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JOINT

REPORT

Survey report from the joint Norwegian/Russian Ecosystem Survey in the Barents Sea and the adjacent waters

August-November 2020

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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 Polar branch of the VNIRO (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 numbers estimation, and additional acoustic transects for the capelin stock size estimation. Due to a combination of the Covid-19 pandemic and some delay with the arrival of survey RV “AtlantNIRO” to Murmansk, deviations from the general design resulted in biased I time of covering the Western and Eastern Barents Sea, and some reduction in stations for some sampling in 2020. However, the capelin monitoring was given high priority and performed in synchrony. The 18-th joint Barents Sea autumn Ecosystem Survey (BESS) was carried out during the period from 13-th August to 04-th November 2020 by the Norwegian research vessels: “G.O. Sars”, “Johan Hjort”, and “Kronprins Haakon”, and the Russian research vessels “Vilnyus” and “AtlantNIRO”. Survey coordinators in 2020 were Dmitry Prozorkevich (PINRO) and Geir Odd Johansen (IMR). No Russian experts participated in the Norwegian vessels in 2020. We would like to express our sincere gratitude to all the crew and scientific personnel onboard RVs “Vilnyus”, “AtlantNIRO”, “G.O. Sars”, “Johan Hjort” and “ Kronprins Haakon ” for their dedicated work, as well as all the people involved in planning and reporting

Summary of BESS 2020. 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 groups reports.

Content

1 Background

Text by: D. Prozorkevich and G. Skaret

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 IMR in Norway and the Polar Branch of VNIRO (PINRO) in Russia. The general survey plan and tasks are usually agreed at the annual PINRO-IMR Meeting in March, but in 2020, due to the Covid-19 pandemic, it was agreed by correspondence. Ship routes and other technical details was 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, but in 2020 due to the late start of the Russian ships, the survey plan of the eastern coverage area was changed. 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), were some additional bottom trawl hauls for demersal fish survey index estimation are carried out, and additional acoustic transects for the capelin stock size estimation. Additional bottom trawls were also planned in places of significant distribution of commercial invertebrates (snow crab and northern shrimp). The 18-th BESS was carried out during the period from 12-th August to 15-th November 2020 by the Norwegian research vessels “G.O. Sars”, “Johan Hjort”, and “Kronprins Haakon”, and the Russian vessels “Vilnyus” and “AtlantNIRO”. Survey coordinators in 2020 was Dmitry Prozorkevich (PINRO) and Geir Odd Johansen (IMR). There were no Russian experts on board Norwegian vessels in 2020 due to the Covid-19 pandemic. The scientists and technicians 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 “Kronprins Haakon”, “Vilnyus”, “G.O. Sars”, “Johan Hjort” and “AtlantNIRO” for their dedicated work, as well as all the people involved in planning and reporting of BESS 2020.* This report is a summary of the observations and status assessments based on the survey data. Further interpretation on drivers, trends and consequences will be reported by ICES WGIBAR. Other ICES working groups and workshops (WGMME, WGZE, WGOH, WGPDMO, AFWG, WGWIDE, NIPAG, WGCRAB, WGEF, WKBAR) will use BESS information for future work.

Table 1. *Vessels and participants in the Barents Sea Ecosystem Survey 2020.*

Research vessel	Participants
”*Vilnyus*” (25.09–15.11)	Alexander Pronuk (Cruise leader), Dmitry Alexandrov, Alexander Benzik, Tatyana Gavrilik, Natalia Pankova, Alexey Kanischev, Michael Nosov, Maksim Gubanishchev, Sergey Harlin, Roman Klepikovsky, Marina Kalashnikova, Natalia Strelkova (benthic expert), Alexandra Kudryashova (benthic expert).
”AtlantNIRO” (17.09–.23.10)	Andrey Safronov (Cruise leader), Nikolay Tymoshenko, Dmitry Churin, Ivan Krasikov, Alexander Golub, Elmira Khalmatova, Alexey Astakhov, Michael Sokolov Andrey Morozov (benthic expert), Yury Pristavko (benthic expert).
”*G.O. Sars*” (12.08–08.09)	Part 1 (12.08-26.08) Erik Olsen (Cruise leader), Egil Frøyen, Ove Misje Aakre, Ines Dias Bernardes, Sofie Gundersen, Celina Eriksson Bjånes, Lea Marie Hellenbrecht, Christine Djønne, Hilde Arnesen, Hege Lyngvær Mathisen, Ida Vee, Sebastian Glindtvad, Claudia Erber, Ellie Watts, Gary Elton, Heidi Gabrielsen (benthic expert), Anne Kari Sveistrup (benthic expert). Part 2 (26.8-8.9) Harald Gjøsæter (Cruise leader), Heidi Gabrielsen, Anja Helene Alvestad, Janicke Skadal, Magne Olsen, Martin Dahl, Jörn Patrick Meyer, Vilde Regine Bjørdal, Stine Karlson, Marianne Petersen Ann-Kristin Olsen, Ida Vee, Sebastian Glindtvad, Claudia Erber, Ellie Watts, Gary Elton, Sten-Richard Birkely (benthic expert).
”*Johan Hjort*” (20.08-04.10)	Part 1 (20.08-09.09) Rupert Wienerroither (Cruise leader), Runar Smestad, Diana Zaera-Perez, Erlend Langhelle, Irene Huse, Synnøve Røsand, Daniela Fuchs, Jan Frode Wilhelmsen, John Nesheim, Erling Boge, Susanne Tonheim, Jane Strømstad Møgster, Monica Martinussen, Jon Ford Part 2 (09.09-04.10) Georg Skaret (Cruise leader), Irene Huse, Else Holm, Vidar Fauskanger, Nils Øien, Kjell Arne Fagerheim, Jori Neteland-Kyte, Magnar Mjanger, Eilert Hermansen, Ståle Kolbeinson, Frøydis Tousgaard Rist, Hilde Arnesen, Gaston Ezequiel Aguirre, Jon Ford
“Kronprins Haakon” (15.09-13.10)	Thomas de Lange Wenneck (Cruise leader), Kristoffer Ingebrigtsen Monsen, Timo Meissner, Jostein Røttingen, Magnus Reeve, Jon Rønning, Ronald Pedersen, Penny Lee Liebig, Hans Victor Koch, Hildegunn Mjanger, Celina Eriksson Bjånes, Silje Elisabeth Seim, Elise Eidset, Lars Kleivane, Atle Børje Rolland, Olaf J. Sørås, Eirik Grønningsæter, Ceslav Czyz, Andrey Voronkov (benthic expert), Mette Strand (benthic expert).

2 Survey execution 2020

Text by: D. Prozorkevich and G. Skaret
Figures by: S. Karlson

In 2020, due to the COVID-19 pandemic, the Russian RV "Vilnyus" began the survey with a significant delay, in the end of September. A second Russian RV "AtlantNIRO" was used for BESS to cover the survey area in the southern and the central parts of Barents sea (include the Loophole). RV "Vilnyus" began surveying from the north, in the main capelin distribution area, for maximum overlap in timing with the coverage on the Norwegian side. Because of the delay, the preliminary stock assessment of capelin was done and quota advise prepared before Norwegian-Russian Fishery Commission. RV "Vilnyus" continued the survey in a general direction from north to south. In the autumn 2020, there was very little ice in the Barents Sea, so RV "Vilnyus" was able to get around Franz Josef Land (Fig 2.2). The last time this area was surveyed in 2013. RV "AtlantNIRO" began BESS in the mid-September and continued from south to north. "AtlantNIRO" only carried out bottom trawls in the Loophole, since the capelin part of BESS had already been finished at that time. Norwegian RVs worked according to plan and covered the western part of the Barents Sea and an area around Svalbard (Spitsbergen). "Johan Hjort" covered the northern and western parts of the Barents sea, "G.O. Sars" the central part, and "Kronprins Haakon" the areas north and north-east of Svalbard (Spitsbergen).

It was decided to keep all the main tasks of the survey similar to previous years (Fig.2.1). Most ecosystem components were well examined in 2020. However due to the late start of the Russian RVs causing a significant time shift between vessels, it was decided not to do the 0-group sampling in the Russian zone. Norwegian vessels completed the 0-group survey in the western part of the survey area, but for many fish species, the 0-group assessment was lost in 2020. The standard oceanography sections "Vardø-Nord" and "Sørkapp-Vest", and the new standard section "Hinlopen", were sampled in the Norwegian survey area (Fig 2.3), and the "Kola", "Kanin" and additional section "Bear Island-East" were done in the Russian survey area (Fig. 2.3). The BESS 2020 survey coverage was much better than in 2019, but the eastern part of the survey area was surveyed later than in previous years. It is unknown exactly how it might affect the stock estimates. The effective vessel days in 2020 amounted to 192 days. The realized research vessel tracks and trawl stations for the BESS 2020 are shown in Figure 2.2. Hydrography and plankton stations are shown in Figure 2.3.

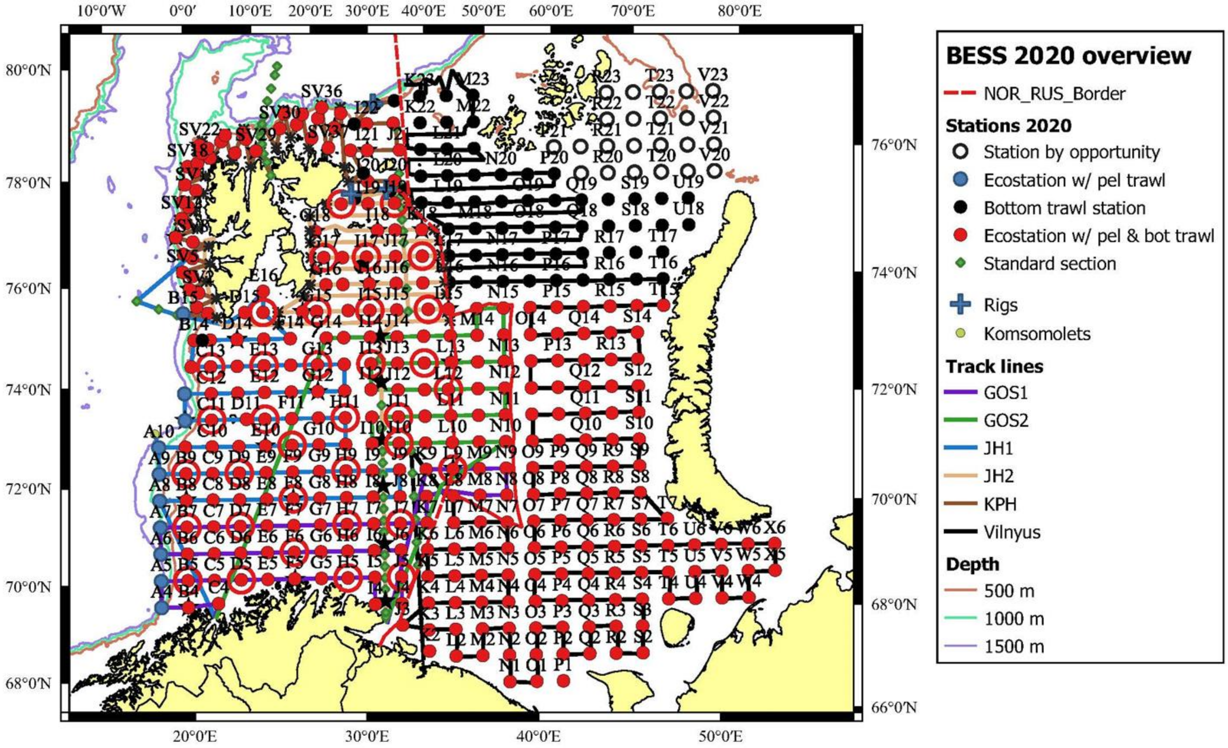

Figure 2.1 *BESS 2020, planned survey map with ecosystem stations and vessel tracks.*

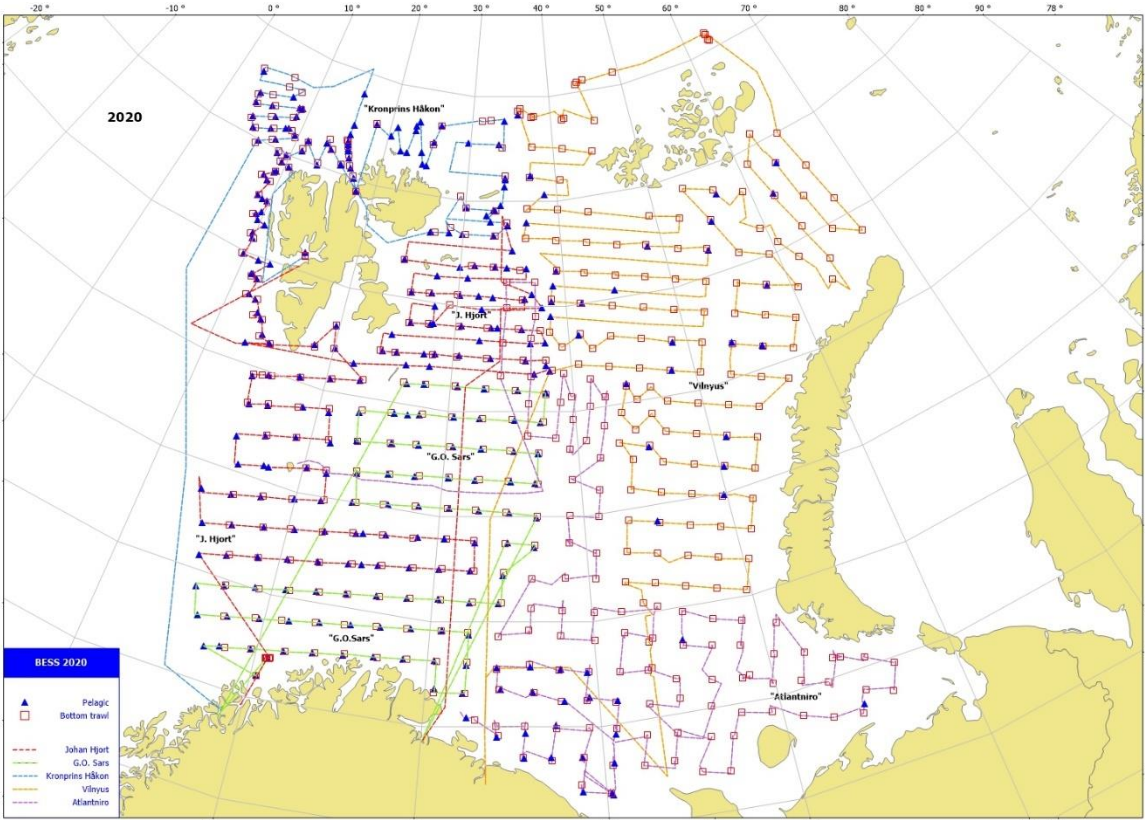

Figure 2.2 *BESS 2020, realized vessel tracks with pelagic and bottom trawl sampling stations, note that some trawl stations are taken in addition to the regular ecosystem stations.*

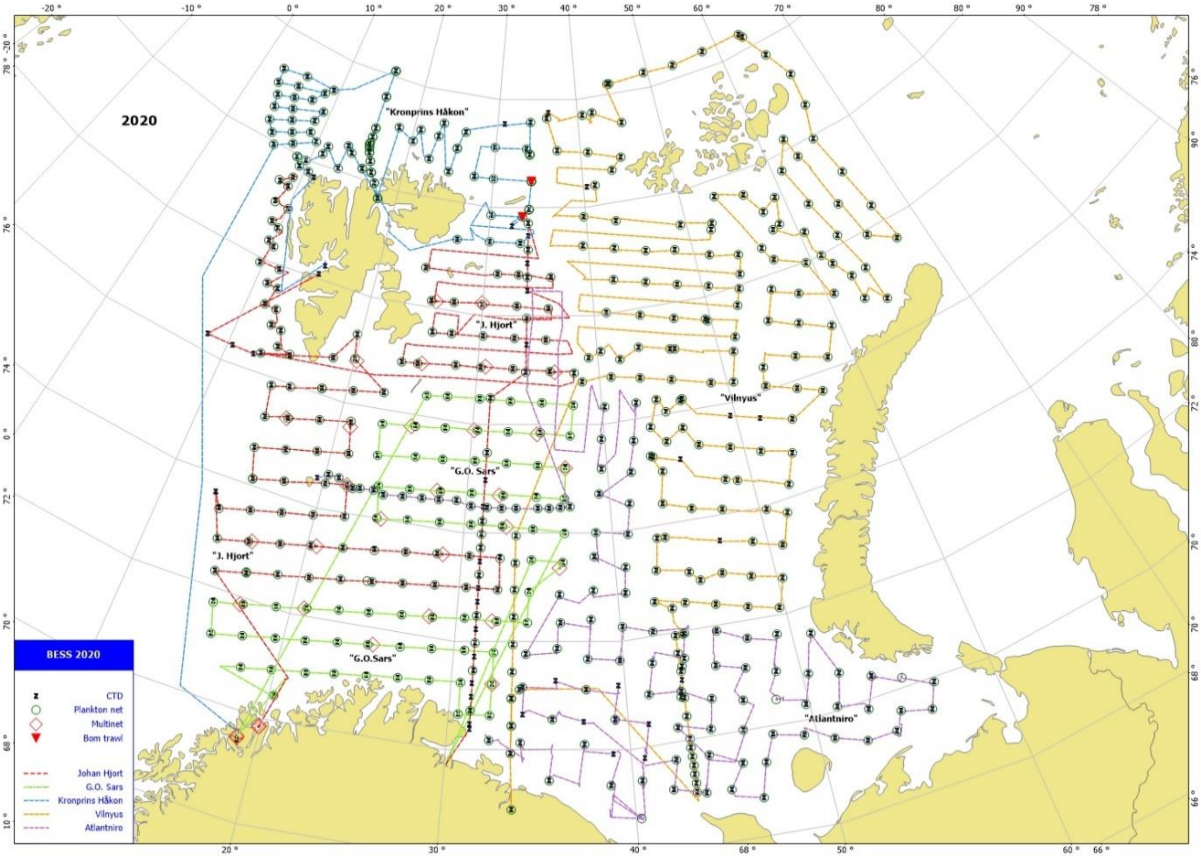

Figure 2.3 *BESS 2020, realized vessel tracks with hydrography and plankton samples at ecosystem stations.*

2.1 Sampling methods

The survey “Sampling Manual” has been developed since 2004 (last updated in 2012) and published on the BESS homepage by specialist and experts from IMR and PINRO (https://www.hi.no/hi/tokt/havforskningsinstituttets-ulike-tokt/okosystemtoktet-i-barentshavet)
This web page have been terminated, but the manual for the survey can be obtained by contacting the survey coordinators.
This manual includes methodological and technical descriptions of equipment, the trawling and capture procedures by the samplings tools, and the methods that are used for calculating the abundance and biomass of the biota.
Contact: Arill Engås, IMR (aril.engaas@hi.no) *& Dmitry 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 2020, with contact persons.

2.2.1 *Annual monitoring of pollution levels*

In 2020 PINRO continued the annual monitoring of pollution levels in the Barents Sea in accordance with a national program. Samples of seawater, sediments, fish and invertebrates was collected and analysed for persistent organic pollutants (POPs) (e.g. PCBs, DDTs, HCHs, HCB) and heavy metals (e.g. lead, cadmium, mercury) and arsenic. The samples were collected at RV "Vilnyus" during BESS in the southern and eastern parts of the Barents Sea. The results from chemical analyses will be reported in 2021.

Contact: Andrey Zhilin, PINRO (zhilin@pinro.ru)

2.2.2 *Fish pathology research*

PINRO undertakes yearly investigations of fish and crabs diseases and parasites in the Barents Sea (mainly in REEZ). The main purpose of the pathology research is annual estimation of epizootic state of commercial fish and crabs species. The observations are entered into a database on pathology. 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)

2.2.3 *Additional oceanographic sections, SAS investigations*

BESS 2020 collected oceanographic data from the “Bear Island – East” section never made in the BESS before. Additional data were sampled from three sections (“Kanin – North”, “West – East” and “Franz Josef Land – Novaya Zemlya”) to be contributed to the international Synoptic Arctic Survey (SAS).

Contact: Alexander Trofimov, PINRO (trofimov@pinro.ru)

2.2.4 *Mooring*

During BESS 2020, a mooring with two SeaGuard Recording Current Meters (SeaGuard RCM) was deployed in the Eastern Basin. Both instruments were equipped with Doppler Current-, Pressure-, Temperature-, Conductivity-, Turbidity- and Oxygen sensors.

Contact: Alexander Trofimov, PINRO (trofimov@pinro.ru)

2.2.5 *Use of deep vision, method test 5*

BESS 2020 included use of the Remote underwater observation system Deep Sea Vision for testing.

Background

DeepVision is a stereo camera system mounted in a robust box which is sewed into a front extension of the trawl codend (Fig. 1). The cameras collect a continuous record of colour images of all fish passing inside, allowing identification and measuring of fish as they are collected along the path of the trawl (Rosen et al. 2013). The system was used during BESS 2020 for the third time in the coverage of the “capelin strata”. The information from DeepVision can potentially help the scrutiny of acoustic data, for example to determine composition of capelin/polar cod and 1-group/0-group capelin in mixed aggregations. In addition, potential differences in length distribution of capelin with depth can be investigated.

Method

The DeepVision camera system was mounted in front of the codend on the Harstad trawl (Fig. 2.2.5.1). The system might influence the geometry of the trawl, so it was only used for capelin target hauls on the acoustic transects and not on the fixed pelagic 0-group hauls. After each haul, the images were transferred from the subsea unit of the DeepVision system to the topside system through a network cable. The images were stored on a hard drive, transferred to the LSSS scrutiny computer and read into LSSS during the scrutinizing session.

