, the calculated index of the biomass (method of squares) of the Northern shrimp was 314.2 thousand tons, in 2018 calculation impossible.

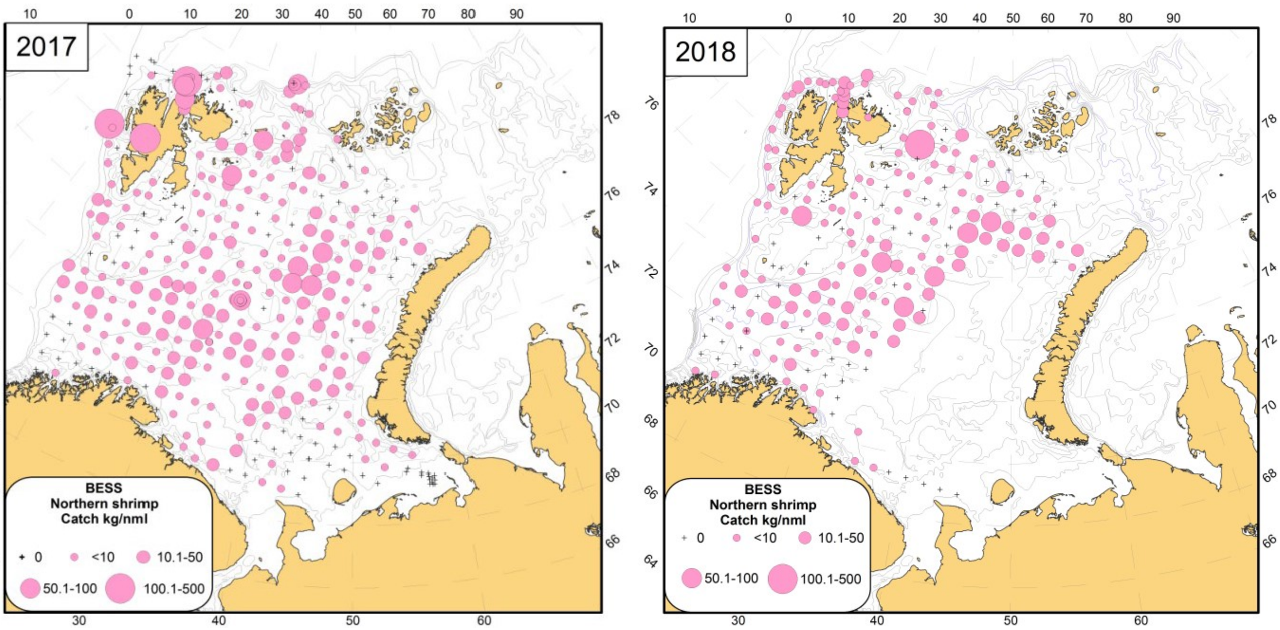


Figure 10.1.1. *Distribution of the Northern shrimp (*Pandalus borealis*) in the Barents Sea, August-October 2017-2018.*

Biological analysis of the northern shrimp was conducted in 2017 by Russian scientists in the eastern part of the survey area. Likewise, in the previous year the bulk of population of the Barents Sea shrimp was made up of individuals of smaller age groups – males with carapace length of 12-27 mm and females with carapace length of 17-30 mm (Figure 10.1.2). In 2018 biological analysis of the northern shrimp was conducted in north-eastern Barents Sea bulk of population there was made up of individuals of smaller age groups – males with carapace length of 11-25 mm and females with carapace length of 17-30 mm.

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[1] In the section 10, the average values are reported with standard error

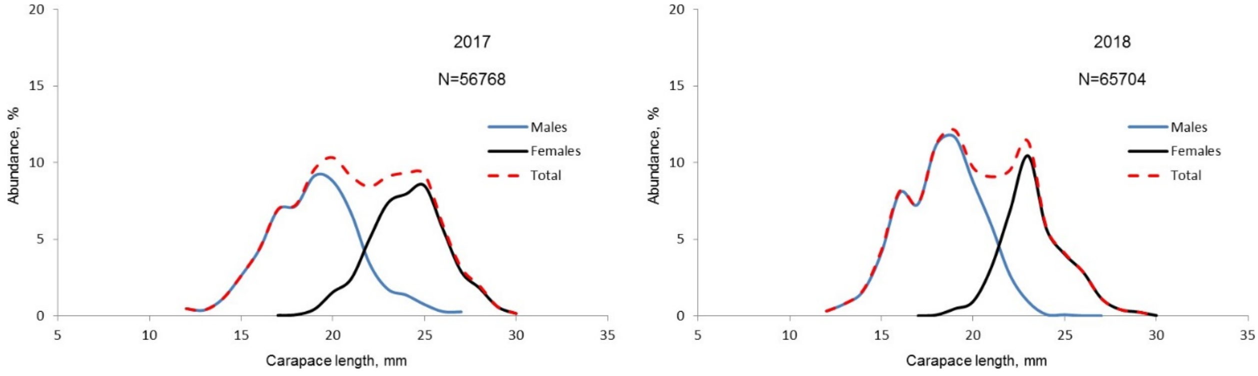


Figure 10.1.2. *Size and sex structure of catches of the Northern shrimp (Pandalus borealis) in the eastern Barents Sea 2017 (left) and in the north-eastern Barents Sea 2018 (right).*

Similarly, in the western survey area the smaller male shrimps (carapace lengths 10-23 mm, compared to females 18-28 mm) were most frequent, making up 59% and 64% of the catches in 2018 and 2017, respectively (Figure 10.1.3).

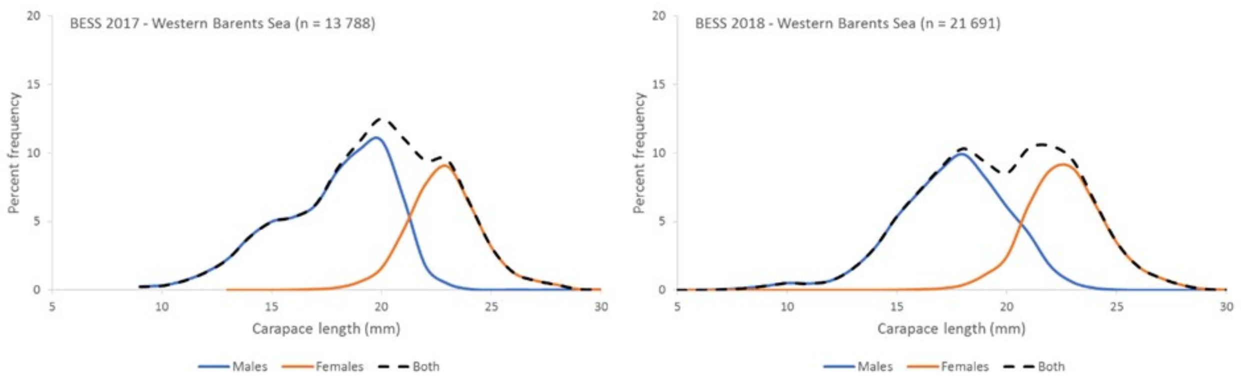


Figure 10.1.3. *Size and sex structure of catches of northern shrimp (*Pandalus borealis*) in the western Barents Sea, August-October 2017 and 2018.*

*Northen shrimp (*Pandalus borealis*). Photo: Øystein Paulsen, IMR.*

10.1 **Red king crab (*Paralithodes camtschaticus*)**

Text by *N. Strelkova*
Figures by *D.V. Zakharov*

The presented data cannot be estimated as representative (valid) due to lack of coverage of south part of the Barents Sea within REZ where the most part of the adult red king crab population are concentrated.
During survey the red king crab was recorded in 5 of 217 trawl catches (Table 10.2.1, Appendix).