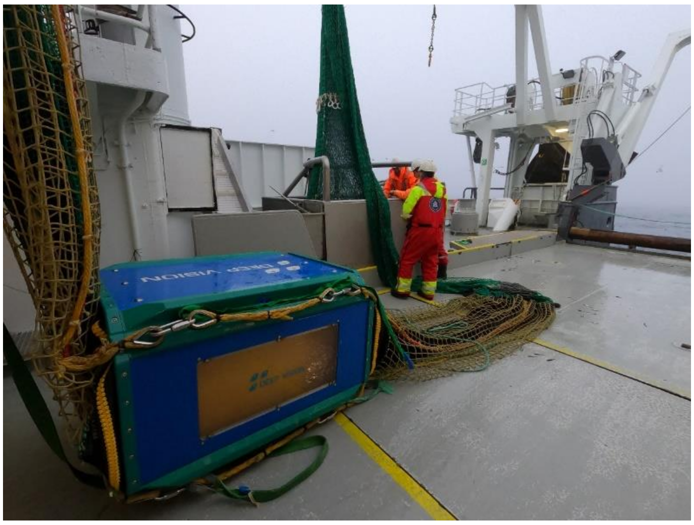

Figure 2.2.5.1 *The DeepVision box mounted on an extension in front of the codend.*

Results

The system worked quite well during the survey, but the depth sensor was malfunctioning (Figs. 2.2.5.2-2.2.5.5). The subsea unit was taken apart to try to fix the problem, but without success. The system was used during five hauls. An example of results from a haul on a mixed polar cod/capelin aggregation is shown in Figures 2.2.5.2-2.2.5.5.

The data are presently (21.04.2021) available here:
\\ces.hi.no\cruise_data\2020\staging\S2020209_PJOHANHJORT_1019\BIOLOGY\CATCH_MEASUREMENTS\DEEP_VISION
and the hope is that DeepVision can become part of the standard equipment during BESS in the areas where we expect most capelin.

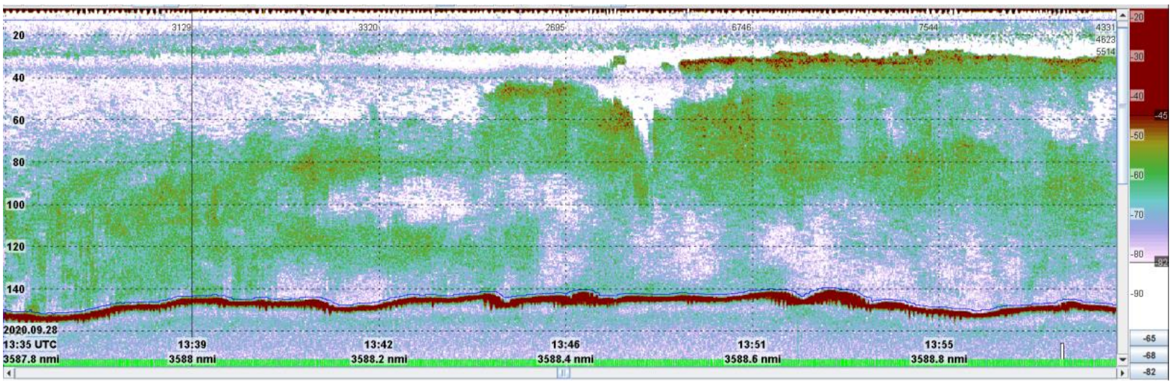

Figure 2.2.5.2 *Echogram example of capelin and polar cod in a mixed aggregation where scrutiny of acoustic data is challenging.*

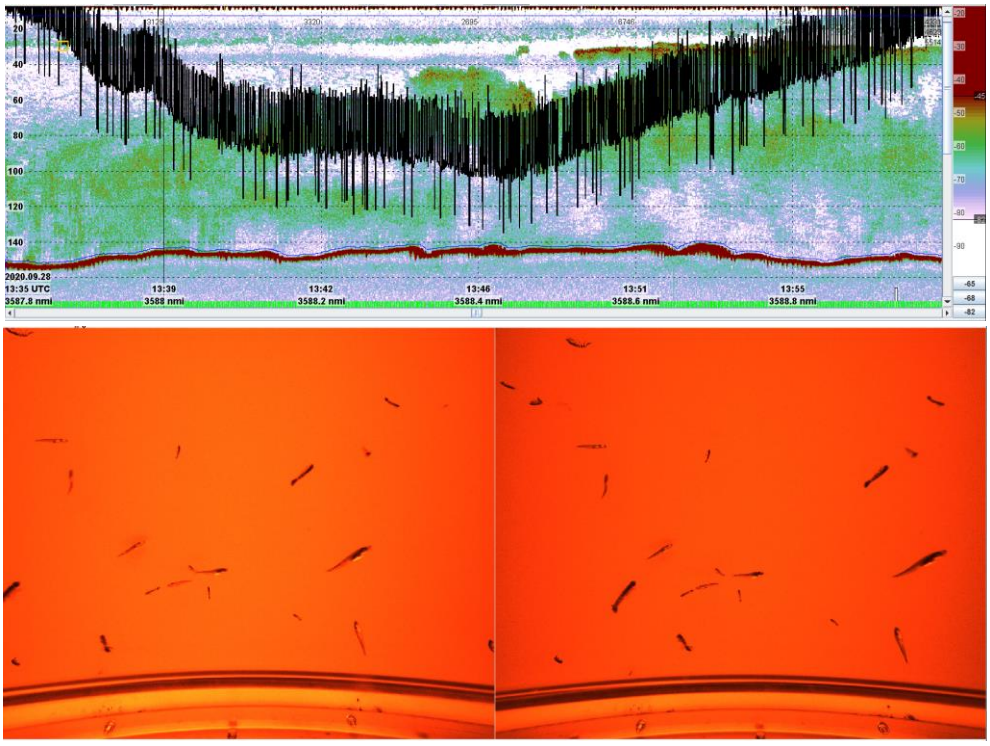

Figure 2.2.5.3 *Upper panel: Trawl path through the mixed polar cod/capelin aggregation marked in black (note that the variability is caused by a depth sensor malfunctioning, the path 'in the middle' is the correct one). The small yellow box on the trawl path is the position where the snapshot was taken. Lower panel: Snapshots from stereo cameras - left and right hand side, respectively. 0-group fish is dominating among the fish entering into the trawl.*

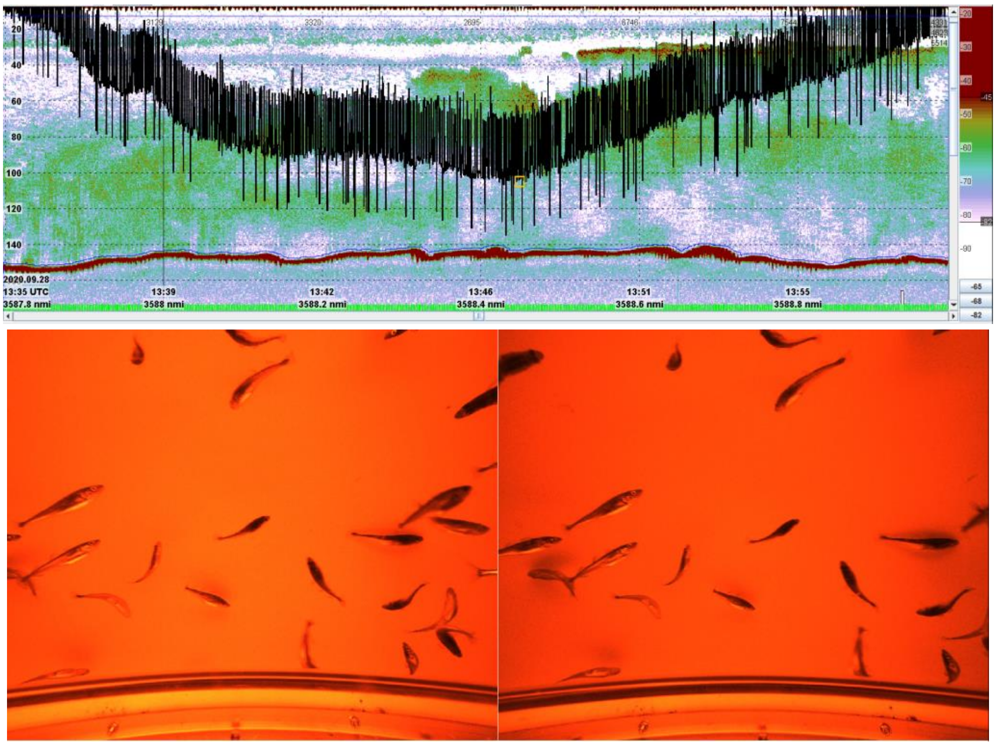

Figure 2.2.5.4 *Upper panel: Trawl path through the mixed polar cod/capelin aggregation marked in black (note that the variability is caused by a depth sensor malfunctioning, the path 'in the middle' is the correct one). The small yellow box on the trawl path is the position where the snapshot was taken. Lower panel: Snapshots from stereo cameras - left and right hand side, respectively. Polar cod is now dominating among the fish entering into the trawl.*

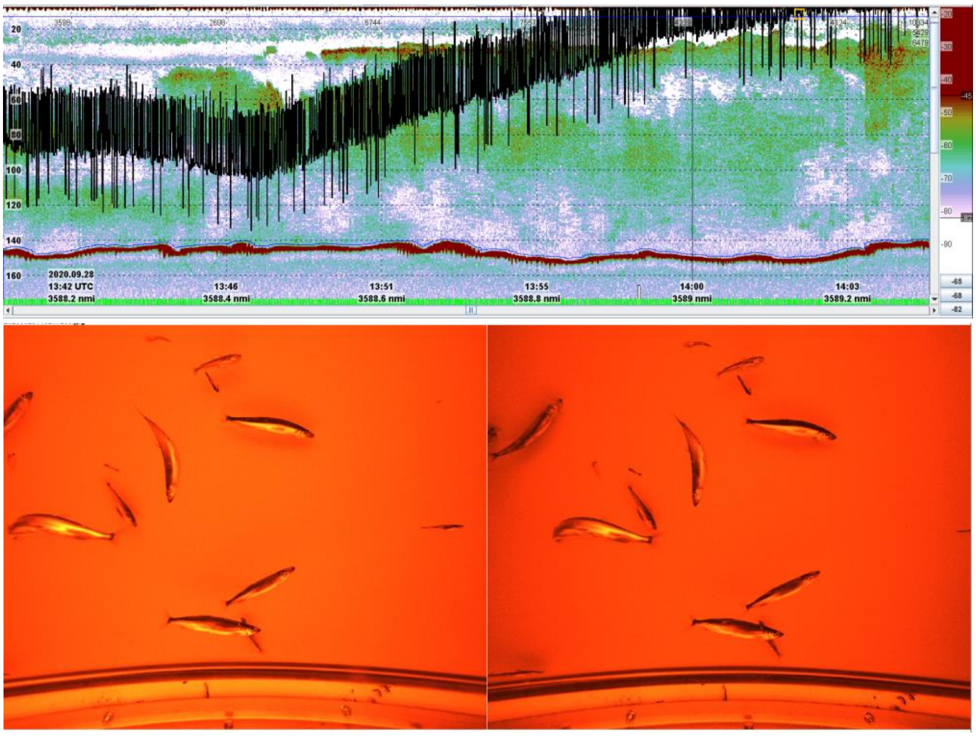

Figure 2.2.5.5 *Upper panel: Trawl path through the mixed polar cod/capelin aggregation marked in black (note that the variability is caused by a depth sensor malfunctioning, the path 'in the middle' is the correct one). The small yellow box on the trawl path is the position where the snapshot was taken. Lower panel: Snapshots from stereo cameras - left and right hand side, respectively. Capelin is now dominating among the fish entering into the trawl.*

Contact: Georg Skaret, IMR (georg.skaret@hi.no)

2.2.6 *Radioactivity in deep sea shrimps*

BESS 2020 collected samples of deep sea shrimp from two specific areas for investigations of radioactive substances. Natural and anthropogenic radionuclides will be analysed in shell and meat and in raw and boiled shrimps. This is a collaboration between IMR and the Norwegian Radiation and Nuclear Safety Authority.

Contact: Hilde Elise Heldal, IMR (hilde.elise.heldal@hi.no)

2.2.7 *Micro plastics, sampling test*

Method development micro plastics. For deciding which methods would be recommended for future long-term observation series on micro plastics. Suction pump, Manta trawl, WP2 and biota was used for daily sampling in four areas. In 2020, the Mantatrål was used daily and samples frozen for later analyses. The pump and WP2 will be tested at other cruises.

Contact: Bjørn Einar Grøsvik, IMR (bjorn.grosvik@hi.no)

2.2.8 *Saithe samples*

Sampling of ovarian tissue of >40 cm NEA haddock in order to increase our knowledge of the maturity cycle for improving estimates of the spawning stock biomass. The sampling involve weighing the gonads, determining the maturity stage and collecting ovarian tissue in BIOPSAFE-tubes.

Contact:Edda Johannessen, IMR (edda.johannessen@hi.no)

2.2.9 *Sea acidification, water samples from fixed CTDs*

BESS 2020 provided extra samples besides the standard sampling from the "Vardø-Nord" section.
Contact: Melissa Chierici, IMR (melissa.chierici@hi.no)

2.2.10 *Pollution compounds in in fish, frozen samples*

Contaminant levels in the most important commercial fish species from Norwegian waters are monitored annually to ensure reliable and updated data about environmental status and food safety. In this project we want to collect samples of cod, saithe and mackerel from the Barents Sea. The samples will be analysed for a wide range of environmental contaminants, including heavy metals and persistent organic contaminants.
Contact: Bente Nilsen, IMR (bente.nilsen@hi.no)

2.2.11 *Stomach content from cod, frozen samples for lab courses*

BESS 2020 provided stomach content from cod for use in training classes and courses.
Contact: *Herdis Langøy Mørk, IMR* (herdis.langoey-moerk@hi.no)

2.2.12 *Gastropod sampling for sea acidification studies, "Vardø-Nord" section*

Collection of the shellforming pteropods «Butterfly snail» as part of the studies on ocean acidification and effects in Norwegian waters. The project is financed through Miljødirektoratet and is a pilot study. Samples will be collected using WP2 net tows with a 64 µm net size to capture both larvae and juveniles of the pteropods, most likely *Limacina helicina* and *Limacina retroversa* (most common in this area). The sampling will be performed in two depth intervals (0-100 m, and 0-bottom) at 3 stations covering Atlantic water and the Arctic water as to obtain an environmental gradient. Studies on the water chemistry from this region have shown that Arctic water has a lower pH and lower aragonite saturation (meaning a higher dissolution potential for aragonite). These species are considered especially vulnerable for ocean acidification due to their relatively labile aragonite shell. After collection the samples will be transported to IMR in Tromsø where each sample will be separated into 4 different size classes and preserved for future analysis of the shells with regard to their general condition, density, mineral composition and shell thickness. Water sampling for water chemistry will be collected at the same stations and analysed at CO_2 lab at IMRI in Tromsø. This is part of the standard monitoring on the BESS.
Contact: Melissa Chierici, IMR (melissa.chierici@hi.no)

2.2.13 *Sampling of Carctilaginous species (Chondrichtyes)*

All cartilaginous fishes (sharks, skates, chimaera) were measured (length, weight, sex) as part of a general data collection to increase knowledge about these species in the Barents Sea. *B. spinicauda* were frozen for an ongoing UiT morphometric study. Skate egg capsules were recorded to over time map potential nursery areas. *A. radiata* was frozen for later stomach analyses (delayed due to Covid-19). *A. hyperborea* was collected for an MSc thesis which will be delivered in summer 2021. Very rare cartilaginous species were photographed and tissue samples taken for species ID confirmation; the same holds true for "unsure species ID on board". This is very important, as wrong species entries are leading to wrong species distribution ranges. These special requests for cartilaginous fishes are an extension of the monitoring activities of the survey and will help improving our knowledge also for these species in the Barents Sea.
Contact: Claudia Junge, IMR (claudia.junge@hi.no)

2.2.14 *Sampling of 0-group saithe*

BESS 2020 provided trawl samples of 0-group saithe west of Svalbard (Spitsbergen).
Contact: Elena Eriksen, IMR (elena.eriksen@hi.no)

2.2.15 *Benthos sampling, super stations*

Additions to BESS benthos long-time monitoring stations. In 2020 IMR benthos research team conducted sampling and analysing of data from Campelen trawl bycatch within standard sampling network in frames of the Ecosystem Research Cruise on board RV “Kronprins Haakon”. In addition, some extra samples were collected.

In 2020, the Team-økotokt suggested establishing benthos “super-stations” for monitoring that included grab-sampling in addition to Campelen trawl sampling. It was warned by the benthos expert that this would demand extensive extra work on land and that this was not included in any budgets. Team-Økotokt decided that benthos should move on with this additional sampling and solve the problem with work on land with Program leaders to later.

Benthos suggested that such extra sampling could be established as a continued long-time benthos monitoring series connected to AeN project. Økotokt project stations J20 and J21 (Fig.2.2.15.1) coincide with two of the AeN project’s sampling stations. Therefore, in addition to the Campelen trawl, three 0.25m^2 quantitative grab samples and one quantitative Beam trawl sample were taken on both stations. Beam trawl sampling was conducted at speed 2 knots 5 minutes at the bottom.

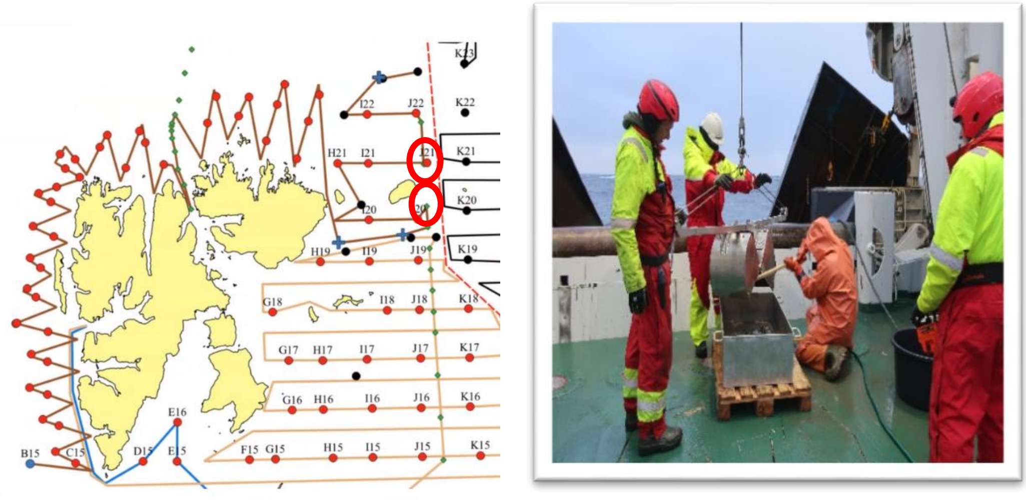

Figure 2.2.15.1 *In addition to the Campelen trawl, three 0.25m^2 quantitative grab samples and one quantitative Beam trawl sample were taken on both stations J20 and J21. Beam trawl sampling was conducted at speed 2 knots 5 minutes at the bottom.(Photo: Andrey Voronkov, IMR)*

We followed standard procedures to treat the samples. When on board, grab content was examined with a ruler to check grab filling degree. At station J19 it was approximately 7-10 cm and at J20 – approximately 12-15 cm between sediment surface and grab’s lead. Therefore, filling degree was good enough and approved. Photos of the sediments were taken. Station J19 characterized by moderate dense clay, gray in color. Top layer was soft silt, brown in color. Long *Spiochaetopterus typicus* tubes penetrated both layers. Sediments on station J20 were: extremely dense, heavy clay, gray in color, with thin layer of brown silt with coarse sand and gravel on top. Little amount of sediments was sampled with a spoon into plastic bags from each of the grab samples, labelled and frozen for further analysis at the lab. Sediments from grabs were washed through 1 mm sieve and animals were fixed in 4% borax buffered formalin. Beam trawl samples were washed through 5 mm sieve and the sieve content was fixed in 4% borax buffered formalin. Photos of the washed catch were taken when possible. Preserved samples are well labelled and stored in IMR’s storage in Tromsø. The collected samples are now ready to become a part of a planned and funded project activity, and it is important that taxonomical and quantitative treatment will be accomplished in near future.

If it is managed to fulfill the work on land, the result will give valuable results for estimation of interannual changes in benthos species richness, abundance and biomass. This is suggested as part of the AeN (no contact has been established yet) and Ecosurvey project monitoring plans.

There is a possibility to combine these data with results of video-monitoring on the selected stations planned to 2021-2022.

When AeN project is completed in 2023, there is a need for establishing of one more permanent benthos monitoring station in Yermak Plateau.

Contact: Jan Erik Stiansen (jan.erik.stiansen@hi.no) & *Lis Lindahl Jørgensen, IMR* (lis.lindahl.jørgensen@hi.no)

2.2.16 *Arctic monitoring, additional locations*

BESS 2020 provided samples from the Arctic Yermak Plateau, further north than the standard BESS surveillance area,

Contact: Geir Odd Johannesen, IMR (geir.odd.johannesen@hi.no)

2.2.17 *Collecting underwater observations labs*

BESS 2020 collected underwater oceanographic monitoring rigs for the Coordinated Arctic Acoustic Thermometry Experiment

Contact: Jan Erik Stiansen, IMR (jan.erik.stiansen@hi.no) *& Hanne Sagen, Nansen Environmental and Remote Sensing Center* (Hanne.sagen@nersc.no)

2.2.18 *Trace elements in sea water*

Water samples environmental toxicology analyses to detect trace elements.

Contact: *Michael Banks, IMR* (mikael.banks@hi.no)

3 DATA MANAGEMENT

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

3.1 Databases

A wide variety of data are collected during the ecosystem surveys. All data collected during the BESS are quality controlled and verified by experts from IMR and PINRO during the survey. The data are stored in IMR and PINRO national databases, with different formats. However, the data are exchanged so that both institutions have access to each other's data in their respective databases (i.e. both institutes use equal joint data). The quality of biology database exchange improved significantly in 2020 due to a joint data exchange project between IMR and PINRO. *Thanks are due to experts Herdis Langøy Mørk (IMR) and Tatyana Prokhorova (PINRO) for excellent work.*

3.2 Data application

The main aim of the BESS is to cover the whole Barents Sea ecosystem geographically and provide survey data for commercial fish and shellfish stock estimation. Stock estimation is particularly important for capelin, because capelin TAC is based on the survey result, and the Norwegian-Russian Fishery Commission determines TAC immediately after the survey. In addition, a broad spectrum of physical variables, ecosystem components and pollution are monitored and reported. The survey data will be used by ICES working groups and workshops mentioned in the "Background" chapter 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 as part of the IMR/PINRO Joint Report series when assembled into a complete pdf-report when the main components are completed. Some post-survey information, not included in the written report (e.g. plankton and fish stomach samples which need longer processing time) will be published as individual parts of the report later.

3.3 Time series of distribution maps

Maps from this and previous year's surveys will be made available in a redesigned IMR web site for the joint Norwegian/Russian Barents Sea Ecosystem Surveys.

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

In August–October 2020, surface temperature was on average 1.4°C higher than the long-term mean in almost all over the surveyed area (95%) (Fig. 4.1.1.9). Positive anomalies increased eastwards and reached more than 3°C in the south-eastern Barents Sea. Negative anomalies (about −0.7°C on average) were found only in a small area south of Bear Island. Compared to 2019, the surface temperature in 2020 was much higher (by 1.4°C on average) in most of the surveyed area (~80%), with the largest positive differences (>3°C) in the south-eastern and south-westernmost parts of the sea. Negative differences in temperature between 2020 and 2019 were mainly found in the western Barents Sea between 73 and 76°N as well as over the Murman Rise.

Arctic waters were mainly found, as usual, in the 50–100 m layer north of 77°N (Fig. 4.1.1.3 and 4.1.1.5). Temperatures at depths of 50 and 100 m were higher than the long-term means (on average, by 0.7 and 0.5°C respectively) in about two thirds of the surveyed area with the largest positive anomalies in the south-east, especially at 50 m depth. Negative anomalies (about −0.4°C on average) were mostly found over the Great Bank and in some areas in the central Barents Sea. Compared to 2019, the 50 and 100 m temperatures in 2020 were lower (on average, by 1.0 and 0.5°C respectively) in half of the surveyed area, especially in the central and south-eastern parts of the sea; positive differences were mainly observed in the south-western Barents Sea as well as south and east of the Svalbard (Spitsbergen).

Bottom temperature was in general 0.7°C above average in two thirds of the surveyed area with the largest positive anomalies in the south-eastern Barents Sea (Fig. 4.1.1.10). Negative anomalies (−0.5°C on average) were mainly found in some areas in the southern and northern parts of the sea with the largest values east of the Svalbard (Spitsbergen) and over the Great Bank. Compared to 2019, the bottom temperature in 2020 was on average 0.5°C lower in 60% of the surveyed area with the largest differences over the North Kanin Bank and in the Eastern Basin. Bottom waters were warmer (on average, by 0.5°C) than in 2019 mainly in the western part of the sea, east of the Svalbard (Spitsbergen) and north of Kanin Peninsula. In August–October 2020, the area covered by bottom water with temperatures below zero was 6% larger than in 2019 and the largest since 2011.

Surface salinity was on average 0.3 higher than the long-term mean in about 40% of the surveyed area with the largest positive anomalies (>0.4) in the north and south-east (Fig. 4.1.1.11). Negative anomalies (–0.15 on average) were observed in the western and central parts of the sea as well as in a small area north of Kanin Peninsula. In August–October 2020, surface waters were on average 0.2 fresher than in 2019 in about 60% of the surveyed area; they were saltier (on average, by 0.4) mainly east of the Svalbard (Spitsbergen) and in the south-eastern Barents Sea.

Salinity of deeper waters was lower than average (by 0.1 on average) in about half of the surveyed area at 50 m depth and almost all over the sea (80% of the area) at 100 m depth with the largest negative anomalies in coastal waters in the south-western Barents Sea. Positive anomalies were observed in the northern, especially east of the Svalbard (Spitsbergen), and south-eastern parts of the sea. In August–October 2020, waters at 50 and 100 m were fresher (by 0.1 on average) than in 2019 in most of the surveyed area (57 and 65% respectively) with the largest negative differences east of the Svalbard (Spitsbergen) and in coastal waters in the south-western Barents Sea. Significant positive differences (>0.1) in salinity between 2020 and 2019 were mainly observed in the south-eastern Barents Sea. At a depth of 50 m, both positive and negative anomalies and differences were larger than at 100 m. At a depth of 100 m, salinity anomalies and differences of <0.1 in magnitude occupied 90 and 77% of the surveyed area respectively.

Bottom salinity was slightly lower than average in about 80% of the surveyed area with the largest negative anomalies (>0.1 in magnitude) mainly in coastal waters in the south-western Barents Sea and east of Bear Island (Fig. 4.1.1.12). Positive anomalies were found in the south-eastern part of the sea and in some areas around the Svalbard (Spitsbergen). In August–October 2020, the bottom waters were a bit fresher than in 2019 in three fourths of the surveyed area. Only in the south-eastern Barents Sea, they were much saltier compared to 2019. As a whole, bottom salinity anomalies and differences were small (<0.1 in magnitude) almost all over the surveyed area (85 and 74% respectively).

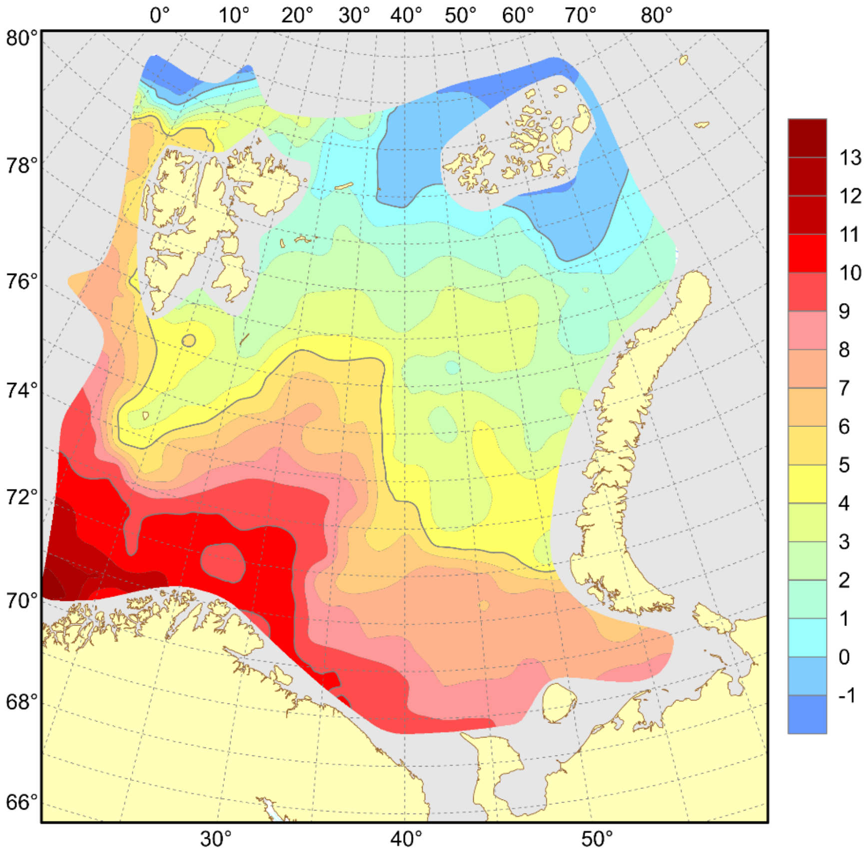

Figure 4.1.1.1 *Distribution of surface temperature (°C), August–October 2020.*

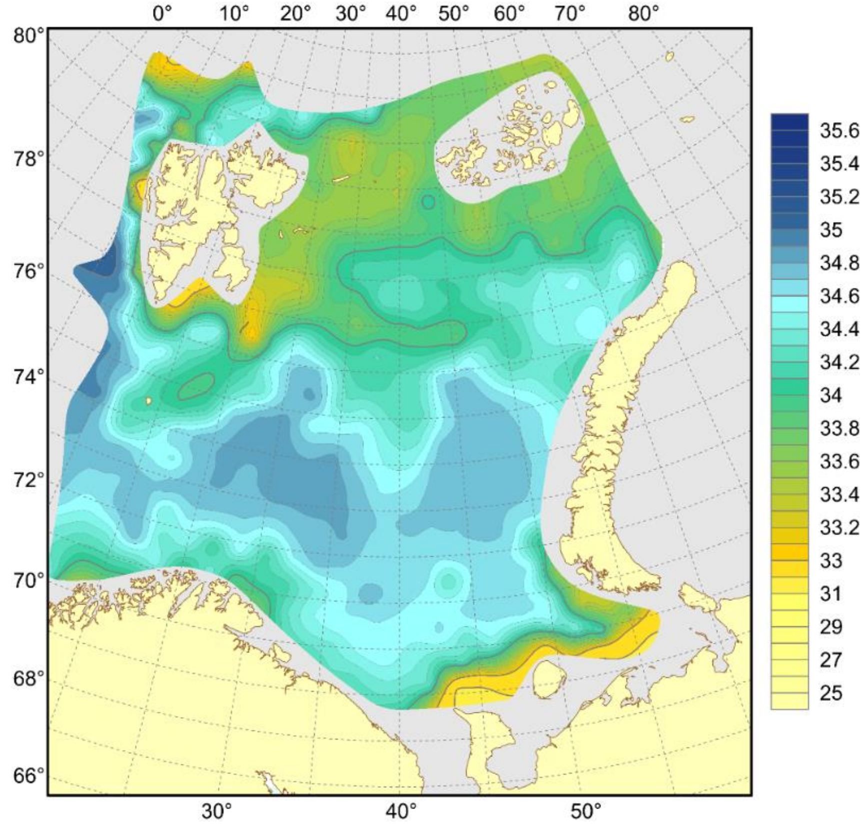

Figure 4.1.1.2 *Distribution of surface salinity, August–October 2020.*

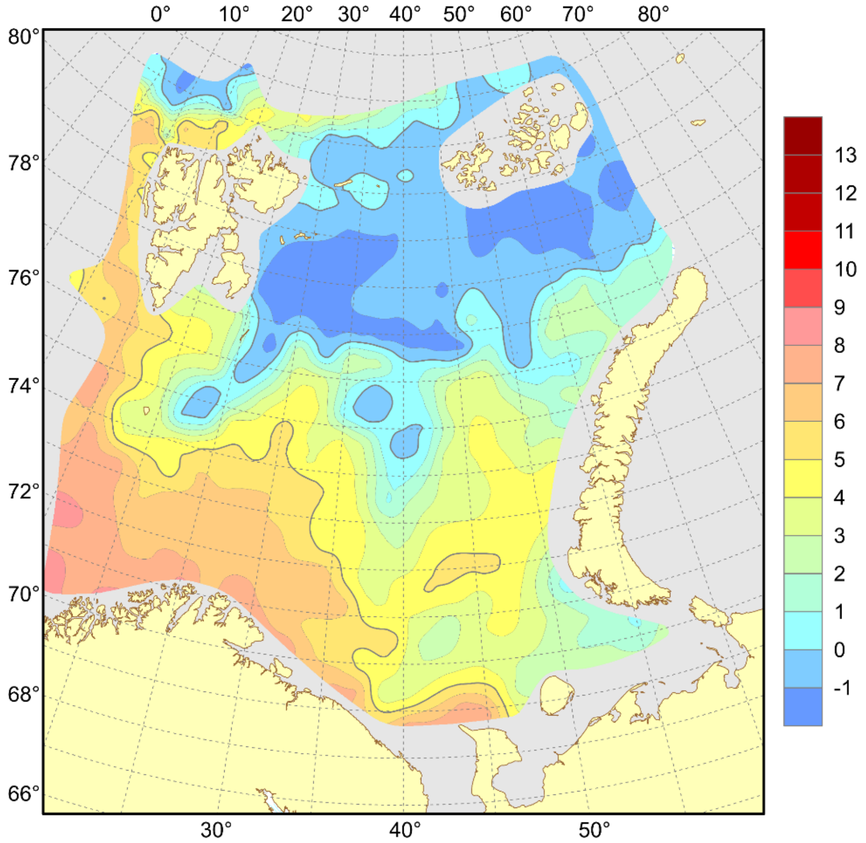

Figure 4.1.1.3 *Distribution of temperature (°C) at the 50 m depth, August–October 2020.*

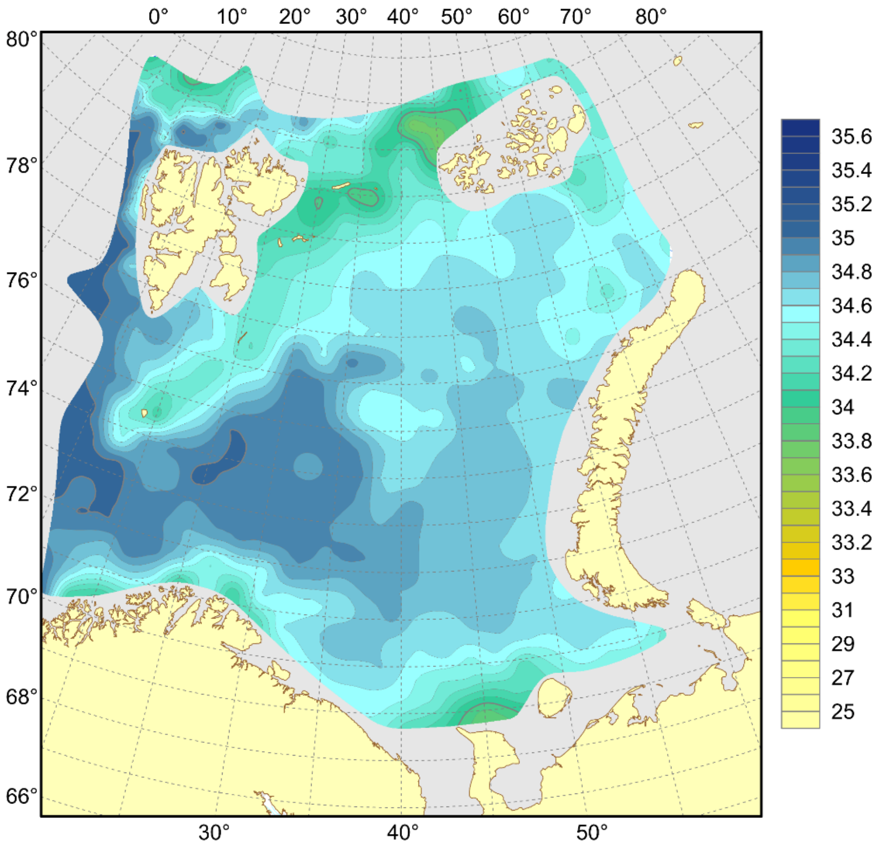

Figure 4.1.1.4 *Distribution of salinity at the 50 m depth, August–October 2020.*

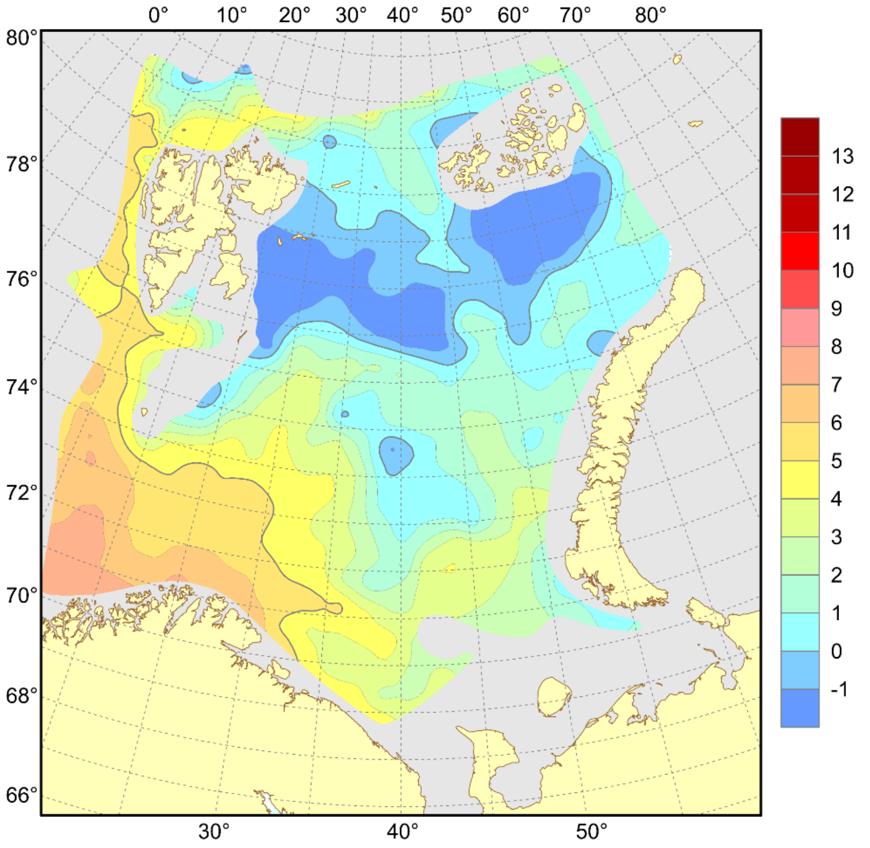

Figure 4.1.1.5 *Distribution of temperature (°C) at the 100 m depth, August–October 2020.*