According to the data of 2017 the most dance concentration of the crab was not covered by BESS 2018 (Fig. 10.2.1). As in the previous year, the crab was not registered in the Norwegian open sea waters.

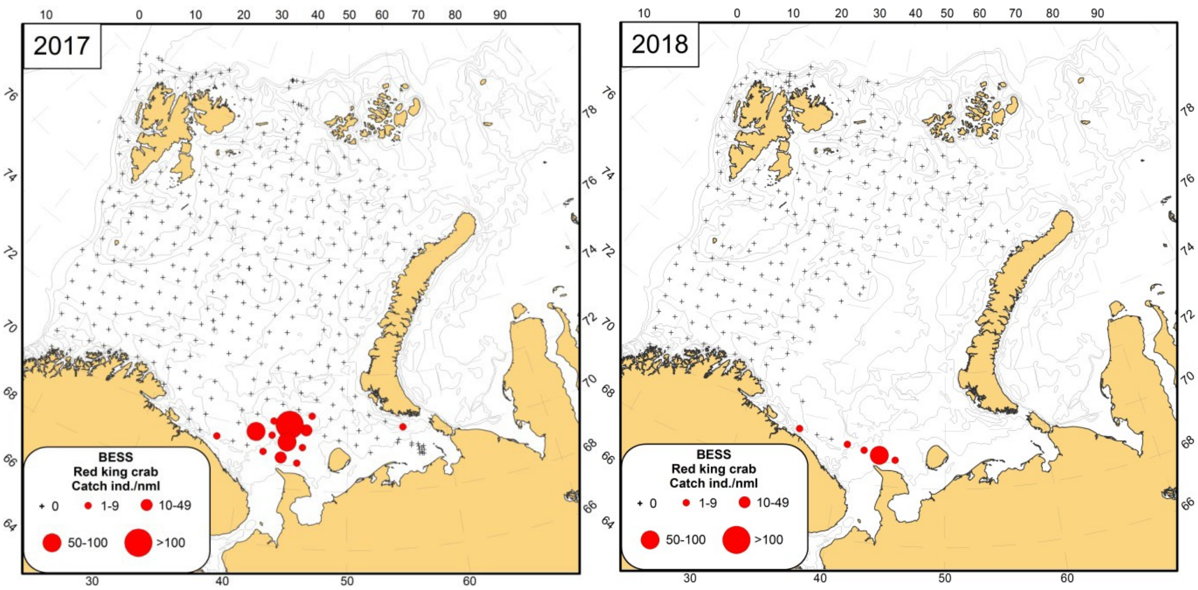


Figure 10.2.1 *Distribution of the red king crab (Paralithodes camtschaticus) in the Barents Sea, August-October 2017 and 2018*

The biomass of red king crab catches in 2018 varied from 14.1 to 112.5 kg/haul (16.5-135.1 kg/nml) compared with 0.8 to 324.3 kg/haul (0.3-397.9 kg/nml) in 2017. The average biomass was 34.9±19.4 kg/haul (41.9±23.3 kg/nml) compared with 52.8±25.4 kg/haul (64.6±31.3 kg/nml) in 2017.

The abundance of crab ranged from 4 to 50 ind./haul (5.0-60.1 ind./nml) given an average crab abundance of 14.6±8.9 ind./haul (17.5±10.7 ind./nml) compared with 1-109 ind./haul (0.1-133.7 ind./nml) and 23.0±10.0 ind./haul (28.3±12.4 ind./nml) in 2017.

Given above data are not good suitable for comparison due to difference of crab area coverage.

But comparing of 7 stations in the southernmost transect (35-45° N), carried out in the similar positions both in 2017 and 2018 (see Fig. 10.2.1), chows increasing of all quantitative parameters in 2018 comparing 2017 but without statistical confidence (Table 10.2.2, Appendix).

The size structure of the red king crab population in 2018 has a weakly expressed bimodal pattern and is quite similar to that of 2017 (Fig. 10.2.2).

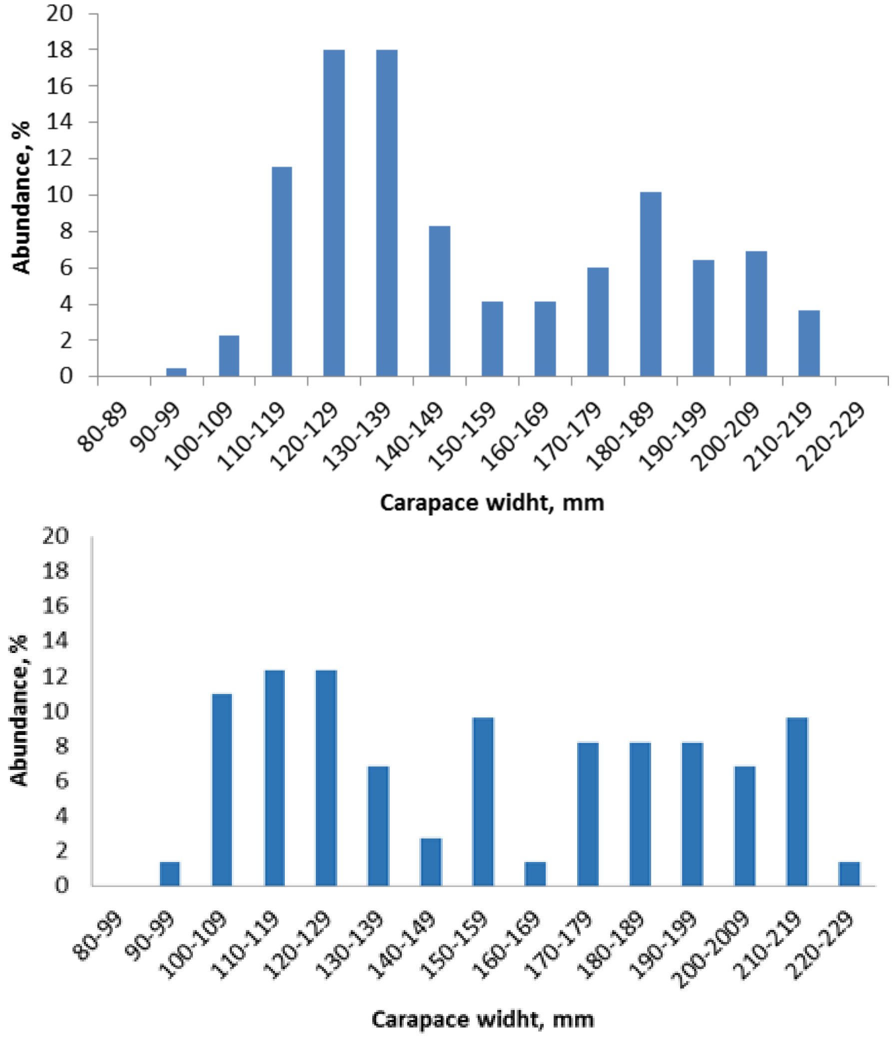


Figure 10.2.2 *Size structure of the red king crab population in the Barents Sea in August-October 2017 (upper) and 2018 (lower).*

10.2 Snow crab (*Chionoecetes opilio*)

Text by *N. Strelkova and Ann Merete Hjelset*

Figures by *D.V. Zakharov*

Presented data cannot be estimated as representative (valid) due to lack of coverage of the eastern Barents where the most part of the snow crab population is concentrated. In 2017 the snow crab was recorded in 61 out of 217 trawl catches (Table 10.3.1, Appendix).

In 2017 the snow crab was for the first time recorded in the water of Spitsbergen. In 2018 one young male with carapace wide 34 mm and weight 12 g was caught to south-west of South Cap of Spitsbergen in the depth 350 m (Fig. 10.3.1). In general, in 2018, the border recordings of the snow crabs were made further to the southwest boreal part of the Barents Sea shelf compared to previous years.

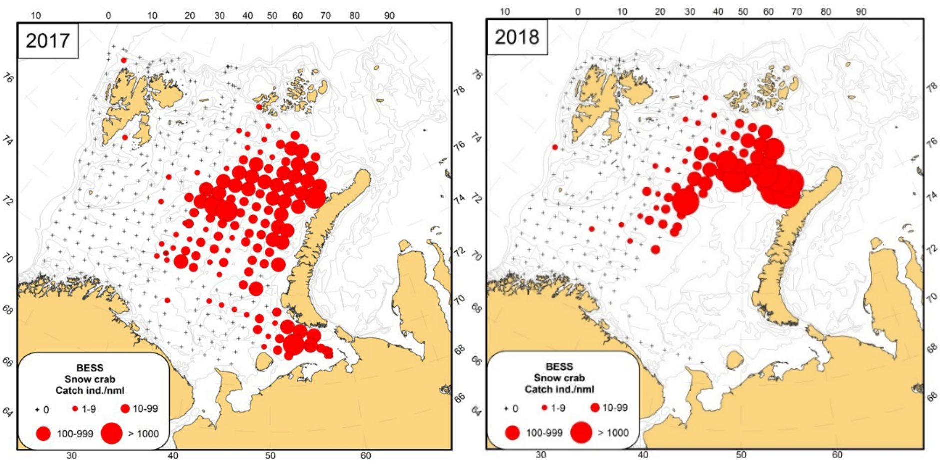


Figure 10.3.1. *Distribution of the snow crab in the Barents Sea, August-October 2017 and 2018*

Due to lack of coverage the comparison of data for 2017 and 2018 is possible only for part of the crab area.

In the part of the Barents Sea (northern of 76°N) the biomass of snow crab in 2018 varied from 5 g to 268.0 kg/haul with an average of 16.7±6.4 kg/haul compared with 0.001-101.6 kg/haul and 13.5±2.9 kg/haul in 2017.

The abundance in 2018 ranged from 1 to 4496 ind./haul with an average of 393.6±129.7 ind./haul compared with 1-1000 ind./haul and 149.2±31.7 ind./haul in 2017.
Comparison of the data obtained in the north part of the Barents Sea, covered by stations both in 2017 and 2018, shows statistically nonsignificant increasing of all quantitative parameters of abundance and biomass in 2018 comparing 2017. (Table 10.3.2, Appendix).

Compared with previous year, the mean abundance of snow crab, standardized to nautical mile, has increased in 2.7 times while biomass in 1.2 times only. It can be results of preferential increasing of juvenile part of population that is agreeing with size structure of the crab catches in 2018 (Fig. 10.3.2).

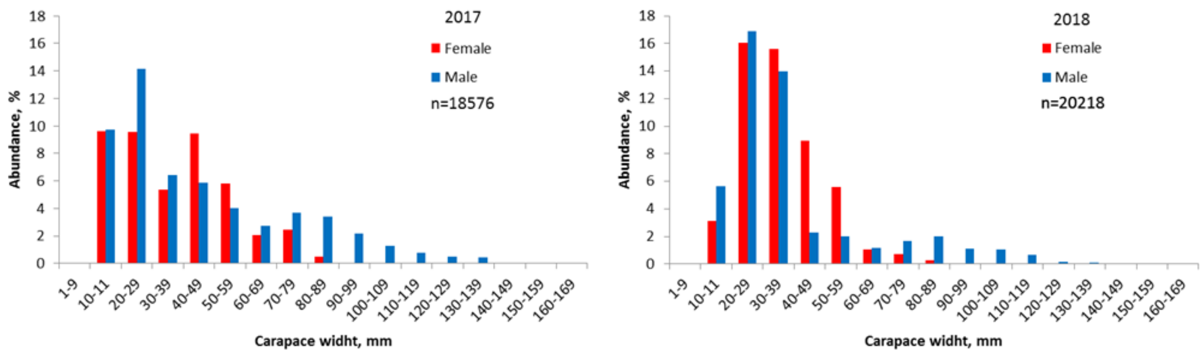


Figure 10.3.2 *Size structure of the snow crab population in the Barents Sea in 2017 and in the north part of the sea in 2018*

10.2 Iceland scallop (*Chlamys islandica*)

Text by *I.E. Manushin and L.L. Jørgensen*
Figures by *D.V. Zakharov*

In 2018 the Iceland scallop was recorded in 65 of 217 trawl catches. The survey showed a wide distribution of scallops in the Barents Sea. The deepest record in 2018 was at 441 m, but the most abundant catches were recorded in the shallow banks and elevations of the bottom: Spitsbergen Bank, Central Bank, Great Bank, Novaya Zemlya Bank (Figure 10.4.1).

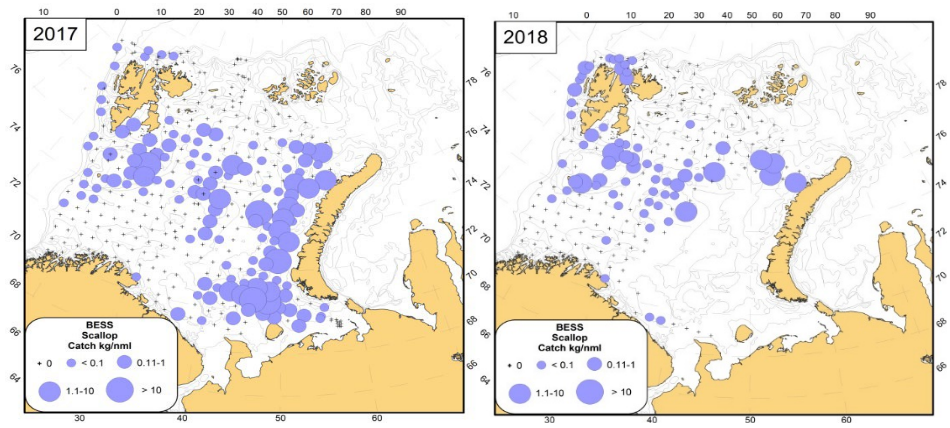


Figure 10.4.1 *Distribution of Iceland scallop (Chlamys islandica) in the Barents Sea, August- October 2017-2018*

The biomass of scallops in 2018 varied from 1.5 g to 5.6 kg/haul (0.001-6.9 kg/nml). The average biomass is 442±76 g/haul (537±91 g/nml) (table 10.4). The abundance ranged from 1 to 189 ind./haul (1-225 ind./nml). The average abundance of scallops is 26±4 ind./haul (31±4 ind./nml)(Table 10.4, Appendix).