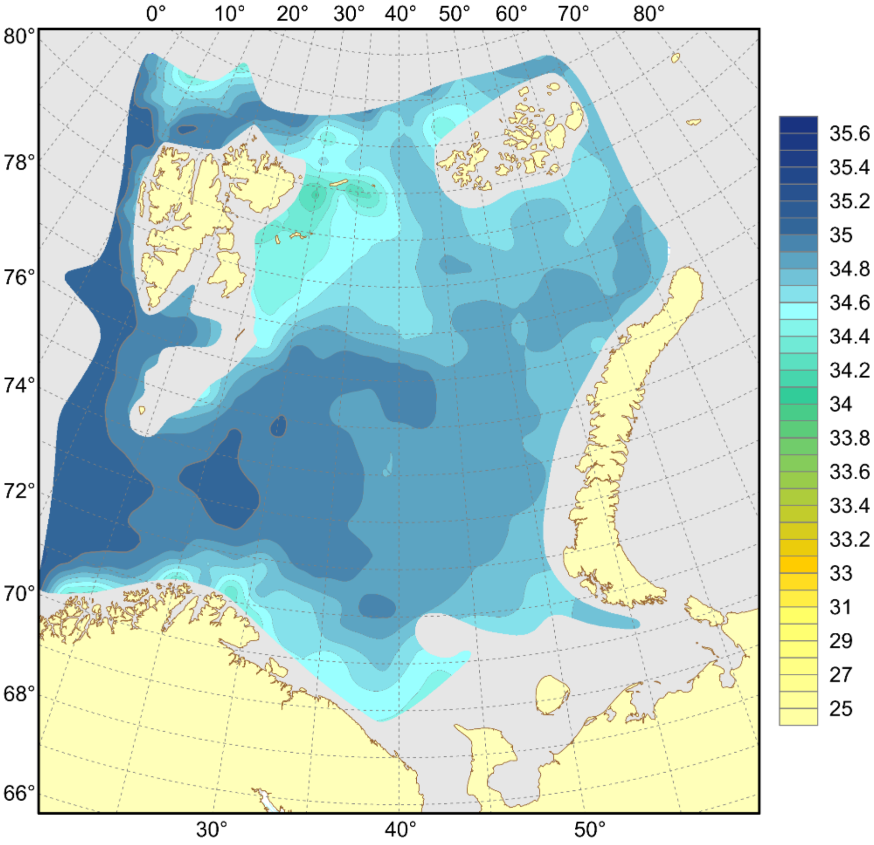

***Figure 4.1.1.6** Distribution of salinity at the 100 m depth, August–October 2020.*

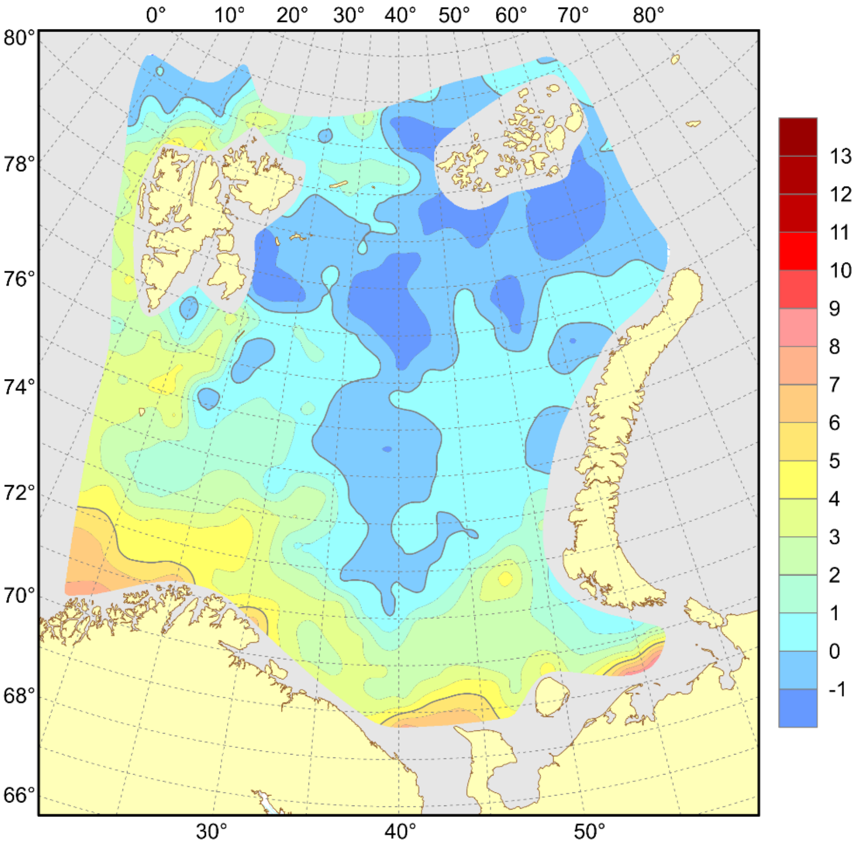

***Figure 4.1.1.7** Distribution of temperature (°C) at the bottom, August–October 2020.*

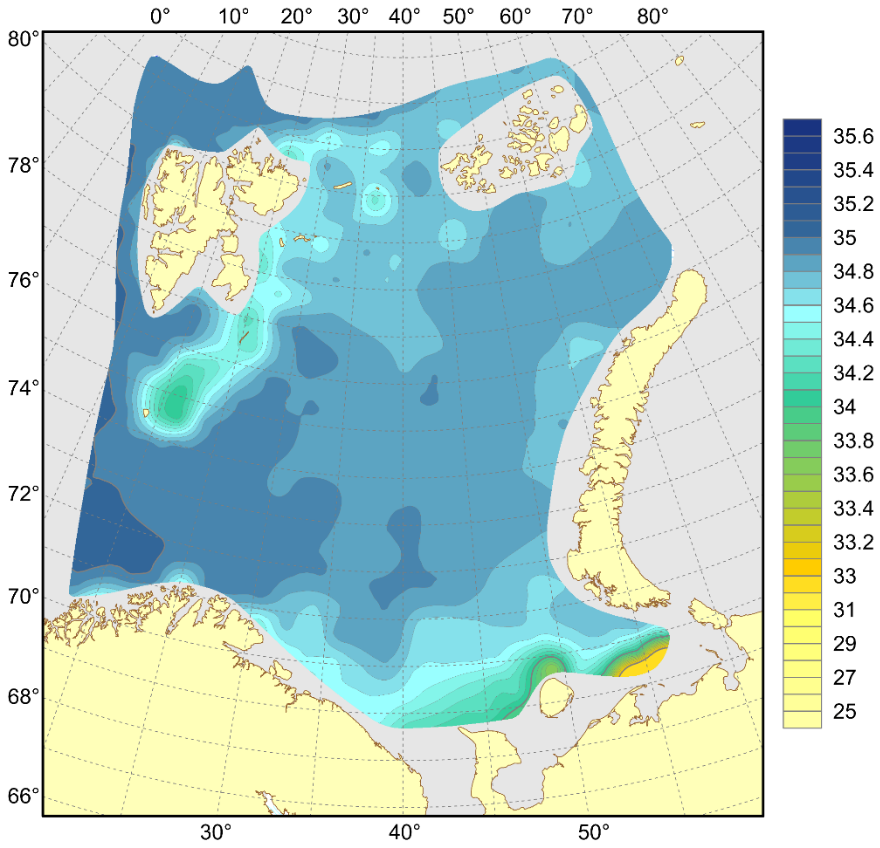

Figure 4.1.1.8 *Distribution of salinity at the bottom, August–October 2020.*

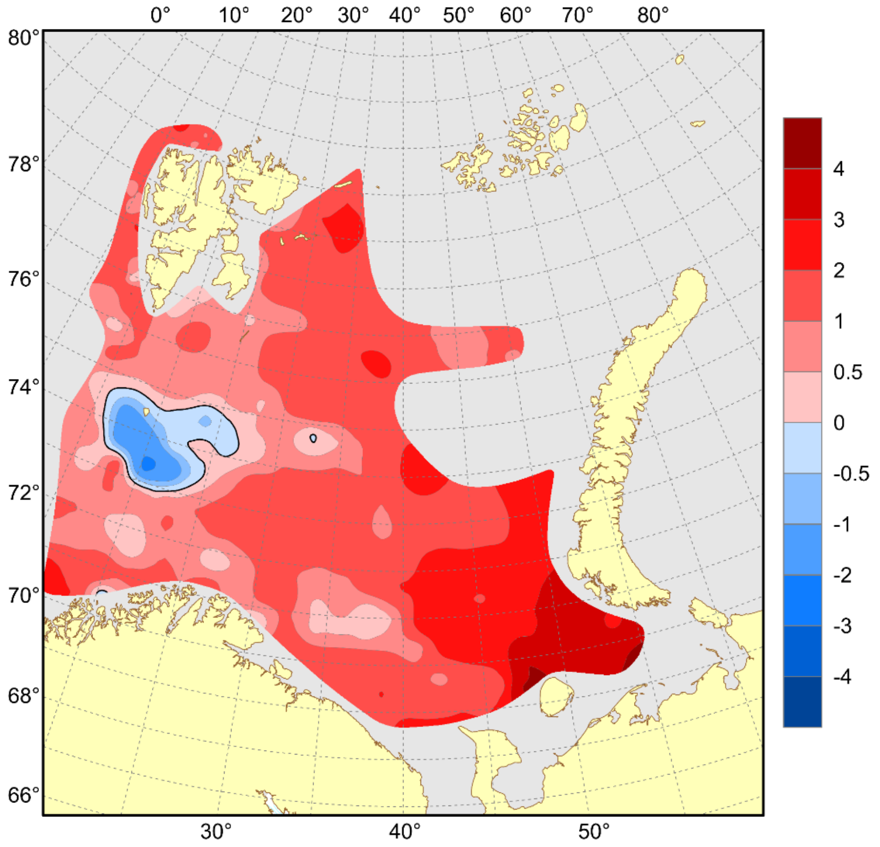

Figure 4.1.1.9 *Surface temperature anomalies (°C), August–October 2020.*

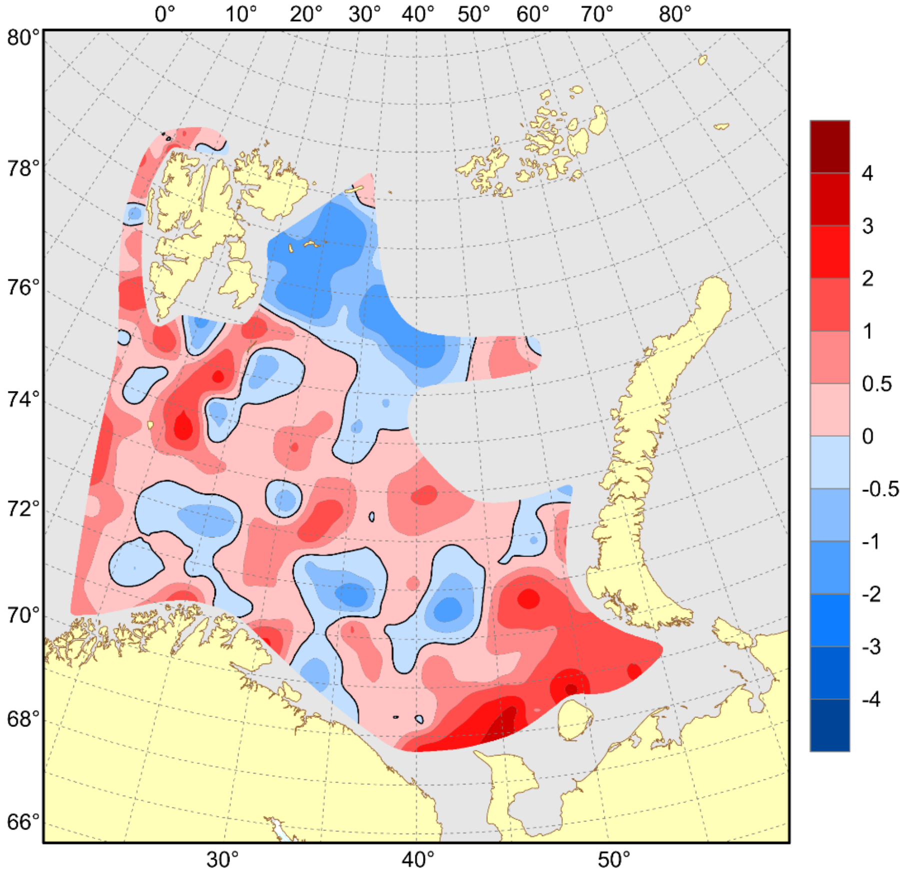

Figure 4.1.1.10 *Temperature anomalies (°C) at the bottom, August–October 2020.*

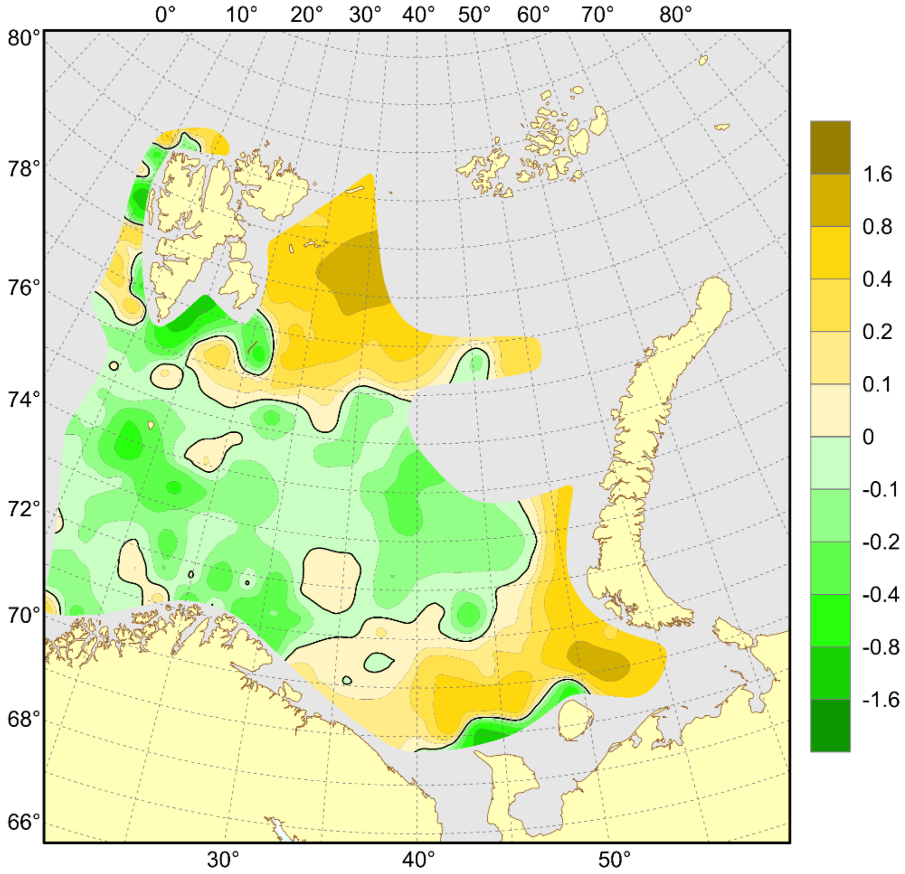

Figure 4.1.1.11 *Surface salinity anomalies, August–October 2020.*

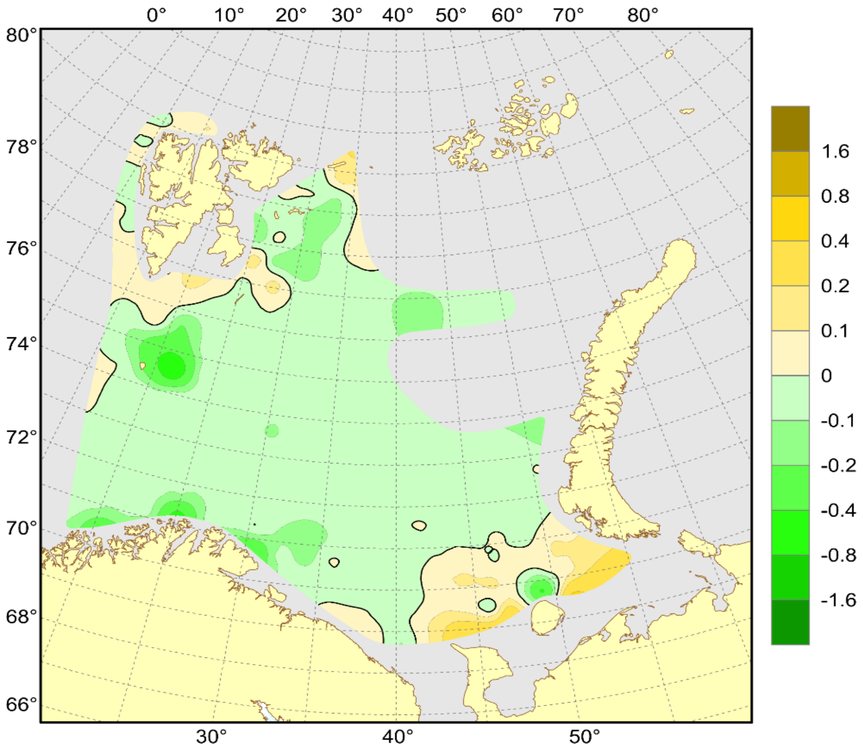

Figure 4.1.1.12 *Salinity anomalies at the bottom, August–October 2020.*

4.1.2 *Standard sections*

Table 4.1.2.1 shows mean temperatures in the main parts of standard oceanographic sections of the Barents Sea, along with historical data back to 1965.

The "Fugløya–Bear Island" and "Vardø–Nord" sections cover the inflow of Atlantic and Coastal water masses from the Norwegian Sea to the Barents Sea. The mean Atlantic Water (50–200 m) temperature in the inflow region to the Barents Sea, i.e. at the "Fugløya–Bear Island" section, was 0.2°C higher than the long-term mean (1981–2010) and 0.3°C warmer than in 2019 (Table 4.1.2.1). Warming as compared to 2019 was also observed in the "Vardø–Nord" section (Table 4.1.2.1). However, the Arctic Water in the northern parts of this section (above Storbanken) is still about 1.5°C colder than observed in 2016.

The "Kola" and "Kanin" sections cover the flow of Coastal and Atlantic waters in the southern Barents Sea. In August–October 2020, the "Kola" section was sampled twice: in the middle of August (during the survey before the BESS, Table 4.1.2.1) and in late September. In August, temperature anomalies (relative to 1981–2010) in the "Kola" section decreased northwards and with depth. The temperature anomaly averaged over 0–200 m decreased from +0.7°C in Coastal waters in the inner part of the section to +0.4 and +0.1°C in Atlantic waters in the central and outer parts respectively. The highest anomaly of +1.3°C (typical of anomalously warm years) was observed in the upper 50 m later in Coastal waters, whereas the lowest anomaly close to the average was found in the 50–200 m layer in Atlantic waters in the outer part of the section. From August to September, Atlantic water temperature anomalies in the "Kola" section changed insignificantly in the central part of the section and increased by 0.5°C in its outer part. The mean salinity of Atlantic waters in the "Kola" section (0–200 m) in August and September was 0.02–0.08 lower than the long-term (1981–2010) mean. In the "Kanin" section, the mean temperature of Atlantic waters (0–200 m) was 1.0°C higher than the long-term (1981–2010) mean that was typical of anomalously warm years. As the "Kanin" section was sampled this year in November, much later than usual, the mean temperatures from it were not presented in Table 4.1.2.1.

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 1965–2020. The sections are: “Kola” (70°30'N – 72°30'N, 33°30'E), “Kanin S” (68°45'N – 70°05'N, 43°15'E), “Kanin N” (71°00'N – 72°00'N, 43°15'E), “Vardø – Nord” (VN, 72°15'N – 74°15'N, 31°13'E) and “Fugløya – Bear Island” (FBI, 71°30'N, 19°48'E – 73°30'N, 19°20'E).*

Year	Section and layer (depth in metres)						
	Kola	Kola	Kola	Kanin S	Kanin N	VN	FBI
	0–50	50–200	0–200	0–bot.	0–bot.	50–200	50–200
1965	6.7	3.9	4.6	4.6	3.7	3.8	5.2
1966	6.7	2.6	3.6	1.9	2.2	3.2	5.3
1967	7.5	4.0	4.9	6.1	3.4	4.4	6.3
1968	6.4	3.7	4.4	4.7	2.8	3.4	5.0
1969	6.7	3.1	4.0	2.6	2.0	3.8	6.3
1970	7.8	3.7	4.7	4.0	3.3	4.1	5.6
1971	7.1	3.2	4.2	4.0	3.2	3.8	5.6
1972	8.7	4.0	5.2	5.1	4.1	4.6	6.1
1973	7.7	4.5	5.3	5.7	4.2	4.9	5.7
1974	8.1	3.9	4.9	4.6	3.5	4.3	5.8
1975	7.0	4.6	5.2	5.6	3.6	4.5	5.7
1976	8.1	4.0	5.0	4.9	4.4	4.4	5.8
1977	6.9	3.4	4.3	4.1	2.9	3.6	4.9
1978	6.6	2.5	3.6	2.4	1.7	3.2	4.9
1979	6.5	2.9	3.8	2.0	1.4	3.6	4.7
1980	7.4	3.5	4.5	3.3	3.0	3.7	5.5
1981	6.6	2.7	3.7	2.7	2.2	3.4	5.3
1982	7.1	4.0	4.8	4.5	2.8	4.1	6.0
1983	8.1	4.8	5.6	5.1	4.2	4.8	6.1
1984	7.7	4.1	5.0	4.5	3.6	4.2	5.7
1985	7.1	3.5	4.4	3.4	3.4	3.7	5.6
1986	7.5	3.5	4.5	3.9	3.2	3.8	5.5
1987	6.2	3.3	4.0	2.7	2.5	3.5	5.1
1988	7.0	3.7	4.5	3.8	2.9	3.8	5.7
1989	8.6	4.8	5.8	6.5	4.3	5.1	6.2
1990	8.1	4.4	5.3	5.0	3.9	5.0	6.3
1991	7.7	4.5	5.3	4.8	4.2	4.8	6.2
1992	7.5	4.6	5.3	5.0	4.0	4.6	6.1
1993	7.5	4.0	4.9	4.4	3.4	4.2	5.8
1994	7.7	3.9	4.8	4.6	3.4	4.8	5.9
1995	7.6	4.9	5.6	5.9	4.3	4.6	6.1
1996	7.6	3.7	4.7	5.2	2.9	3.7	5.7
1997	7.3	3.4	4.4	4.2	2.8	4.0	5.4
1998	8.4	3.4	4.7	2.1	1.9	3.9	5.8
1999	7.4	3.8	4.7	3.8	3.1	4.8	6.1
2000	7.6	4.5	5.3	5.8	4.1	4.2	5.8
2001	6.9	4.0	4.7	5.6	4.0	4.2	5.9
2002	8.6	4.8	5.8	4.0	3.7	4.6	6.5
2003	7.2	4.0	4.8	4.2	3.3	4.7	6.2
2004	9.0	4.7	5.7	5.0	4.2	4.8	6.4
2005	8.0	4.4	5.3	5.2	3.8	5.0	6.2
2006	8.3	5.3	6.1	6.1	4.5	5.3	6.9
2007	8.2	4.6	5.5	4.9	4.3	4.9	6.5
2008	6.9	4.6	5.2	4.2	4.0	4.7	6.4
2009	7.2	4.3	5.0	-	4.3	5.2	6.4
2010	7.8	4.7	5.5	4.9	4.5	-	6.2
2011	7.6	4.0	4.9	5.0	3.8	5.1	6.4
2012	8.2	5.3	6.0	6.2	5.2	5.7	6.4
2013	8.8	4.6	5.6	5.5	4.6	4.9	6.3
2014	8.0	4.6	5.4	4.5	4.1	5.2	6.1
2015	8.5	4.8	5.7	6.1	4.6	5.5	6.6
2016	8.7	4.7	5.8	-	5.5	5.1	6.5
2017	7.9	4.8	5.6	-	-	5.2	6.4
2018	8.1	4.9	5.7	-	-	-	6.0
2019	7.8	4.4	5.2	5.5	4.1	4.7	5.9
2020	8.2	4.3	5.3	-	-	5.1	6.2
Average 1981–2010	7.6	4.2	5.0	4.6	3.6	4.4	6.0

4.2 Antropogenic pollution

4.2.1 *Marine litter*

Text by: T. Prokhorova, B. E. Grøsvik, R. Klepikovskiy

Figures by: D. Prozorkevich

Anthropogenic litter floating at the surface and collected in trawls in 2020 was observed onboard all Norwegian vessels and Russian vessel "Vilnyus".