Appendix: Ch 10

Shellfish

Ch. 10.1 Northern shrimp

Table 10.1.1. *The total catch of shrimp during ecosystem surveys of 2005-2018*

Year	Total number of station	Number of station with shrimp	Average abundance, ind./nml	Average biomass, 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±19.1.0	9.5±0.6
2014	165	101	1676.0±10.1.0	8.4±1.0
2015	334	247	1371.0±15.6	7.1±0.6
2016	317	187	1457.9±13.1.0	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
Total	**5233**	**3947**	**1998.4±177.4**	**10.5±0.6**

Ch. 10.2 Red king crab

Table 10.2.1. *The total catches of the red king crab during BESS 2005-2018.*

Year	Total number of station	Number of station with red king crab	Total numbers, ind.	Total biomass, 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

Tables 10.2.2 *Comparing of abundance and biomass parameters of red king crab catches in southernmost transect (35-45° N) in 2017 and 2018 and Student's t-test of statistical significance of differences.*

Parameters	2017	2018	*t* statistic	Critical value for *t* statistic (*α*=0.05)	*p*
Number of stations	7	7			
Number of station with crabs	4	5			
Abundance: min–max, ind./nml	1.18–18.13	4.98–60.06			
Average abundance, ind./nml	3.8±2.5	12.5±8.0	1.04	2.179	0.32
Biomass: min–max, kg/nml	0.91–38.51	16.49–135.10			
Average biomass, kg./nml	10.08±5.56	29.91±17.85	1.11	2.179	0.29

Ch. 10.3 Snow crab

Table 10.3.1 *The total catch of snow crab during ecosystem surveys of 2005-2018*

Year	Total number of station	Number of station with snow crab	Total numbers, ind.	Total biomass, kg
2005	649	10	14	2.5
2006	550	28	68	11
2007	608	55	133	18
2008	452	76	668	69
2009	387	61	276	36
2010	331	56	437	22
2011	401	78	6219	154
2012	455	116	37072	1169
2013	493	131	20357	1205
2014	304	78	12871	658
2015	335	89	4245	378
2016	317	84	2156	137
2017	376	159	25878	1422
2018	217	61	19494	846

Tables 10.3.2 *Comparing of abundance and biomass parameters of the snow crab catches in north part of the Barents Sea (northern 76° N) in 2017 and 2018 and Student's t-test of statistical significance of differences.*

Parameters	2017	2018	*t* statistic	Critical value for *t* statistic (α=0.05)	p
Number of stations	135	118			
Number of station with crabs	46	44			
Abundance: min–max, ind./nml	1.2–1204.8	0.9–5273.9			
Average abundance, ind./nml	178.9±37.6	478.9±155.3	1.89	1.99	0.062
Biomass: min–max, kg/nml	1.34–122.43	0.007–314.33			
Average biomass, kg./nml	16.33±3.56	20.27±7.62	0.47	1.99	0.64

Ch. 10.4 Iceland scallop

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

Year	Stations	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

*Full survey area not covered

Iceland scallops, Chlamys islandica*. Photo: J. Sundet, IMR*

11 BENTHIC INVERTEBRATE COMMUNITY

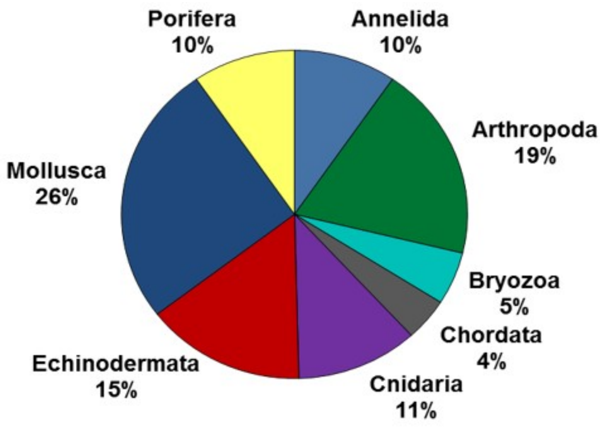
Text by: N. Strelkova, D. Zakharov, L. Lindal Jørgensen, Manushin I.E., Nosova T.B.
Figures by: L. Zakharova

In 2018, bycatch records of megabenthos was made from 217 bottom trawl hauls across all four research vessels of the ecosystem survey. The megabenthos was processed to closest possible taxon with abundance and biomass recorded. This was done by six Russian specialists (Juravleva N., Strelkova N., Zimina O., Zakharova L., Nosova T., Uzbekova O.) and four Norwegian specialists (Voronkov A., Gabrielsen H., Johansen R., Keulder-Stenevik F). The total number of taxa identified from the caught invertebrates is presented in table 11.1(in Appendix) and more detailed information about taxonomic processing in the different vessels – in the table 11.2 (in Appendix).

Species diversity

A total of 574 invertebrate taxa (404 identified to species level) have been recorded in 2018. In 2018 amount of identifications till species level was highest in all period of ecosystem surveys (Table 11.1). The main reason can be standardization of the taxonomical processing: during ecosystem cruises 2018 in all vessels benthic experts used for identification new ID book "Atlas of megabenthic organisms in the Barents Sea and adjacent waters" (Zakharov et al., 2018).

Despite of different coverage, the total taxonomic structure of bycatches is practically similar in 2017 and 2018 (Figure 11.1). The most diversity groups in the trawl catches in 2018 were Mollusca (132 taxa), Arthropoda (98 taxa) and Cnidaria (81 taxa) (Figure 11.1.1). Among mollusks, 56 % of taxa belong to the Gastropoda, 31 % – to the Bivalvia and the remaining 13 % are distributed among Cephalopoda, Polyplacophora and Caudofoveata groups. The taxa of Artropoda phylum in the main were presented by Malacostraca and Pycnogonida (84 % of the taxa), and Cnidaria taxa – by hydroids (65 % of taxa) and anthozoans (35 % of taxa).



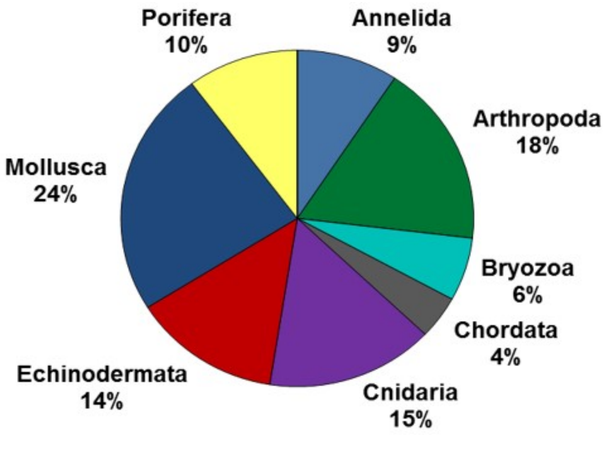


Figure 11.1 *The number of main taxa per megabenthic groups (%) in the Barents Sea, August-October 2017(left) and 2018 (right).*

The species density in the terms of the number of taxa in trawl catches ranged from 5 to 95 with average of 39.0±1.1[2] taxon's per trawl-catch. The hot-spot of taxonomic diversity was observed around of the Spitsbergen archipelago. As a total, the reduction of the taxonomic diversity occurred in the east direction, and the lowest values on some stations (less 10 taxa/trawl) were recorded in the area of Kola Peninsula (Figure 11.2).

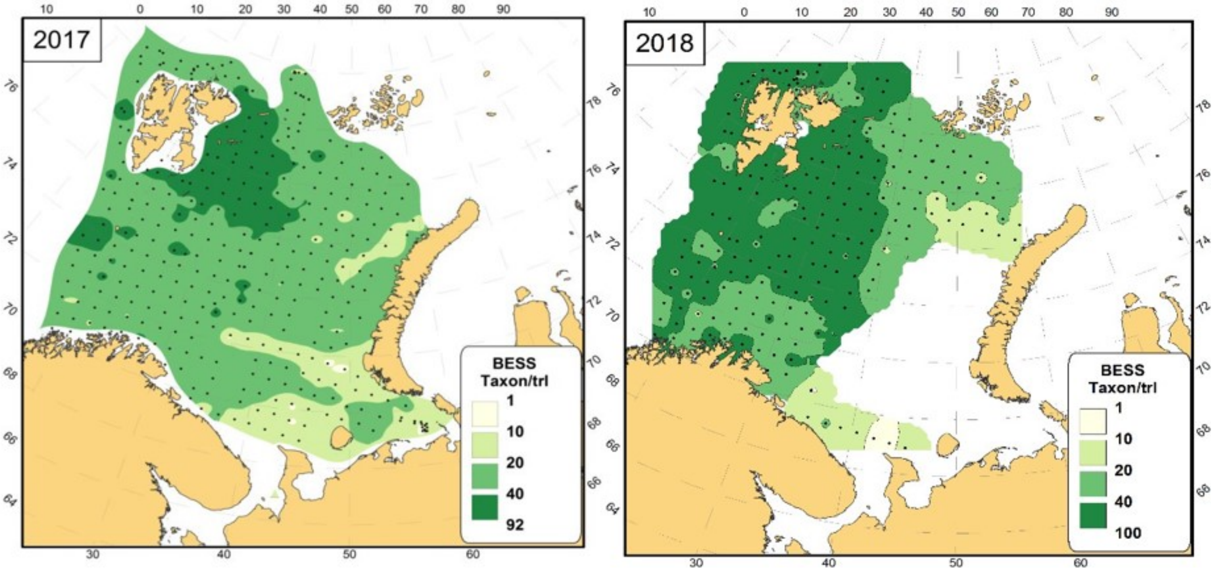


Figure 11.2 *The number of megabenthic taxa per trawl-catch in the Barents Sea, August-October 2017-2018.*

Compared with 2017, the total number of recorded species and the species density increase by 21 % and 24.6% respectively.

The ten most common species and taxon's in the catches in 2018 were the following: *Ctenodiscus crispatus* (recorded at 73 % of the stations), Porifera (68 %), *Ophiopholis aculeata* (67 %), Polynoidae (65 %), *Sabinea septemcarinata* (64 %), *Pontaster tenuispinus* (64 %), *Ophiacantha bidentata* (62 %), *Ophiura sarsi* (59 %), *Henricia* spp. (59 %) and *Ophioscolex glacialis* (51 %).

Abundance (number of individuals)

The number of invertebrates individuals in the trawl catches (excluding the pelagobenthic species *Pandalus borealis*) ranged from 11 to 50221 (12.5-62581 ind./n.ml) with an average of 3966±485 ind. per trawl-catch (4932±608 ind./n.ml).

The most abundant catches (about fifty thousand ind.) were recorded in the northern part of the Barents Sea to the south of the Franz Josef Land archipelago (Figure 11.3). In the area of this hot-spot the trawl-catches in the terms of abundance principally dominated by the brittle stars *Ophiacantha bidentata*, *Ophiopleura borealis* and *Ophioscolex glacialis*.

Abundance hot-spot in the area close to the Novaya Zemlya shallow is dominated by sea urchin *Strongylocentrotus pallidus*.

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[2] In Section 11, the average values are reported as standard error

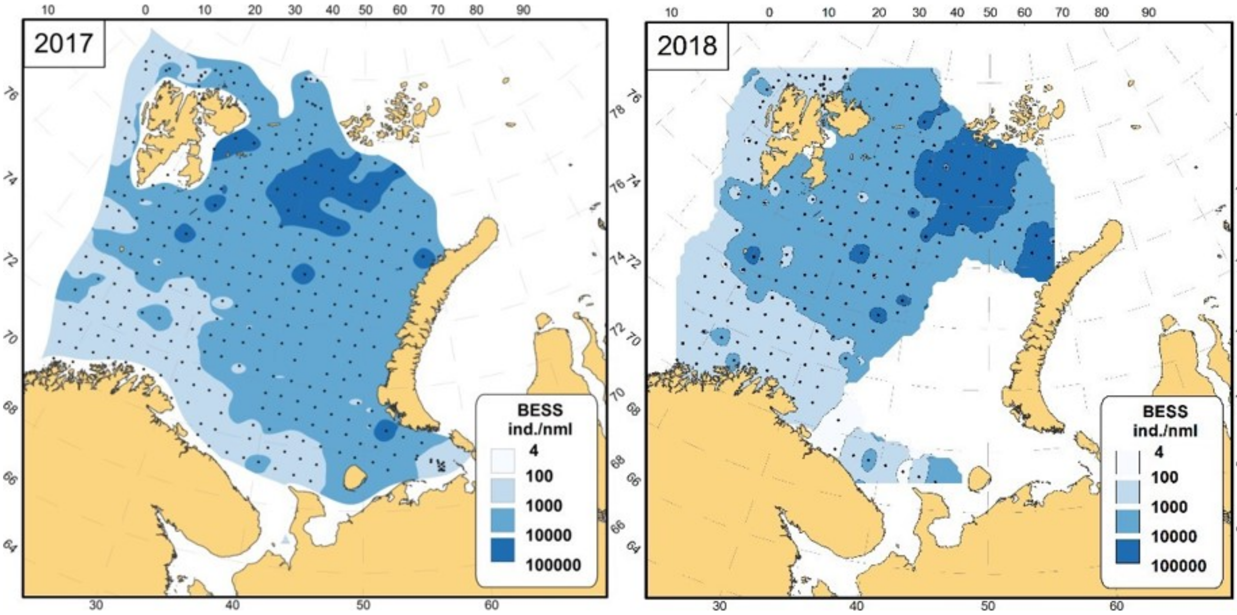

Figure 11.3 *The number of individuals of megabenthos (excluding* Pandalus borealis*) in the Barents Sea, August-October 2017-2018.*

Biomass

Like in previous year in 2018 the biggest part of the total biomass of the by-catches was made up by Sponges, Echinoderms, and Crustaceans (95 %) (Figure 11.4). The increase in the proportion of sponges compared to 2017 resulted by difference of the sea area coverage.