Plastic dominated among anthropogenic pollutants on the water surface (68.9 % of observations) (Fig. 4.2.1.1). The maximum surface observation of plastic litter was 0.21 m^3, with the average of 0.01 m^3. Due to currents, recorded debris could be dumped directly in some areas and transported from other areas. Wood was recorded in 22.1 % of the observations. The maximum surface observation of wood was 1.96 m^3, with the average of 0.12 m^3. Metal, paper and rubber was observed singularly.

Fishery related litter was recorded in 22.6 % of plastic litter observations at the surface (Fig. 4.2.1.2). Fishery related litter was represented by ropes (OSPAR code 31) and floats/buoys (OSPAR code 37). Fishery plastic both maximum and average observations (0.21 m^3 and 0.03 m^3 correspondingly) was larger than non-fishery plastic (0.055 m^3 and 0.002 m^3 correspondingly).

Vi found average amount of surface litter in the Russian part of the survey area (using length and width of observations tracks). The maximum amount was 0.077 m^3 per km^2 with the average of 0.0008 m^3 per km^2. Most of the surface litter amount was fishery plastic (the maximum catch was 0.017 m^3 per km^2 with the average of 0.0001 m^3 per km^2.

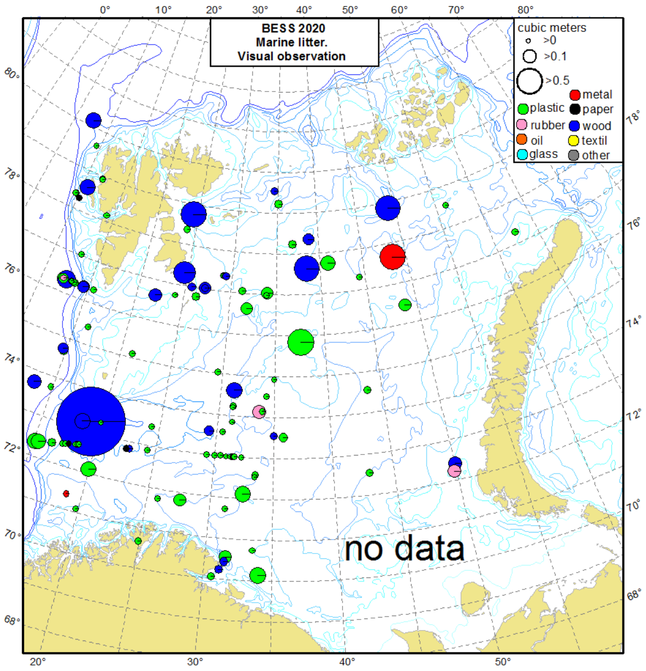

Figure 4.2.1.1 *Type of observed anthropogenic litter (m^3) at the surface in the BESS 2020.*

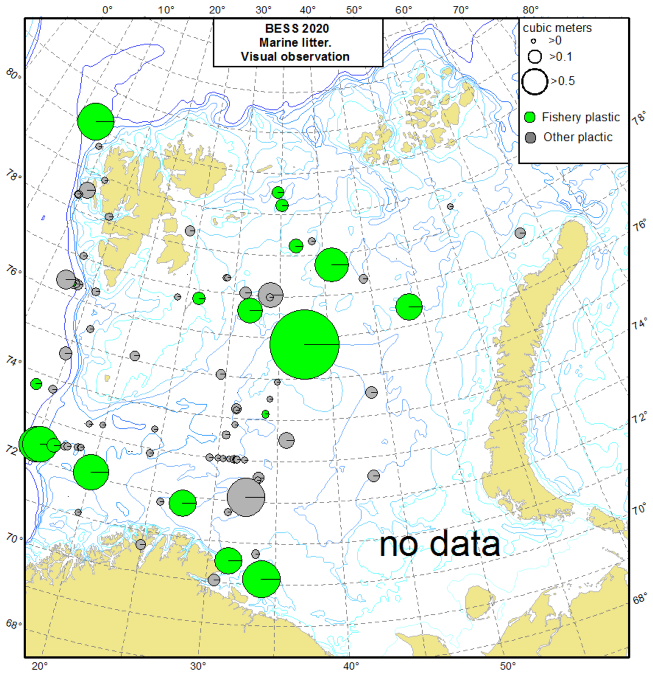

Figure 4.2.1.2 *Litter observations of plastic at the surface indicated as fishery related and other litter in the BESS 2020 (crosses – occurrences of anthropogenic litter).*

Anthropogenic litter was observed in 24.6 % of pelagic trawl stations (Fig. 4.2.1.3). As in previous years, plastic dominated from all anthropogenic matter in pelagic trawls (88.5 % of stations with observed litter). Weight of plastic litter from pelagic trawls was from 0.1 g to 16 kg with average of 0.024 kg (except the single maximum catch of 16 kg). Considering the low catchability by pelagic trawl for low-density polymers, the total amount of this matter in the Barents Sea could be much higher. Another type of litter (wood, textile, paper and metal) was observed singularly. The maximum catch of litter by pelagic trawl was 10.8 kg per n.mile, with the average of 0.037 kg per n.mile.

Litter was observed throughout the survey in the bottom trawl catches (27.4 % of the bottom trawl stations, Fig. 4.2.1.4). Plastic also dominated the litter content from the bottom trawls (92.6 % of stations with observed litter). Weight of plastic litter in bottom trawls was from 1 g to 14 kg with average of 0.11 g (except the single maximum catch of 14 kg). Unlike previous years, wood wasn't so widely registered in bycatch (only 5.8 % of stations with observed litter compared with 24.8 % in 2019). Textile, paper, metal, rubber and glass were observed among the bottom trawl catches sporadically. The maximum catch of litter by bottom trawl was 18.5 kg per n.mile, with the average of 0.08 kg per n.mile.

Litter from fishery was a significant part of plastic litter both in the pelagic and bottom trawls (50.7 % and 67.0 % respectively, Fig. 4.2.1.5).

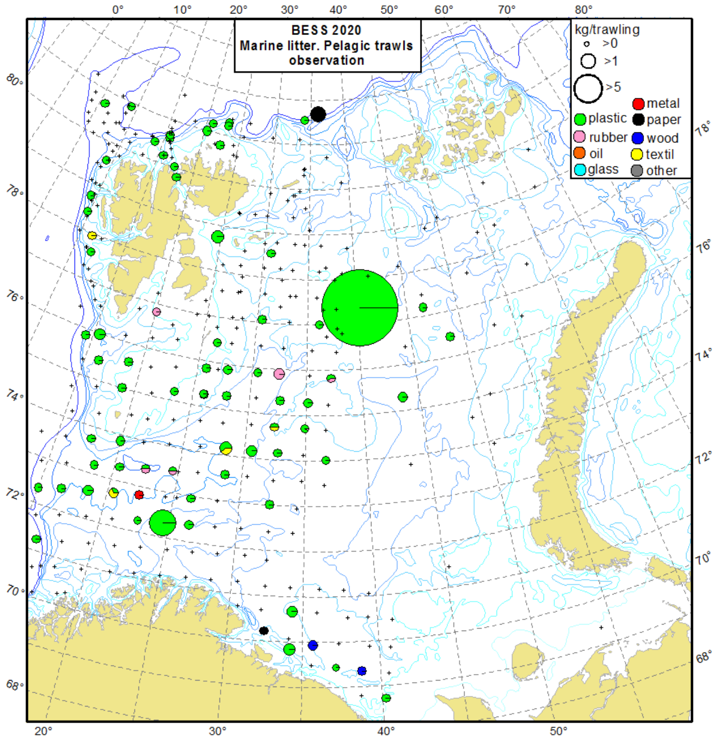

__Figure 4.2.1.3__ Type of anthropogenic litter collected in the pelagic trawls (kg) in the BESS 2020 (crosses – pelagic trawl stations).

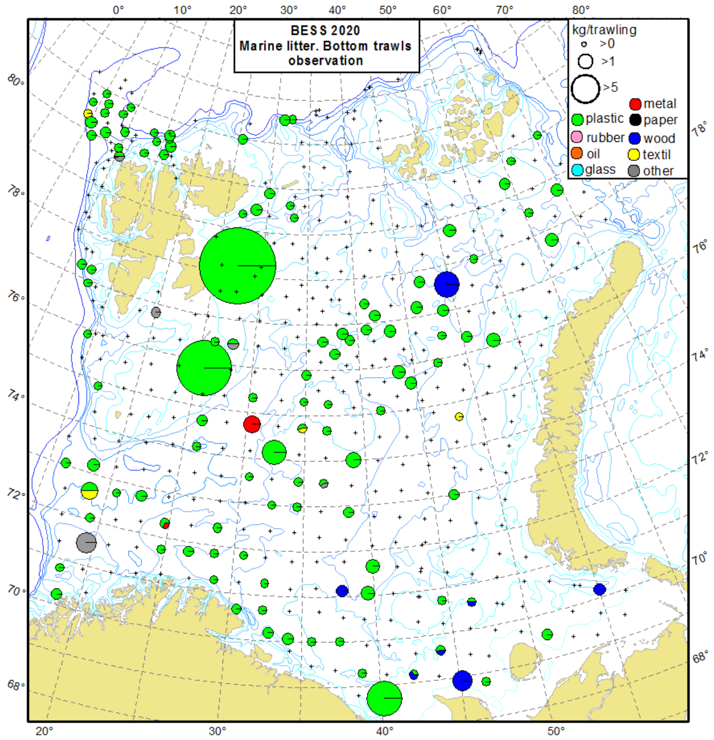

__Figure 4.2.1.4__ Type of anthropogenic litter collected in the bottom trawls (kg) in the BESS 2020 (crosses – bottom trawl stations).

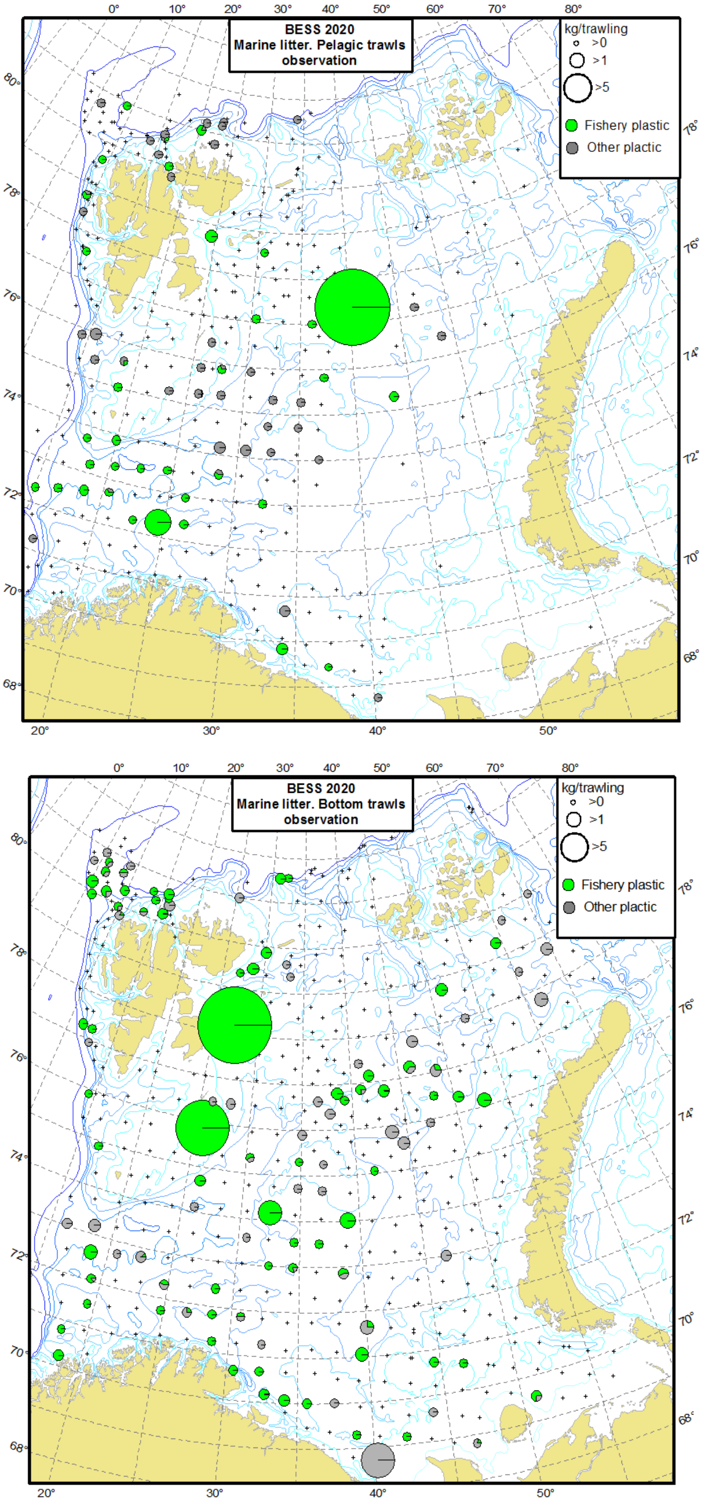

Figure 4.2.1.5 *Fishery plastic proportion among the plastic litter collected in the pelagic (the upper figure) and bottom trawls (the lower figure) in the BESS 2020 (crosses – trawl stations).*

5 PLANKTON COMMUNITY

5.1 Phytoplankton, chlorophyll a and nutrients

Text by: E. Bagøien

About 20 phytoplankton samples were collected from stations dispersed within the Norwegian sector of the Barents Sea during the joint ecosystem cruise in 2020. The samples were collected from depth of 10 m using CTD-mounted water-bottles. The samples were fixed in Lugol's solution, and species abundances have been analysed at IMR in Flødevigen using the Utermöhl sedimentation method for volumes of 50 ml.

Nutrient and chlorophyll samples were collected from rosette-mounted water-bottles released at various depths at the CTD stations in the Norwegian sector of the Barents Sea. The nutrient samples (20 ml) were preserved with chloroform (200µl), and thereafter kept at about 4°C until subsequent chemical analysis on shore at IMR. The chlorophyll-samples were collected by filtering 263 ml of seawater through glass-fibre filters, which were then frozen at about -18°C until subsequent extraction of pigments in acetone and thereafter fluorometric analysis in the IMR laboratory on shore. Concentrations of nitrate, nitrite, silicate and phosphate, along with chlorophyll and phaeopigments, in all collected samples have now been analysed.

Data on phytoplankton species, chlorophyll or nutrient levels are not presented in the cruise-report, but the results are available at IMR.

5.2 Mesozooplankton biomass and geographic distribution

Text by: E. Bagøien, I. Prokopchuk, Z. Ostapenko, A. Dolgov and J. Rønning
Figure by: E. Bagøien

Mesozooplankton sampling stations during the BESS in 2020 are presented in Fig. 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. A comparison study has shown that the total zooplankton biomass collected by the two gears is roughly comparable. The Norwegian biomass samples are dried before weighing, while the Russian samples are preserved in 4% formalin and their wet-weight measured. Dry-weight is then estimated by dividing the wet-weight with a factor of 5. Mesozooplankton was sampled in the south-eastern part of the Barents Sea by RV "AtlantNIRO", but biomass data for this area are unavailable at this time. Further, in 2020 the zooplankton sampling by RV "Vilnyus" was made late in the season (29. Sep - 15. Nov) compared to the Norwegian vessels (13. Aug - 1. Oct). Since RV "Vilnyus" route went from north to south, the available Russian zooplankton biomasses for the most south-easterly region presented in Figure 5.2.1 were sampled much later than the westerly Norwegian biomasses at comparable latitudes.

The spatial distribution of total mesozooplankton biomass shown in Figure 5.2.1 is based on a total of 293 samples, of which 178 were located in the Norwegian sector and 115 in the Russian sector (just considering samples from RV "Vilnyus"). Within the Norwegian sector, for which the longest time-series exists, the average biomass was 6.8 (± 6.0 SD) g dry-weight m^{-2}. This was a bit lower than in 2019 (8.0 g dry-weight m^{-2}) and slightly below the 20-year long-term mean for 2000-2019 (7.0 g dry-weight m^{-2}). Note that the density of stations west and north-west of Svalbard

(Spitsbergen) in 2020 was higher than usual in earlier years, and also as compared to the rest of the Norwegian sector in 2020 (Fig. 5.2.1). All the Norwegian stations shown in Figure 5.2.1. are included in the 2020 biomass average presented above. Since the area west and north-west of Svalbard (Spitsbergen) also had a somewhat higher biomass per unit area than the Norwegian sector as a whole (Fig. 5.2.1), this implies that the estimated average for the entire Norwegian sector was a little biased towards a higher level. The average zooplankton biomass for the samples available within the Russian sector was 6.9 (± 4.8 SD) g dry-weight m^{-2}, which is not comparable to the averages for the Russian sector from earlier years due to markedly different spatial coverages in the eastern region. It is important to note that comparing average biomasses for different years is vulnerable to differing area coverages. Challenges in covering the same area over a series of years are inherent in such large-scale monitoring programs, and interannual variation in ice-cover and logistical issues are two of several reasons for this. To improve the regularity of the sampling grid across the survey area in 2019, most stations belonging to the "Hinlopen" section north of Svalbard (Spitsbergen) and the whole "Vardø-Nord" section were omitted when calculating the average biomass (omitted stations not shown in Fig. 5.2.1). The purpose of this was to avoid weighting of areas with higher sampling density. However, 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 patterns in biomass distribution. Addressing such challenges is a task for the ICES Working Group (WGIBAR), which make interannual biomass comparisons within-well defined and consistent spatial polygons.

The overall distribution patterns show similarities across years, although some interannual variability is apparent. In 2020, we observed the familiar pattern of comparatively high biomasses (> 10 g dry-weight m^{-2}) in the south-western region as well as north-northeast of Svalbard (Spitsbergen) and around Franz Josef Land, along with relatively low biomasses in the central region as well as just west of Novaya Zemlya (Fig. 4.2.1).

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

- Advection 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

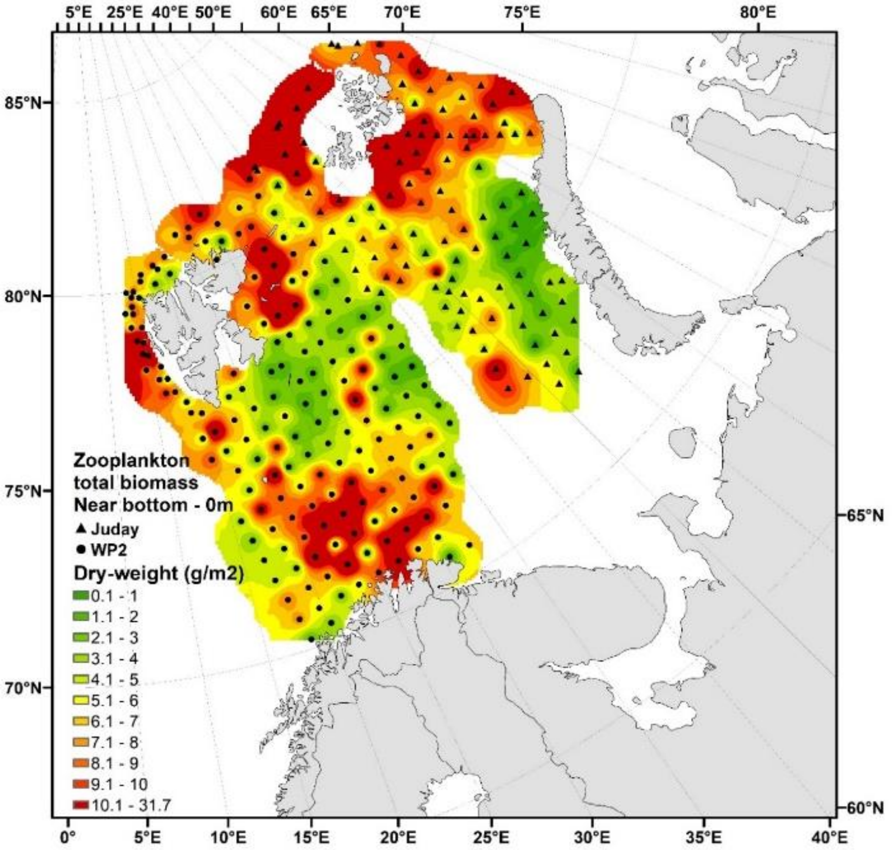

Figure 5.2.1 *Distribution of total zooplankton biomass (g dry-weight m^{-2}) from near-bottom to surface in the Barents Sea during BESS 2020 - based on a total of 293 stations. The data visualized were collected by WP2 and Juday nets with mesh-size 180 μm. Interpolation was made in ArcGIS v.10.5, module Spatial Analyst, using inverse distance weighting (IDW).*

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

5.3 Macrozooplankton

Due to limited resources the macrozooplankton was not possible to estimate from the 2020 survey in time for this report. The time series will be completed and update from 2019 and 2020 will be added to next year survey report.

6 FISH RECRUITEMENT (YOUNG OF THE YEAR)

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

Total biomass

Zero-group fish are important consumers of plankton and are prey for other predators, and, therefore, are important for transfer of energy between trophic levels in the ecosystem. Estimated total biomass of 0-group fish species (cod, haddock, herring, capelin, polar cod, and redfish) varied from a low of 165 thousand tonnes in 2001 to a peak of 3.4 million tonnes in 2004 with a long-term average of 1.7 million tonnes in 1993-2020 (Fig. 6.1). In 2020 like in 2019, 0-group fish biomasses were dominated by capelin. In 2020, polar cod and redfish biomasses were relatively high. Biomasses of most fish species (except redfish and haddock) would be even higher if the whole area had been covered in 2020 (see Chapter 2).