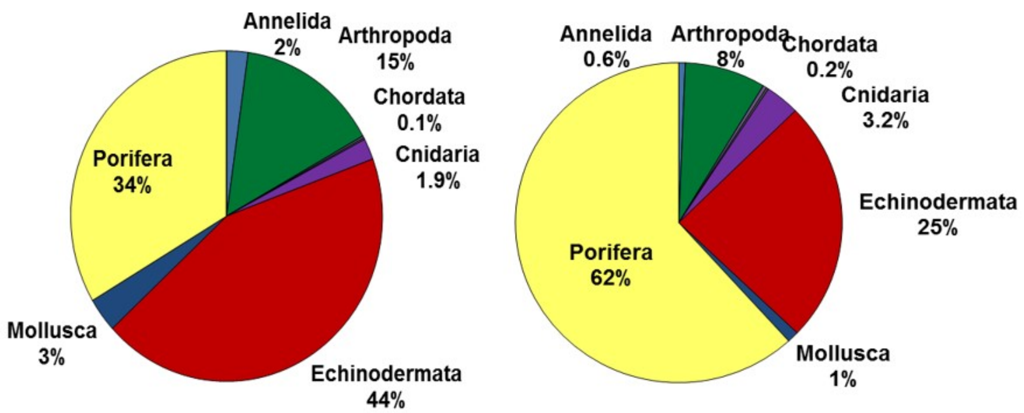

Figure 11.4 *Distribution of biomass (excluding* Pandalus borealis*) across the main mega benthic groups (%) in the Barents Sea, August-October 2017 (left) and 2018 (right).*

The invertebrate's biomass taken by the trawl (excluding pelagobenthic species *Pandalus borealis*) ranged from 55 g to 6,9 t (0.055-7663 kg/nml) with an average of 72.66±32.01 kg per trawl-catch (91.06±36.37 kg/nml).

The maximum bycatch of megabenthos, as in previous year, was observed in the southwestern part of the Barents Sea in the depth of 331 m (Figure 11.5) and dominated by two species of *Geodia* sponges (*G. barretti* and *G. macandrewii*).

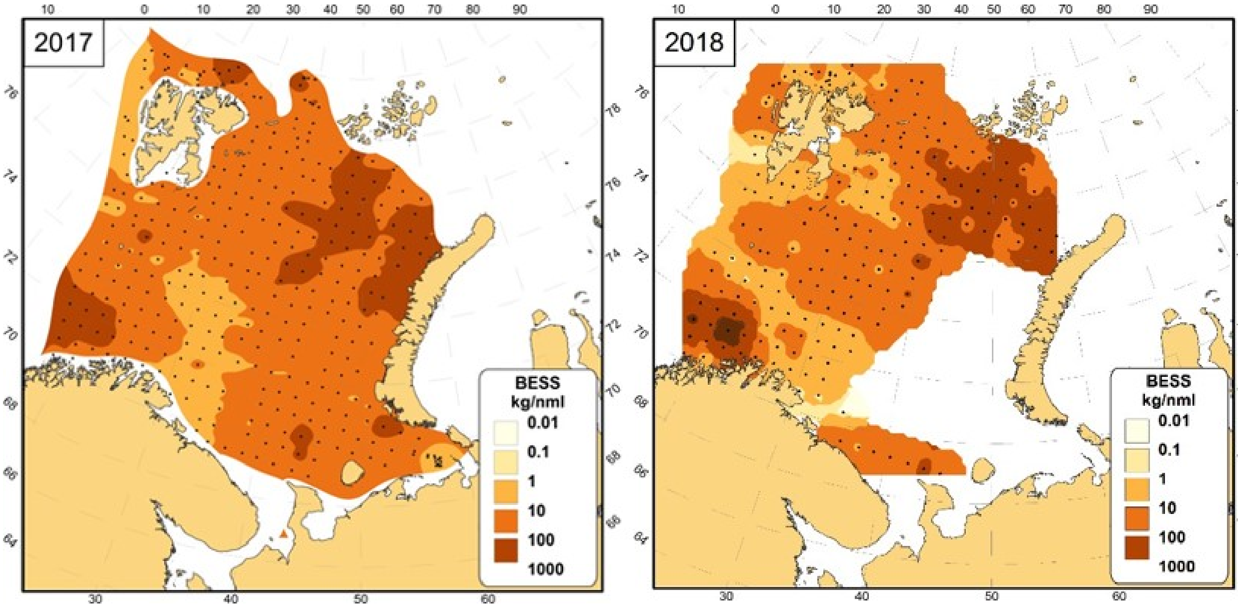

Figure 11.5 *Biomass distribution of megabenthos (excluding* Pandalus borealis*) in the Barents Sea, August-October 2017 and 2018.*

As in previous years, the northern central part of the sea is clearly dominated by echinoderms and south western part, by sponges (Figure 11.6).

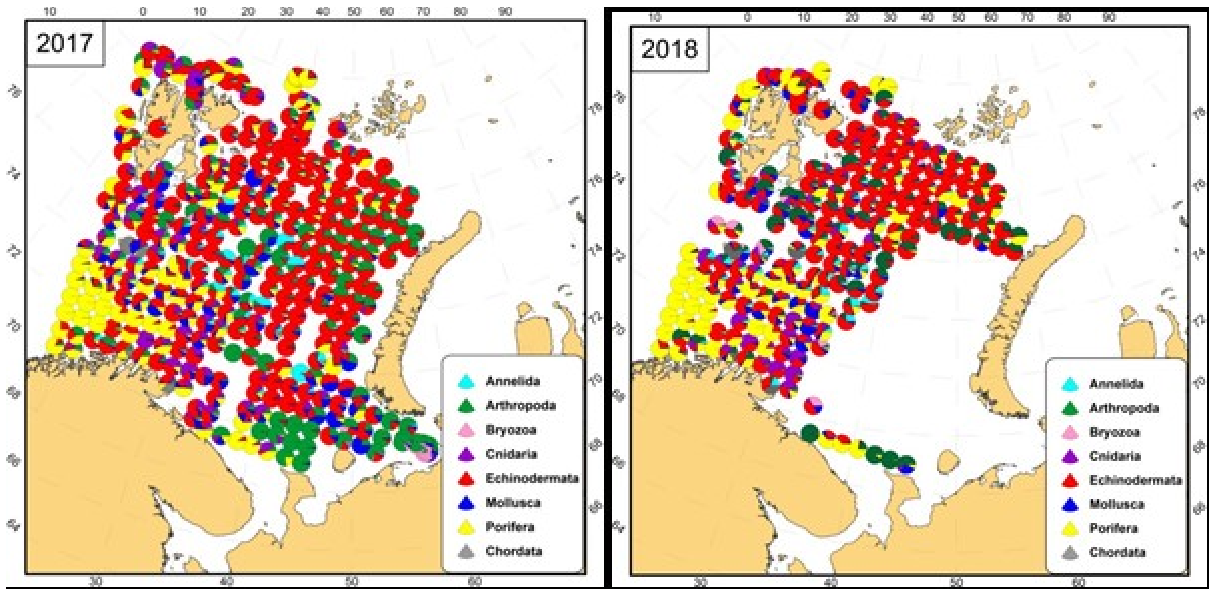

Figure 11.6 *Biomass distribution of main taxonomic groups per station in the Barents Sea (excluding* Pandalus borealis*), August-October 2017-2018.*

The most dominant species observed in the trawl catches were the *Geodia* sponges (54.0 % of the total biomass), *Chionoecetes opilio* (5.5 %), *Strongylocentrotus pallidus* (4.9 %), *Ophiopleura borealis* (4.8 %), *Gorgonocephalus* arcticus (2.4 %).

Reference:

Zakharov, D.V., Strelkova, N.A., Manushin, I.E., Zimina, O.L., Jørgensen, L.L., Luybin, P.A., Nosova, T.B. 2018. Atlas of the megabenthic organisms of the Barents Sea and adjacent waters. PINRO, Murmansk. 534 p.