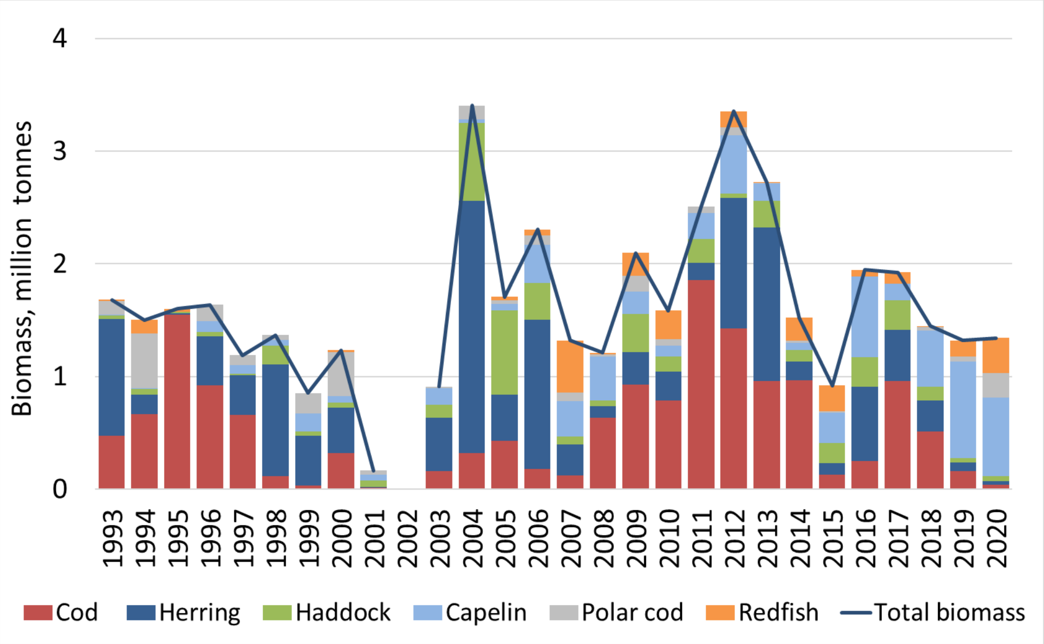

Figure 6.1 *Biomass of 0-group fish species in the Barents Sea, August–October 1993–2020.*

Abundance and biomass estimates were calculated by different software: SAS: for the 23 fisheries subareas, 1980-2016, MatLab: for the new 15 subareas, 1980-2018, (Fig. 6.2), StoX: for the new 15 subareas, 2016-2020, (Fig. 6.2). Due to software upgrading (led to challenges with script running in SAS), personal resource limitation (MatLab), no control of input data for estimations and lower StoX-estimates (comparing to SAS and MatLab), we decided to developed R-scripts (R is free software) for estimation of abundance and biomass indices. The 2019 and 2020 abundance and biomass indices were calculated by R and presented here, while abundance and biomass indices for other years will be presented later. For cod fishes, capelin and redfish, correction of the trawl efficiency coefficient is used in the calculations and the abundance is calculated. For other 0-group species (flat fish, wolfish, etc.) the trawl efficiency is unknown, therefore only the abundance “index” is given.

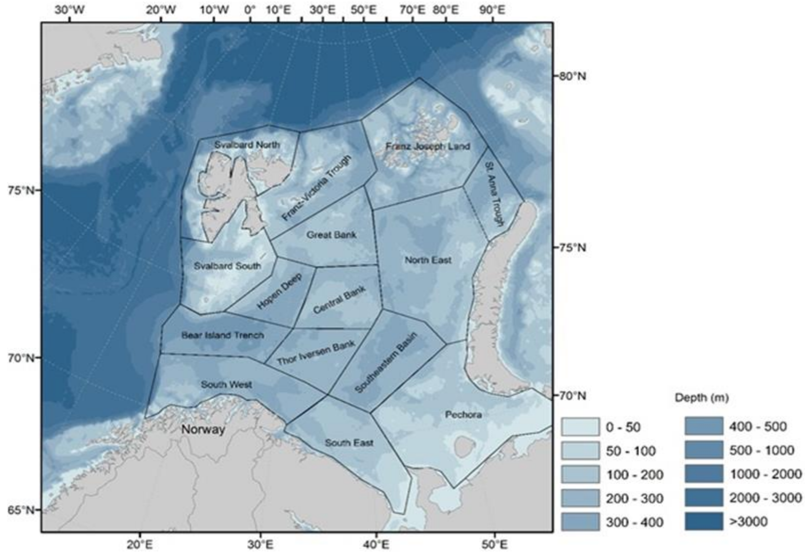

Figure 6.2 *Map showing subdivision of the Barents Sea into 15 subareas (regions) used to calculate estimates of 0-group abundance based on the BESS.*

6.1 Capelin (*Mallotus villosus*)

The highest average abundance per strata were found in Hopen Deep (202.199 billion ind.) and Central bank – 107.985 billion ind. (Fig. 6.1.1). Most of capelin were relatively large with body length of 5-6.4 cm in 2020 comparing to 4-5.4 cm in 2019. Larger individuals were found mainly in northern areas, while smaller in south-western areas (South West and Bear Island Trench, Fig. 6.1.2).

Capelin length varied from 3 to 7 cm, while dominated by capelin of 4.5 - 6.5 cm. The smallest capelin with average length of 4 cm were found in the western area (South West and Bear Island Trench). The largest (with an average length of 5.6 cm) capelin were found in the northern areas, that indicated most likely earlier spawning and that larvae drifted further. Relatively large 0-group capelin indicated that they experienced a sufficient feeding and living conditions during the first summer.

In 2019, a record strong year class of capelin occurred. Estimated abundance of 0-group capelin varied from 2.082 billion in 1993 to 1 910.516 billion individuals in 2019 with a long-term average of 448.346 billion individuals for the 1980-2020 period (Fig. 6.1.2). In 2020, the eastern Barents Sea was not covered, where 0-group capelin were often found, and thus abundance and biomass were recalculated. In 2020, the total abundance for 0-group capelin was well above the long term mean and was 1 265. 044 billion individuals (Fig. 6.1.2). Estimated biomass of 0-group capelin was four time higher than the long-term mean and was 697 thousand tonnes. Therefore, the 2020-year class of capelin seemed to be strong.

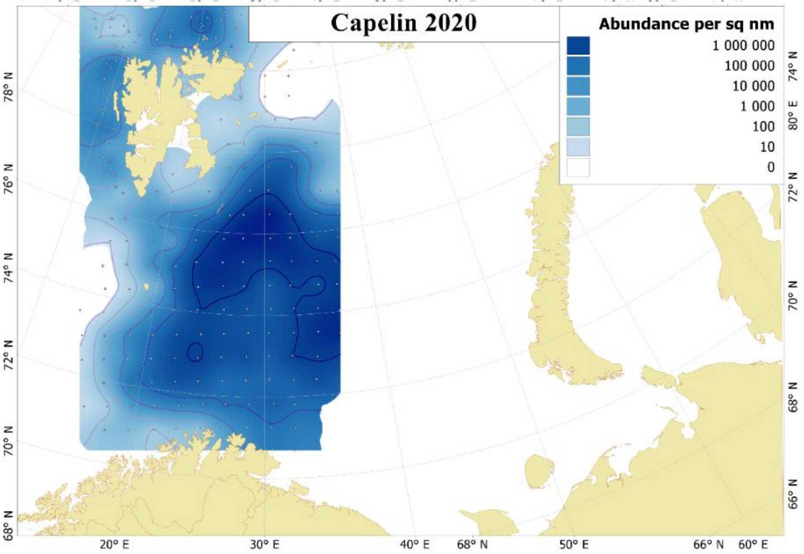

Figure 6.1.1 *Distribution of 0-group capelin, August-September 2020. Dots indicate sampling locations.*

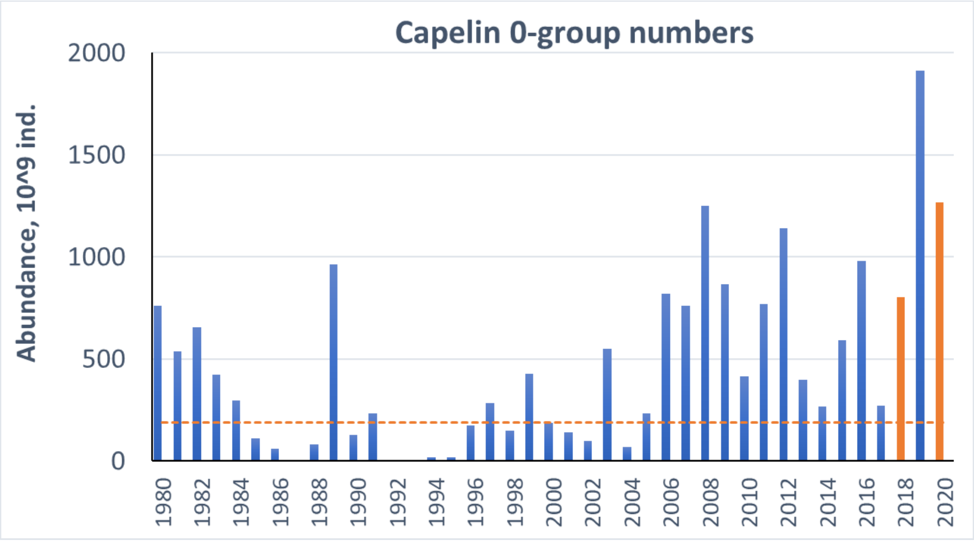

Figure 6.1.2 *0-group capelin abundance estimates and fluctuation 1980-2020. Orange line shows the long-term average; the blue columns indicates fluctuating abundance. Note that estimates were calculated for the new 15 subareas in the Barents Sea 2019 and 2020 in R. Abundance of capelin in 2018 and 2020 were recalculated due to lack of coverage in the eastern Barents Sea.*

6.2 Cod (*Gadus morhua*)

Main concentrations of 0-group cod were found in central areas. In 2020, the eastern Barents Sea was not covered, where 0-group cod were often found.

Estimated abundance of 0-group cod varied from 276 billion in 1980 to 464.124 billion individuals in 2014 with a long-term average of 113.727 billion individuals for the 1980-2020 period (Fig. 3.6.2). In 2020, the total abundance of 0-group cod was lowest observed since 2001 and was 40.226 billion individuals. The distribution of 0-group cod in the Barents Sea was not covered due to lack of coverage in the Russian zone (see Chapter 2), and therefore abundance was recalculated. But anyway, the abundance of 2020-year class is well below the long-term mean, and thus may be characterized as weak.

In 2020, 0-group cod were larger than in 2019, and were dominated by fish of 6.5 – 8.4 cm length. The largest cod (with an average length > 8.0 cm) were observed in the northern areas, while smallest cod (with an average length < 5.0 cm) were found close to the Norwegian coast.

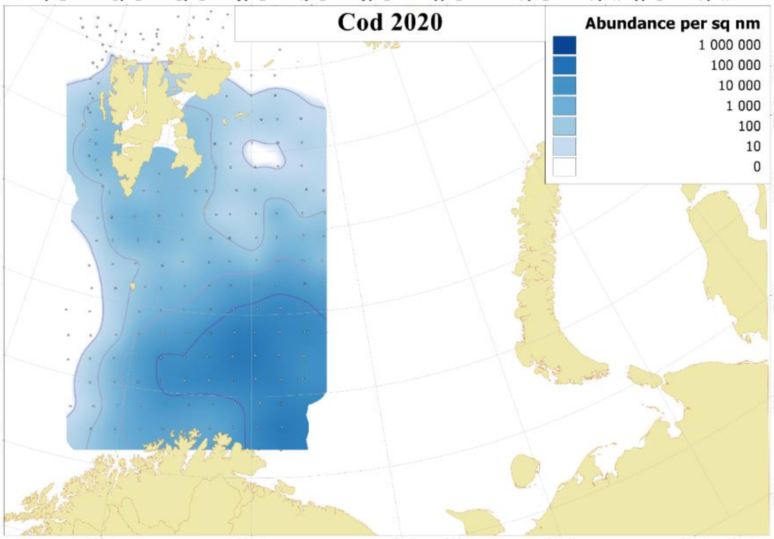

Figure 6.2.1 *Distribution of 0-group cod, August-September 2020. Dots indicate sampling locations.*

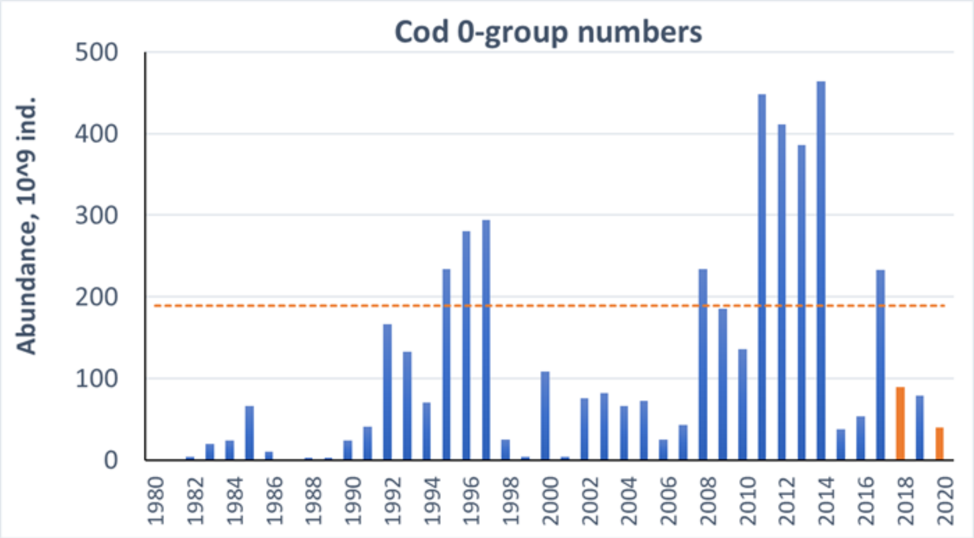

Figure 6.2.2 *0-group cod abundance estimates and fluctuation 1980-2020. Orange line shows the long-term average; the blue columns indicates fluctuating abundance. Note that estimates were calculated for the new 15 subareas in the Barents Sea 2019 and 2020 in R. Abundance of cod in 2018 and 2020 were recalculated due to lack of coverage in the eastern Barents Sea.*

6.3 Haddock (*Melanogrammus aeglefinus*)

Most of haddock (68%) were distributed in the south western areas (South West, Bear Island Trench and Thor Iversen Bank) of the Barents Sea (Fig. 6.3.1.). Estimated abundance of 0-group haddock varied from 696 million in 1989 to 98.746 billion individuals in 2005 with a long-term average of 13.293 billion individuals for the 1980-2020 period (Fig. 6.3.2). In 2020, the total abundance estimates for 0-group haddock were 7.161 billion, that was higher than in 2019, while well below the long term mean values observed in the time series. Lack of coverage in the eastern

Barents Sea will not influence the level of abundance due to 0-group haddock distributes usually in the western part. Thus the 2020-year class may be characterized as very weak

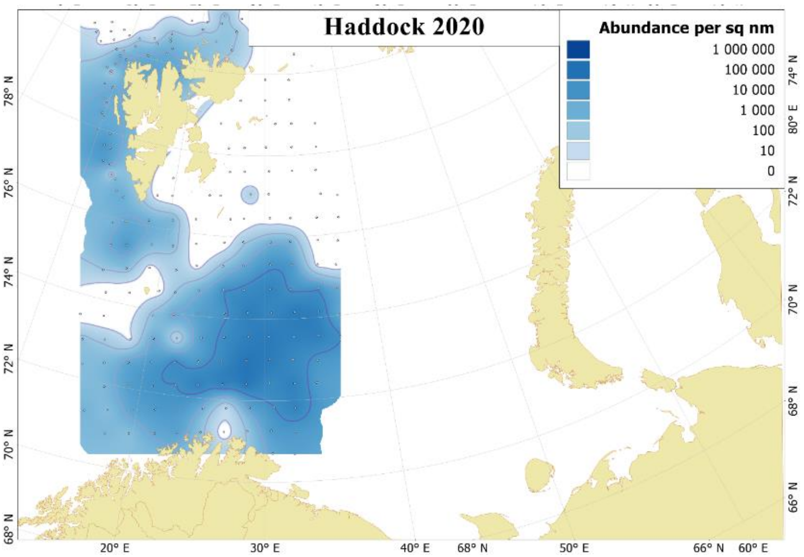

__Figure 6.3.1__ Distribution of 0-group haddock, August-September 2020. Dots indicate sampling locations.

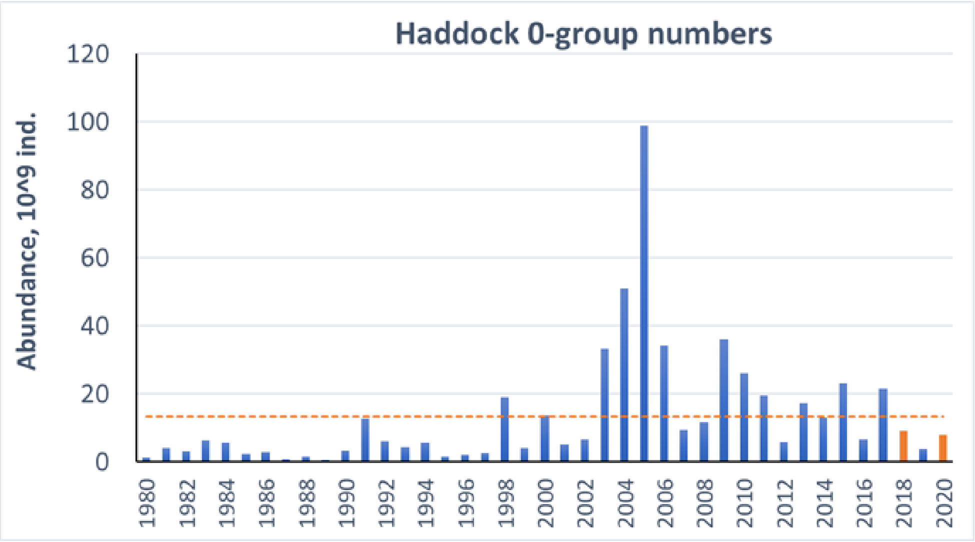

__Figure 6.3.2__ 0-group haddock abundance estimates and fluctuation 1980-2020. Orange line shows the long-term average; the blue columns indicates fluctuating abundance. Note that estimates were calculated for the new 15 subareas in the Barents Sea 2019 and 2020 in R. Abundance of haddock in 2018 and 2020 were recalculated due to lack of coverage in the eastern Barents Sea.

In 2020, 0-group haddock dominated by fish of 7.0 – 9.4 cm length. The largest haddock (with an average length > 10.0 cm) were observed in the northern areas, while smallest haddock were found close to the Norwegian coast (with an average length < 8.0 cm).

6.4 Herring (*Clupea harengus*)

0-group herring were found in the southcentral Barents Sea (Fig. 6.4.1.). In 2020, the eastern Barents Sea was not covered, where 0-group herring were often found.

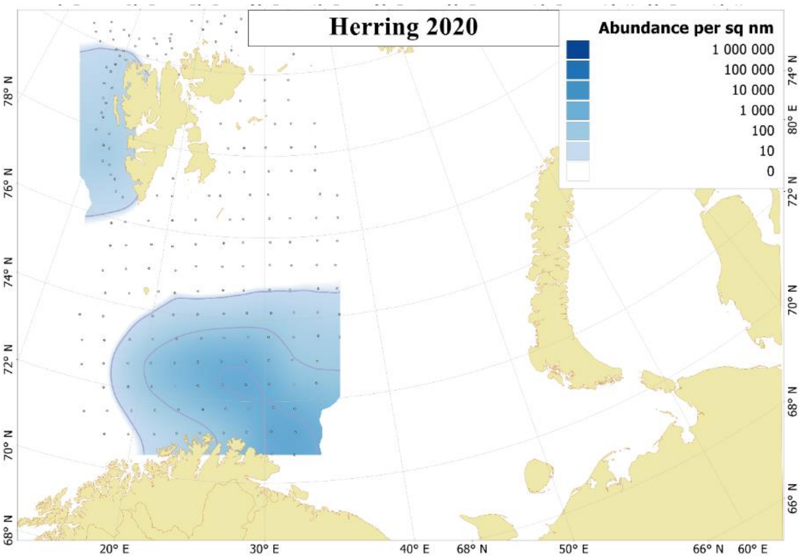

Figure 6.4.1 *Distribution of 0-group herring, August-September 2020. Dots indicate sampling locations.*

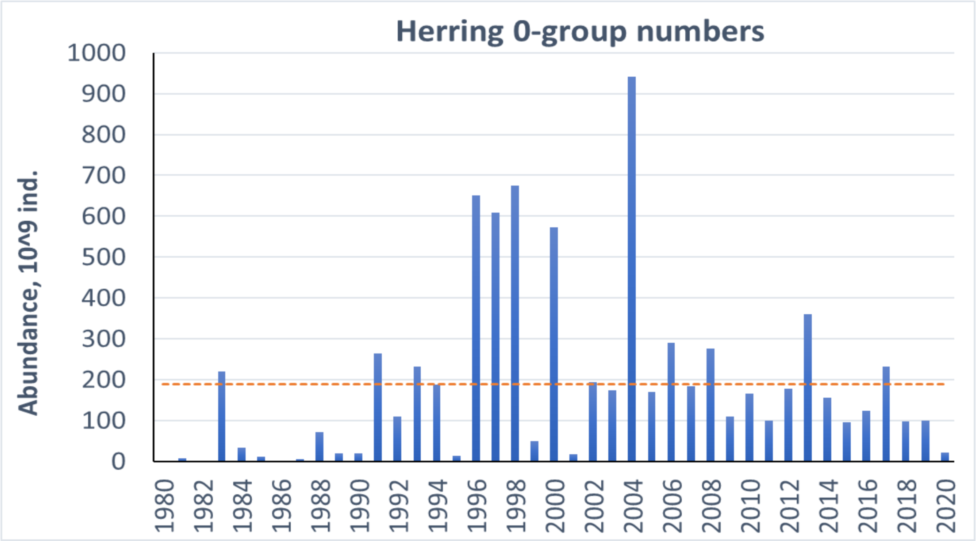

Figure 6.4.2 *0-group herring abundance estimates and fluctuation 1980-2020. Orange line shows the long-term average; the blue columns indicates fluctuating abundance. Note that estimates were calculated for the new 15 subareas in the Barents Sea 2019 and 2020 in R. Abundance of herring in 2018 and 2020 were underestimated due to lack of coverage in the eastern Barents Sea.*

Estimated abundance of 0-group herring varied from 93 million in 1986 to 940.773 billion individuals in 2004 with a long-term average of 188.65 billion individuals for the 1980-2020 period (Fig. 6.4.2). In 2020, the eastern Barents Sea was not covered, where 0-group herring were also distributed (although usually much less than in the western part). Thus abundance and biomass indices were some underestimated. In 2020, the total abundance for 0-group herring was well below the long term mean and was 25.015 billion individuals (Fig. 6.4.2). Estimated biomass of 0-group herring was half of 2019, 22 times lower the long term mean and was 5.25 thousand tonnes. Therefore, the 2020-year class of herring seemed to be very weak.