Appendix: Ch 11
Benthic communities

Table 11.1
The material analyzed in the ecosystem surveys 2005-2017 and its main characteristics

Year	Number stations	Total		Average abun-dance, ind./nm	Average biomass, kg/nm	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	852613.6	15.4	4887.8	89.2	404	574
Total	5016	13138616	202.2	2940.7*	45.2*	694	1058

* The average long-term value

Table 11.2
Statistics of megabenthos bycatch processing and assessment of the quality of taxonomic processing of invertebrates in the BESS 2018

Research vessels	"G.O. Sars"	"Helmer Hansen"	"Johan Hjort"	"Vilnus"	**Total**
Number of processed hauls	44	37	78	58	**217**
Phyllum	12	11	12	11	**12**
Class	28	28	31	25	**30**
Order	75	75	88	67	**79**
Family	153	164	196	108	**216**
Species	**215**	**201**	**291**	**122**	**404**
Total number of taxa	299	292	398	171	574
Percentage of species identification*	71.9	68.8	73.1	71.3	70.3

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

12 MARINE MAMMALES AND SEABIRDS

12.1 Marine mammals

Text by: R. Klepikovskiy and N. Øien
Figures by: R. Klepikovskiy

In total, 2119 individuals of 9 species of marine mammals were observed and 77 individuals were not identified during the survey in August-October 2018. The distributions of observations are given by numbers in Table 12.1.1 and locations in Figs 12.1.1-12.1.2.

For technical reasons, some eastern and southeastern areas of the Barents Sea were not covered by this research.

As in previous years, the white-beaked dolphin (*Lagenorhynchus albirostris*) was the most abundant species with more than 70% of all registrations. This species was widely distributed in the survey area. Compared to 2017, there was also an increase in the numbers of registered white- beaked dolphins. The largest groups of white-beaked dolphins occasionally include up to 30-35 individuals. The highest densities of this species apparently overlap with the distributions of capelin, codfishes, herring and polar cod in the survey area.

Table 12.1.1. *Numbers of marine mammal individuals observed during the ecosystem survey in 2018.*

Name of species	Total	%
Fin whale	105	4.8
Humpback whale	202	9.2
Minke whale	183	8.3
Blue whale	1	0.05
Unidentified whale	33	1.5
White-beaked dolphin	1600	72.9
Harbour porpoise	13	0.6
Killer whale	2	0.1
Sperm whale	12	0.5
Unidentified dolphin	38	1.7
Unid. small cetacean	4	0.2
Ringed seal	1	0.05
Unidentified seal	2	0.1
Total sum	2196	100

Although in modest numbers, the toothed whales were represented by sperm whales (*Physeter macrocephalus*), harbour porpoises (*Phocoena phocoena*), and killer whales (*Orcinus orca*) besides the numerous white-beaked dolphins. The sperm whales were observed at deeper waters along the continental slope and other parts of the research area westward of 27° E. The harbor porpoise and killer whale sightings were mainly made in the southern parts of the research area.

The baleen whale species minke (*Balaenoptera acutorostrata*), humpback (*Megaptera novaeangliae*) and fin (*Balaenoptera physalus*) whale were quite abundant as 22 % of the total animals registered belonged to these species. There main concentrations were found east of

Svalbard (Spitsbergen). There were fewer observations of minke whales in 2018 than in 2017, and although they are widely distributed over all the survey area, their highest concentrations were in the northern areas with spatial overlap with capelin and polar cod aggregations.
The humpback whales were as usual recorded mainly in the waters to the east of the Spitsbergen Archipelago and in the area the Great Bank. In 2018, more humpback whales were observed than in the previous year, however, the sizes of the groups of these whales were in general smaller and no more than 5 individuals. The humpback whales were recorded in areas with aggregations of capelin, often with fin and minke whales in the same areas. In 2018, fewer fin whales were observed during the survey as compared to 2017.

As previous years, blue whales (*Balaenoptera musculus*) were not observed north of Svalbard (Spitsbergen). Only one blue whale was registered west of Svalbard (Spitsbergen).

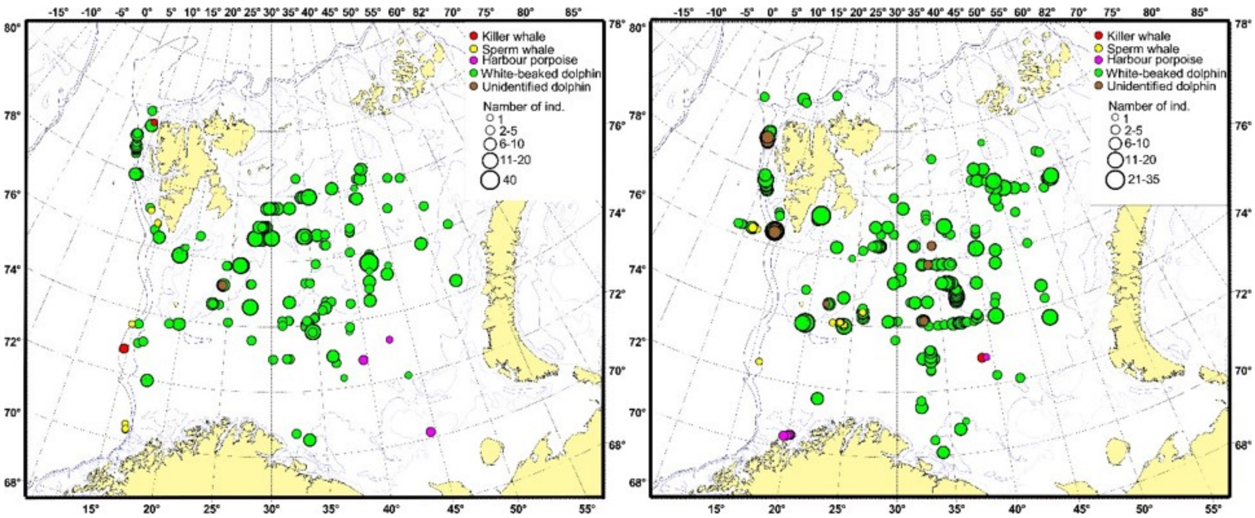

Figure 12.1.1. *Distribution of toothed whales in August-October: 2017 (left) and 2018 (right).*

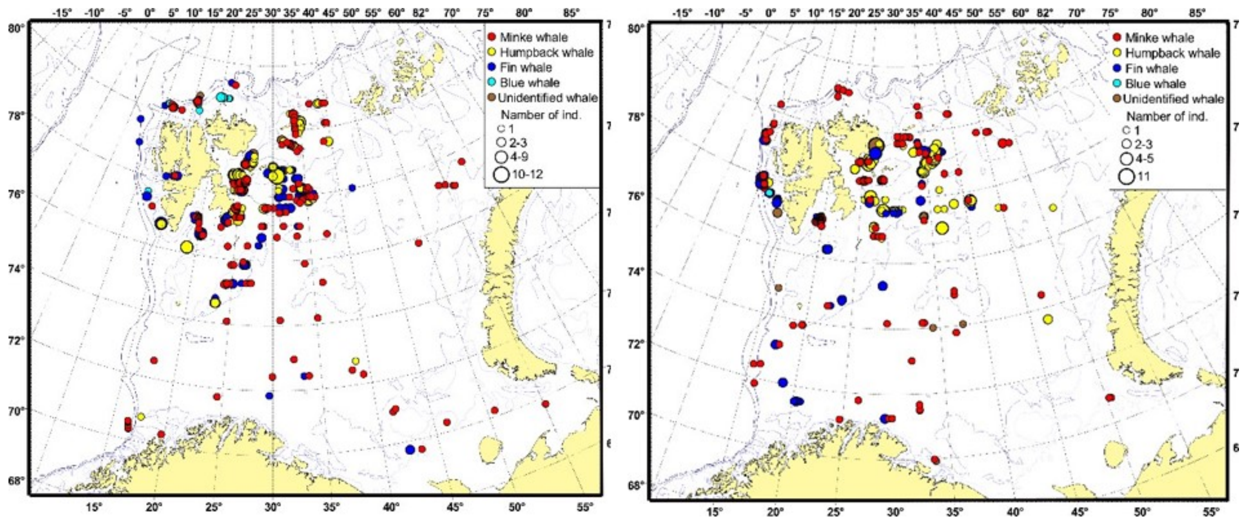

Figure 12.1.2. *Distribution of baleen whales in August-October: 2017 (left) and 2018 (right).*