Most of herring (77%) were distributed in the south western areas (Bear Island Trench and South West) of Barents Sea. Most of 0-group herring were relatively small with body length of 5.5 - 7.5 cm. Larger individuals were observed west of Svalbard (Spitsbergen), while in the southern, central, and northern Barents Sea fish length varied and were most likely depended on feeing condition in the area.

6.5 Polar cod (*Boreogadus saida*)

Polar cod were found around the Svalbard (Spitsbergen) in 2020 (Fig. 6.5.1.). In 2020, the eastern Barents Sea was not covered, and thus south-eastern component of polar cod could not be presented here. Estimated abundance of 0-group polar cod varied from 519 million in 1995 to 2 428.46 billion individuals in 1994 with a long-term average of 440.348 billion individuals for the 1980-2020 period (Fig. 6.5.2).

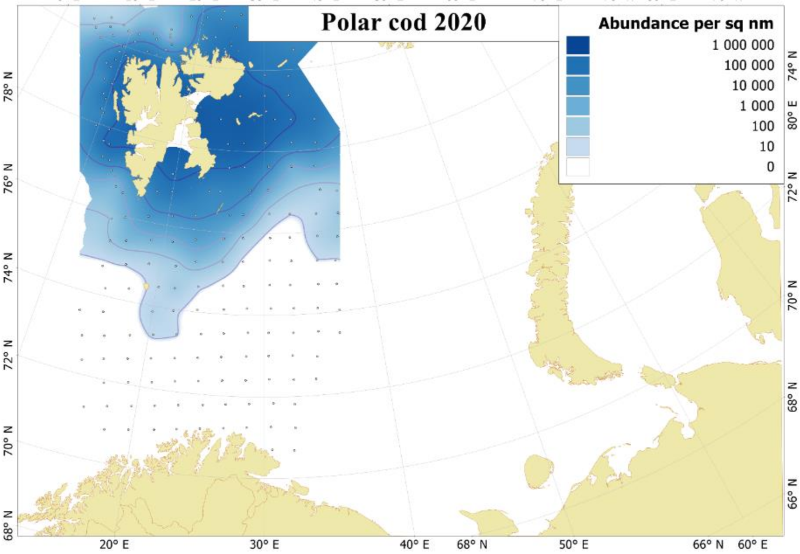

Figure 6.5.1 *Distribution of 0-group polar cod, August-September 2020. Dots indicate sampling locations.*

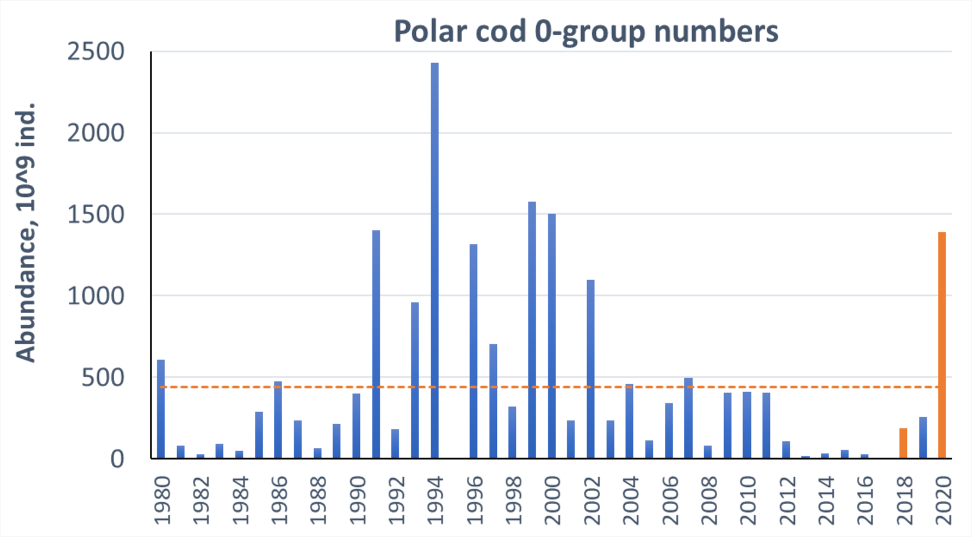

Figure 6.5.2 *0-group polar cod abundance estimates and fluctuation 1980-2020. Orange line shows the long-term average; the blue columns indicates fluctuating abundance. Note that estimates were calculated for the new 15 subareas in the Barents Sea 2019 and 2020 in R. Abundance of polar cod in 2018 and 2020 were recalculated due to lack of coverage in the eastern Barents Sea.*

In 2018 and 2020, the eastern Barents Sea was not covered, where 0-group polar cod were often found, and thus abundance and biomass indices were recalculated. The eastern component has been dominated in abundance and biomass during 1980, 1990 and early 2000s. The abundance of 2019-year class is low than the long-term mean, but higher than previous six years. Nevertheless, good survival was the reason for the record generation at age 1+ (see chapter 7.2). In 2020, the abundance for 0-group polar cod in western area was estimated 22.251 billion individuals and estimated biomass was high and was 2.5 time higher than long term mean for western component. It can be assumed that the total numbers of 0-group polar cod in the Barents Sea in 2020 could be 1393.285 billion individuals that is much higher than the long-term mean (Fig. 6.5.2).

The average length of polar cod was 5.4 cm. Polar cod length varied from 1.5 to 8.0 cm, while dominated by polar cod of 4.0-5.5 cm. The smallest polar cod (with an average length bellow 3.7 cm) were found in South-eastern, while largest (with an average close to 4.8 cm) in the Franz Victoria Trough and Great Bank regions.

6.6 Saithe (Pollachius virens)

In 2020, saithe was observed only at two station in the central areas. Therefore, abundance was not estimated in 2020.

6.7 Redfish (mostly *Sebastes mentella*)

0-group redfish was distributed from north of Norwegian coast to the north-west of Svalbard (Spitsbergen) in 2020 (Fig. 6.7.1). The densest concentrations were found in the western Barents Sea and west of Svalbard (Spitsbergen). 0-group redfish usually distributed in the western part of the Barents Sea, therefore, lack of coverage survey have slight effect on the of abundance estimation.

Estimated abundance of 0-group deepwater redfish varied from 33 million individuals in 2001 to 1 083 397.5 billion in 1985 with an average of 210 635 billion individuals for the 1980-2020 period (Fig. 6.7.1). In 2020, the total abundance for 0-group deepwater redfish were 526 121.74 billion individuals, which is higher than the long-term mean. Thus the 2020-year class may be characterized as a strong. Estimated biomass were also higher than long term mean (of 235 thousand tonnes) and was 310.12 thousand tonnes. In 2020, 0-group deepwater redfish were distributed mainly in western regions and the Svalbard North strata. Most of largest fish were found in Svalbard North (4.0 - 5.5 cm) and South West (3.5 – 5.0 cm), while some small fish were also observed in South West (1.5 – 3.0 cm).

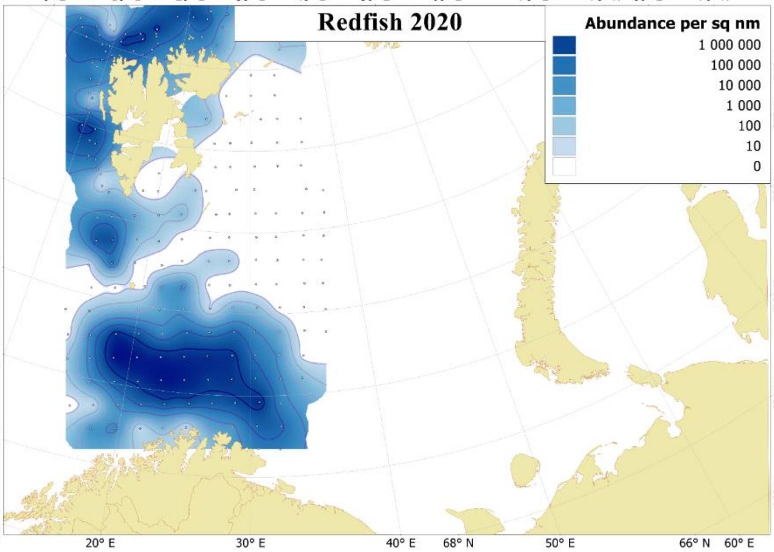

Figure 6.7.1. *Distribution of 0-group redfishes* **(***mostly Sebastes mentella***)**, *August-September 2020. Dots indicate sampling locations.*

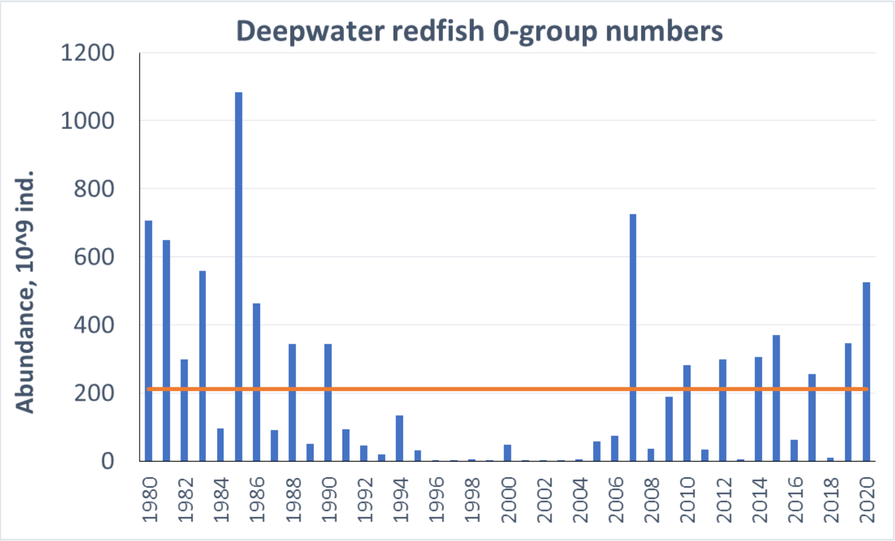

Figure 6.7.2*. 0-group deepwater redfish abundance in the Barents Sea during 1980-2020. Orange line shows the long-term average; the blue columns indicates fluctuating abundance. Note that 2018-2020 estimates were calculated for the new 15 subareas in the Barents Sea by R.*

6.8 Greenland halibut (*Reinhardtius hippoglossoides*)

0-group Greenland halibut was distributed west, north and south of Svalbard (Spitsbergen) in 2020 similar to distribution in 2018-2019 (Fig. 6.8.1). In 2020, the total abundance index for 0-group fish were 50.6 million individuals. Estimated biomass was 0.104 thousand tonnes.

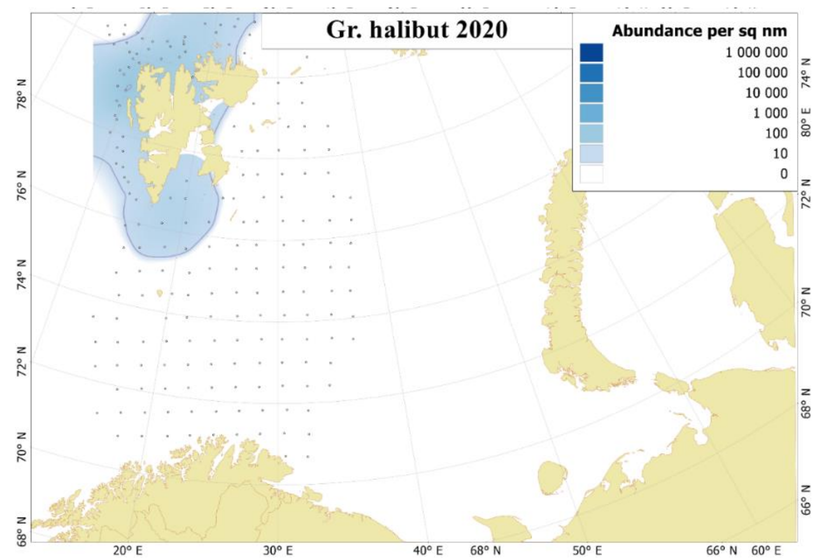

Figure 6.8.1. *Distribution of 0-group Greenland halibut, August-September 2020. Dots indicate sampling locations.*

6.9 Long rough dab (*Hippoglossoides platessoides*)

In 2020, 0-group long rough dab distributed “speckled” (Fig. 6.9.1) comparing to the very widely distribution in 2019. In 2020, the eastern Barents Sea was not covered, and long rough dab could not be presented here. The total abundance index for 0-group fish (for the surveyed area) were 1.438 billion individuals that corresponded to the estimated biomass of 1.2 thousand tonnes.

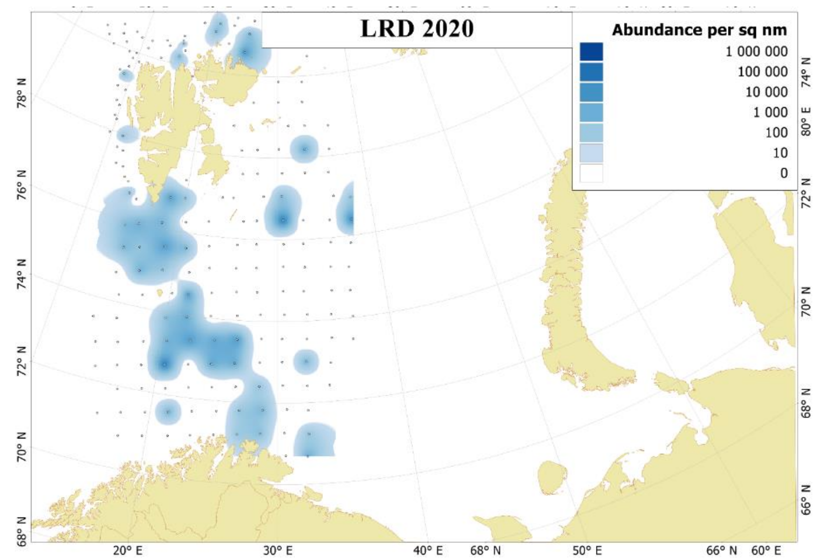

Figure 6.9.1. *Distribution of 0-group long rough dab, August-September 2020. Dots indicate sampling locations.*

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*).

In 2020, the total abundance index for 0-group wolffish were 6 million individuals that corresponded to the estimated biomass of 34 tonnes.

6.11 Sandeel (*Ammodytes marinus*)

0-group sandeel were found in the central part of Barents sea and some south and north of Svalbard (Spitsbergen) in 2020 (Fig. 6.11.1). In 2020, the eastern Barents Sea was not covered, where 0-group sandeel were often found. In 2020, the total abundance index for 0-group fish were 76.4 million individuals that corresponded to the estimated biomass of 153 tonnes.

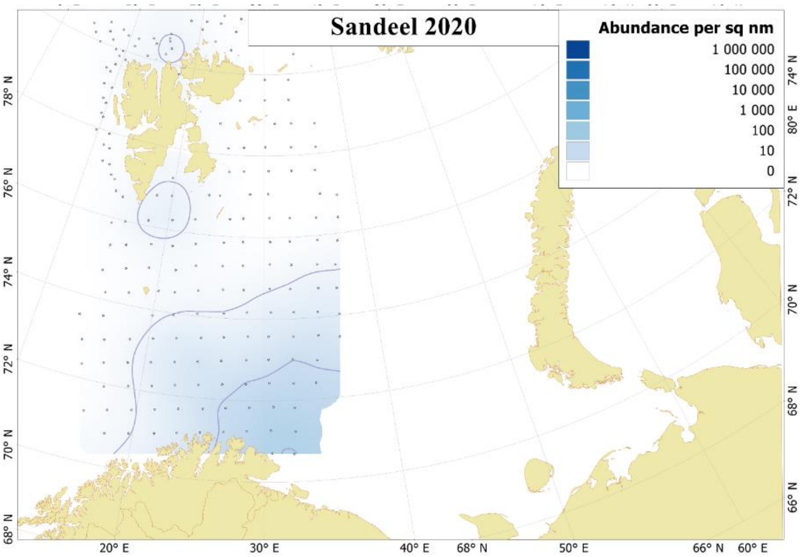

Figure 6.11.1. *Distribution of 0-group sandeel, August-September 2020. Dots indicate sampling locations.*

7 COMMERCIAL PELAGIC FISH

Text by D. Prozorkevich, G. Skaret Figures by S. Karlson, G. Skaret

7.1 Capelin (*Mallotus villosus*)

Due to the delayed start of the survey in the east, the total coverage was not completed by the time of the capelin assessment and quota advice (Fig. 7.1.1.1) which were made on the 8-10 October 2020. In the present report, all data available are included and the results therefore differ from the ones included in the capelin assessment report. Compared with estimates for the assessment, the final estimates changed for TSB – $1884\cdot10^3$ t vs $1720\cdot10^3$ t (+ 9.5%) and for SSB – $533\cdot10^3$ t vs $545\cdot10^3$ t (-2%).

7.1.1 *Geographical distribution*

The geographical distribution of capelin recorded acoustically is shown in Figure 7.1.1.1. The main concentrations were found to the south-east of Svalbard (Spitsbergen) between 76°N and 78°N, which is historically the most typical distribution area for feeding capelin at this time of the year. Quite a lot young capelin were also distributed south of Hope Island to 75°N. Little capelin was found in the east and to the north, but an aggregation of young capelin was found west of the coast Novaja Zemlja a little north of 76°N.

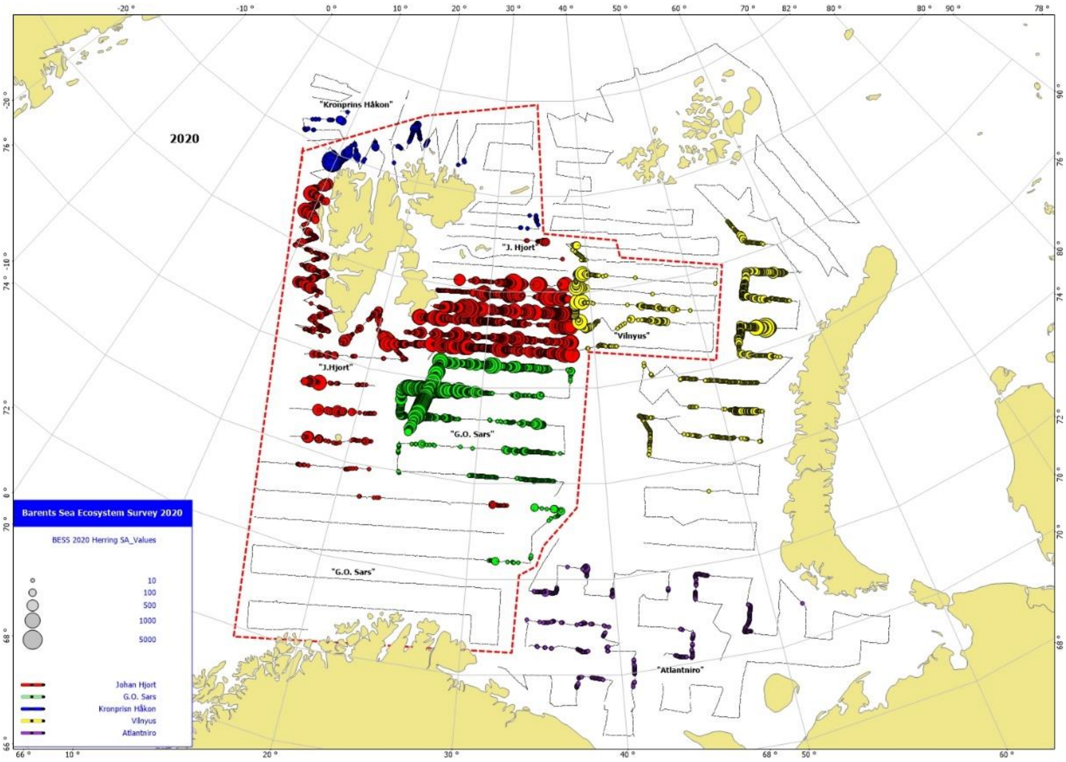

Figure 7.1.1.1 *Geographical distribution of capelin in autumn 2020 based on acoustic recordings. Circle sizes correspond to s_A values (m^2/nmi^2) per nautical mile. The red dashed line marks the area which had been covered by the time of the preliminary capelin assessment*

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. A comparison between the estimates in 2020 and 2019 is given in the Table 7.1.2.3 with the 2019 estimate shown on a shaded background.