In 2018, the only pinnipeds observed was ringed seal (*Phoca hispida*). Harp seal (*Pagophilus groenlandicus*), bearded seal (*Erignathus barbatus*), walrus (*Odobenus rosmarus*) and polar bears (*Ursus maritimus*) were not observed during the survey, moist likely due to lack of ice in the survey area.

12.2 Seabird observations

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

Seabird observations were carried out by standardized strip transect methodology. Birds were counted from the vessel's bridge while the ship was steaming at a constant speed of ca. 10 knots. All birds seen within an arc of 300 m from directly ahead to 90° to one side of the ship were counted. Counts were done only during daylight and when visibility allowed a complete overview of the transect. On the vessels *Helmer Hansen*, *GO Sars* and *Johan Hjort*, birds following the ship i.e. "ship-followers", were counted as point observations within the sector every ten minutes. Ship-followers included the most common gull species and Northern fulmar. 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.

Total transect length covered by the Norwegian research vessels; *Helmer Hansen*, *GO Sars* and *Johan Hjort*, was 7230 km. Total transect length covered by the Russian research vessel; *Vilnus*, was 3963 km. A total of 61 730 birds belonging to 39 different species were counted. The highest density of seabirds was found north of the polar front. These areas were dominated by Brünnich's guillemots (*Uria lomvia*), little auk (*Alle alle*), kittiwake (*Rissa tridactyla*) and Northern fulmar (*Fulmarus glacialis*) (Figs. 12.2.1, 12.2.2).

Broadly, the distribution of the different species was similar to the distribution in the 2017 survey. Alcids were observed throughout the study area but the abundance and species distribution varied geographically. Little auks were found north of Spitsbergen, Brünnich's guillemots were found in the north, Atlantic puffins (*Fratercula arctica*) were found in the southwest and common guillemots (*Uria aalge*) were found in the south. Among the ship- followers, black-backed gulls (*Larus marinus*) and herring gull (*Larus argentatus*) were found in the south, close to the coast. Glaucous gull (*Larus hyperboreus*) was found around Spitsbergen and in the southeastern area. Kittiwakes and Northern fulmars were found throughout the study area, but with highest density of kittiwakes in the eastern and northern areas and highest density of Northern fulmars in the northwest.

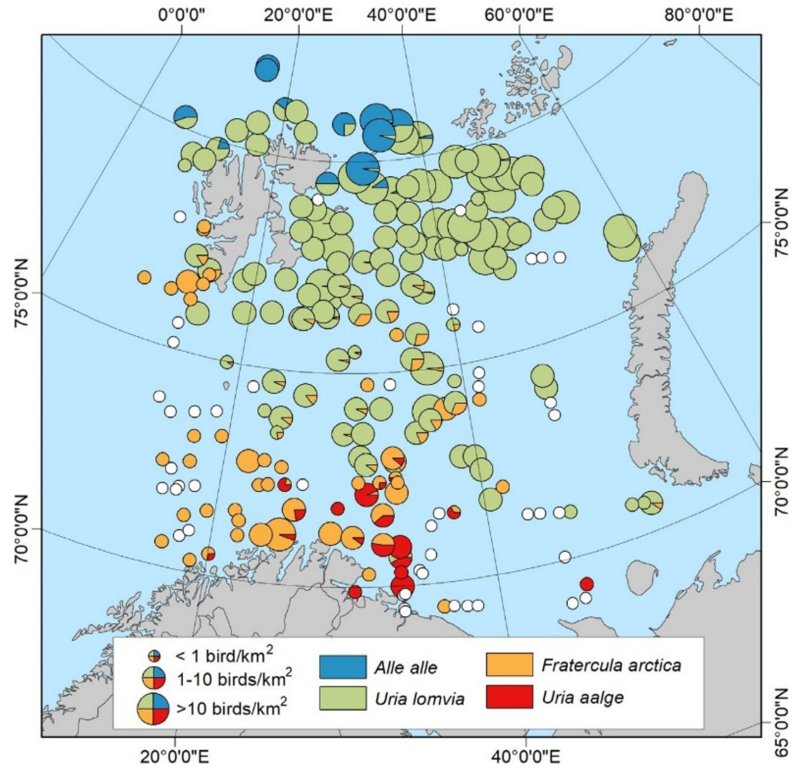

Figure 12.2.1 *Density of auk species along seabird transects in 2018. White circles show zero density.*

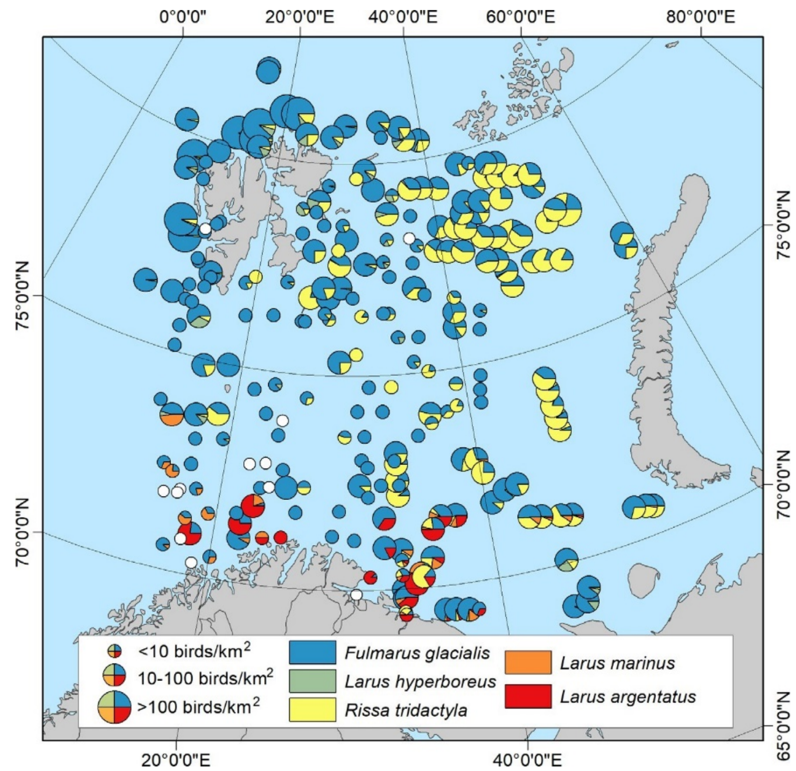

Figure 12.2.2. *Density of the most common gull species and Northern fulmar along seabird transects in 2018. White circles show zero density. Note that because these species are attracted to and tend to follow the ship, densities might be grossly over-estimated.*

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