The total stock was estimated to about 1.88 million tons, which is below the long term average level (2.8 million tons), but 4 times higher than the biomass estimate from 2019. About 28 % (0.53 million tons) of the 2020 stock had length above 14 cm and was therefore considered to be maturing. 1-year old capelin (2019 year class) completely dominated in the capelin stock, and the biomass and numbers of age 1 was the highest since 2000. This agrees well with the results of the 0-group survey in 2019 when this capelin year class was estimated to be very abundant.

Average weight at age was higher than previous years for age groups 2+, 3+ and 4+ and significantly lower for 1+ (Fig. 7.1.2.2). This might correspond with a large number of 1-year old capelin and density dependent growth. The weight at age for 2+ and 3+ were among the highest on record.

A more detailed description of biology and stock development of the Barents Sea capelin can be found in the report of the ICES WGIBAR report for 2021.

The work concerning assessment and quota advice for capelin is dealt with in a separate report that will form part of the ICES AFWG report for 2021.

Table 7.1.2.1. *Barents Sea capelin. Summary of results from the acoustic estimate in August-October 2020.*

Length (cm)	Age/year class					Sum (10^9)	Biomass (10^3 t)	Mean weight (g)
	1	2	3	4	5			
	2019	2018	2017	2016	2015			
6.5-7.0	0.01					0.01	0.01	1.0
7.0-7.5	2.04					2.04	2.30	1.1
7.5-8.0	12.35	0.19				12.54	19.68	1.6
8.0-8.5	49.10					49.10	92.31	1.9
8.5-9.0	55.03					55.03	121.06	2.2
9.0-9.5	66.70	0.24				66.94	178.73	2.7
9.5-10.0	47.71	0.73				48.44	163.73	3.4
10.0-10.5	44.20	1.01				45.21	178.59	4.0
10.5-11.0	43.46	0.53				43.99	206.30	4.7
11.0-11.5	20.65	0.37				21.02	116.86	5.6
11.5-12.0	12.64	0.31				12.95	88.19	6.8
12.0-12.5	6.21	2.06	0.03			8.31	63.39	7.6
12.5-13.0	2.78	1.29				4.08	35.92	8.8
13.0-13.5	1.72	2.26	0.06			4.04	41.77	10.3
13.5-14.0	1.08	2.17	0.12			3.37	42.61	12.7
14.0-14.5	0.49	3.28				3.76	55.16	14.7
14.5-15.0	0.21	4.75	0.31			5.26	85.37	16.2
15.0-15.5	0.05	3.44	0.28			3.78	70.79	18.8
15.5-16.0		2.50	0.69	0.08		3.26	70.36	21.6
16.0-16.5		2.86	0.75	0.05		3.66	85.81	23.4
16.5-17.0		1.64	1.01	0.16		2.81	73.56	26.2
17.0-17.5		0.92	0.41	0.11	0.01	1.46	40.22	27.6
17.5-18.0		0.40	0.18	0.31		0.89	28.45	32.0
18.0-18.5		0.08	0.35	0.07		0.50	17.17	34.2
18.5-19.0		0.05	0.03	0.04		0.13	4.68	36.8
19.0-19.5				0.03		0.03	1.25	43.6
TSN (10^9)	366.43	31.08	4.23	0.84	0.01	402.60		
TSB (10^3 t)	1267.86	486.04	105.50	25.54	0.29		1884.29	
Mean length (cm)	9.42	14.05	16.09	17.17	17.00	14.81		
Mean weight (g)	3.46	15.64	24.93	30.24	22.6			4.68
SSN (10^9)	0.74	19.92	4.02	0.84	0.01	25.54		
SSB (10^3 t)	11.41	396.27	99.71	25.08	0.35		532.82	

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

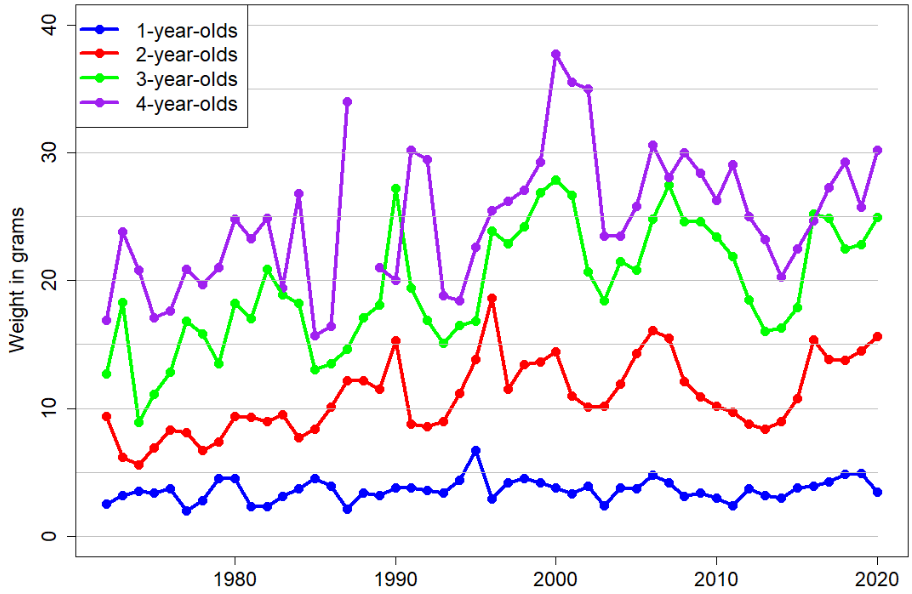

Figure 7.1.2.1 *Weight at age (grams) for capelin from capelin surveys (prior to 2003) and BESS.*

Table 7.1.2.3. *Summary of acoustic stock size estimates for capelin in 2019-2020. A comparison between the estimates this year and last year (shaded background).*

Year class		**Age**	**Numbers (10^9)**		**Mean weight (g)**		**Biomass (10^3 t)**	
2019	2018	1	366.4	17.5	3.46	4.93	1268	90
2018	2017	2	31.1	9.3	15.64	14.53	486	130
2017	2016	3	4.2	7.0	24.93	22.80	105	160
2016	2015	4	0.8	1.2	30.24	25.71	26	30
Total stock in:								
2020	2019	1-4	402.6	34.9	4.68	11.87	1884	411

Table 7.1.2.2. *Barents Sea capelin. Summary acoustic estimates by age in autumn 1973-2020.*

Year	Age										
	1		2		3		4		5		Sum
	TSB, 10^9 t	Mean weight, g	TSB, 10^9 t	Mean weight, g	TSB, 10^9 t	Mean weight, g	TSB, 10^9 t	Mean weight, g	TSB, 10^9 t	Mean weight, g	TSB, 10^9 t
1973	1.69	3.2	2.32	6.2	0.73	18.3	0.41	23.8	0.01	30.1	5.14
1974	1.06	3.5	3.06	5.6	1.53	8.9	0.07	20.8	+	25.0	5.73
1975	0.65	3.4	2.39	6.9	3.27	11.1	1.48	17.1	0.01	31.0	7.81
1976	0.78	3.7	1.92	8.3	2.09	12.8	1.35	17.6	0.27	21.7	6.42
1977	0.72	2.0	1.41	8.1	1.66	16.8	0.84	20.9	0.17	22.9	4.80
1978	0.24	2.8	2.62	6.7	1.20	15.8	0.17	19.7	0.02	25.0	4.25
1979	0.05	4.5	2.47	7.4	1.53	13.5	0.10	21.0	+	27.0	4.16
1980	1.21	4.5	1.85	9.4	2.83	18.2	0.82	24.8	0.01	19.7	6.71
1981	0.92	2.3	1.83	9.3	0.82	17.0	0.32	23.3	0.01	28.7	3.90
1982	1.22	2.3	1.33	9.0	1.18	20.9	0.05	24.9			3.78
1983	1.61	3.1	1.90	9.5	0.72	18.9	0.01	19.4			4.23
1984	0.57	3.7	1.43	7.7	0.88	18.2	0.08	26.8			2.96
1985	0.17	4.5	0.40	8.4	0.27	13.0	0.01	15.7			0.86
1986	0.02	3.9	0.05	10.1	0.05	13.5	+	16.4			0.12
1987	0.08	2.1	0.02	12.2	+	14.6	+	34.0			0.10
1988	0.07	3.4	0.35	12.2	+	17.1					0.43
1989	0.61	3.2	0.20	11.5	0.05	18.1	+	21.0			0.86
1990	2.66	3.8	2.72	15.3	0.44	27.2	+	20.0			5.83
1991	1.52	3.8	5.10	8.8	0.64	19.4	0.04	30.2			7.29
1992	1.25	3.6	1.69	8.6	2.17	16.9	0.04	29.5			5.15
1993	0.01	3.4	0.48	9.0	0.26	15.1	0.05	18.8			0.80
1994	0.09	4.4	0.04	11.2	0.07	16.5	+	18.4			0.20
1995	0.05	6.7	0.11	13.8	0.03	16.8	0.01	22.6			0.19
1996	0.24	2.9	0.22	18.6	0.05	23.9	+	25.5			0.50
1997	0.42	4.2	0.45	11.5	0.04	22.9	+	26.2			0.91
1998	0.81	4.5	0.98	13.4	0.25	24.2	0.02	27.1	+	29.4	2.06
1999	0.65	4.2	1.38	13.6	0.71	26.9	0.03	29.3			2.77
2000	1.70	3.8	1.59	14.4	0.95	27.9	0.08	37.7			4.27
2001	0.37	3.3	2.40	11.0	0.81	26.7	0.04	35.5	+	41.4	3.63
2002	0.23	3.9	0.92	10.1	1.04	20.7	0.02	35.0			2.21
2003	0.20	2.4	0.10	10.2	0.20	18.4	0.03	23.5			0.53
2004	0.20	3.8	0.29	11.9	0.12	21.5	0.02	23.5	+	26.3	0.63
2005	0.10	3.7	0.19	14.3	0.04	20.8	+	25.8			0.32
2006	0.29	4.8	0.35	16.1	0.14	24.8	0.01	30.6	+	36.5	0.79
2007	0.93	4.2	0.85	15.5	0.10	27.5	+	28.1			2.12
2008	0.97	3.1	2.80	12.1	0.61	24.6	0.05	30.0			4.43
2009	0.42	3.4	1.82	10.9	1.51	24.6	0.01	28.4			3.77
2010	0.74	3.0	1.30	10.2	1.43	23.4	0.02	26.3			3.50
2011	0.50	2.4	1.76	9.7	1.21	21.9	0.23	29.1			3.71
2012	0.54	3.7	1.37	8.8	1.62	18.5	0.06	25.0			3.59
2013	1.04	3.2	1.81	8.4	0.94	16.0	0.16	23.2	+	29.1	3.96
2014	0.32	3.0	0.95	9.0	0.64	16.3	0.04	20.3			1.95
2015	0.14	3.8	0.40	10.8	0.20	17.9	0.09	22.5	+	28.1	0.84
2016	0.12	3.9	0.12	15.3	0.08	25.2	0.00	24.7			0.33
2017	0.37	4.3	1.70	13.8	0.42	24.9	0.01	27.3			2.51
2018	0.29	4.9	0.80	13.8	0.48	22.4	0.01	29.3			1.60
2019	0.09	4.9	0.13	14.5	0.16	22.8	0.03	25.7			0.41
2020	1.27	3.5	0.49	15.6	0.11	24.9	0.03	30.2	+	22.6	1.88
Average	0.63	3.6	1.27	11.0	0.79	19.8	0.18	25.0	0.04	27.8	2.81

Note:«+» <0.01• 10^9 t

7.2 Polar cod (*Boreogadus saida*)

7.2.1 *Geographical distribution*

The main distribution of polar cod was found in the north-eastern parts of the survey area which is typical (Fig.7.2.1.1), but concentrations were much higher than recorded in recent years. Polar cod were also abundant west of 35°E, which has not been observed in recent years. Overall, polar cod abundance was very high.

The survey coverage this year went further north and east than in 2018 and 2019 and was much better, but the main polar cod concentrations were found within the standard coverage area.

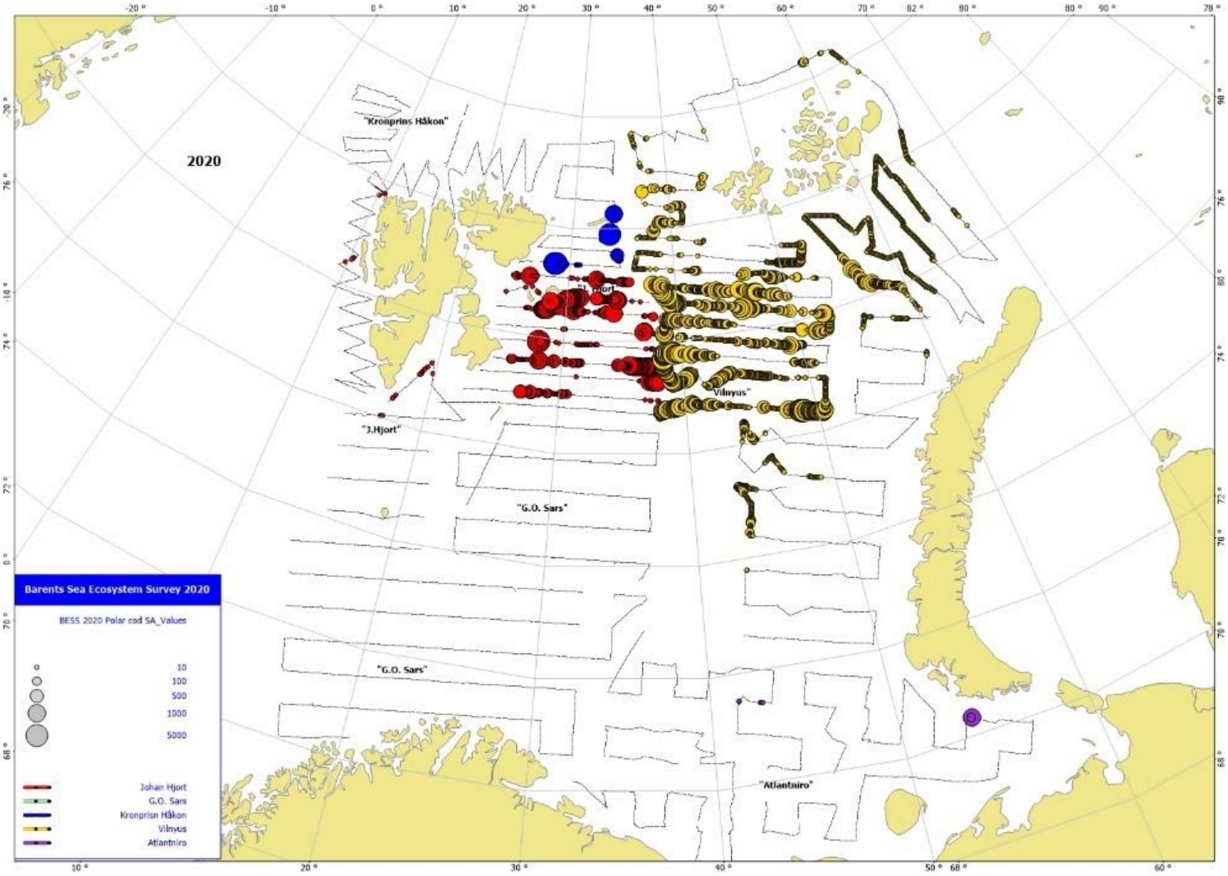

Figure 7.2.1.1 *Geographical distribution of polar cod in autumn 2020 based on acoustic data. Circle sizes correspond to* s_A *values (*m^2/nmi^2*) per nautical mile.*

7.2.2 *Abundance estimation*

The stock abundance estimate by age, number and weight in 2020 is given in Table 7.2.2.1 and the time series of abundance estimates are summarized in Table 7.2.2.2.

The 1-year olds completely dominated and constituted 80% of the estimated total abundance in numbers. This is in good correspondence with the very high number of 0-group polar cod found in the survey last year. The abundance of 1-year-olds was the highest on record, and also the abundance of the other age groups was above average. In 2020, the polar cod biomass estimate was the highest since 2006 and one of the highest on record.

Table 7.2.2.1. *Barents Sea polar cod. Summary of results from the acoustic estimate in August- October 2020.*

Length (cm)	Age group/year class					Sum (10^9)	Biomass $(10^3$ t)	Mean weight (g)
	1 2019	2 2018	3 2017	4 2016	5+ 2014+			
7-8	0.14					0.14	0.41	3.1
8-9	22.07	0.04				22.10	105.88	4.8
9-10	21.84	0.24				22.08	137.33	6.2
10-11	28.91	1.57	0.0004			30.48	254.20	8.3
11-12	27.08	3.08	0.0002			30.16	318.49	10.6
12-13	12.60	3.84	0.03			16.46	227.83	13.8
13-14	2.56	3.42	0.37			6.35	116.52	18.4
14-15	0.32	3.00	0.61	0.02		3.95	92.30	23.4
15-16	0.10	2.23	1.59	0.03		3.95	112.89	28.6
16-17		1.58	1.98			3.57	120.20	33.7
17-18	0.01	0.47	2.11	0.02		2.61	102.10	39.2
18-19		0.14	1.00	0.08		1.23	56.55	46.0
19-20		0.06	0.36	0.17		0.59	32.35	54.8
20-21		0.00	0.09	0.09		0.18	11.47	64.3
21-22			0.03	0.07		0.10	7.57	73.7
22-23			0.03	0.05		0.08	7.20	88.6
23-24				0.01		0.01	1.09	92.1
24-25			0.03	0.07		0.11	12.70	118.5
25-26			0.01	0.02	0.004	0.03	3.44	126.0
26-27				0.0001	0.0001	0.0003	0.04	141.5
27-28								
28-29				0.0002	0.0002	0.0003	0.05	176.2
TSN (10^9)	115.62	19.67	8.24	0.64	0.004	144.17		
TSB $(10^3$ t)	1000.92	378.77	297.60	42.76	0.56		1720.62	
Mean length (cm)	10.5	13.5	16.8	20.3	25.6	11.3		
Mean weight (g)	8.66	19.26	36.13	66.63	128.28			11.93

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

Table 7.2.2.2. *Barents Sea polar cod. Summary acoustic estimates by age in autumn 1986-2020. TSN and TSB are total stock numbers (10^9) and total stock biomass (10^3 tones) 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	86.0
1989	13.540	154.9	1.777	41.7	0.236	8.6	0.060	2.6	15.613	207.8
1990	3.834	39.3	2.221	56.8	0.650	25.3	0.094	6.9	6.799	127.3
1991	23.670	214.2	4.159	93.8	1.922	67.0	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	37.790	594.9
1993	16.269	131.6	18.919	367.1	2.965	103.3	0.147	7.7	38.300	609.7
1994	27.466	189.7	9.297	161.0	5.044	154.0	0.790	35.8	42.597	540.5
1995	30.697	249.6	6.493	127.8	1.610	41.0	0.175	7.9	38.975	426.2
1996	19.438	144.9	10.056	230.6	3.287	103.1	0.212	8.0	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	23.0	102.435	839.5
1999	59.434	399.6	22.760	426.0	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	0.840	48.4	69.262	1347.8
2001	77.144	709.0	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	6.350	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	0.510	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	1803.0
2006	16.190	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	3.230	145.8	0.315	19.8	58.807	1230.1
2008	41.693	421.8	18.114	522.0	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	0.336	16.6	44.090	889.3
2010	27.285	234.2	18.257	543.1	12.982	594.6	1.253	58.6	59.777	1430.5
2011	34.460	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	0.119	8.0	20.457	318.9
2013	2.216	18.1	4.317	102.2	5.243	210.3	0.180	9.9	11.956	340.5
2014	0.687	6.5	4.439	110.0	3.196	121.0	0.080	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	148.0
2016	95.919	792.7	6.380	139.1	0.207	6.9	0.023	0.7	102.529	939.4
2017	13.810	121.8	8.269	200.8	1.112	34.3	0.003	0.1	23.195	357.1
2018**	1.900	16.4	0.980	23.1	0.240	9.4	0.014	0.6	3.124	49.6
2019**	6.109	49.8	1.217	30.3	0.214	6.3	0.014	0.8	7.555	87.2
2020	115.617	1000.9	19.668	378.8	8.237	297.6	0.646	43.3	144.169	1720.6
Average	31.793	256.6	13.497	307.1	4.584	172.2	0.474	26.0	50.377	763.5

* data partly recovered by VPA

** incomplete survey coverage

7.3 Herring (*Clupea harengus*)

7.3.1 *Geographical distribution*

The highest abundances of young Norwegian spring spawning herring (NSSH) were distributed in the south-west in 2020 (Fig. 7.3.1.1). The westernmost recordings were strongly dominated by 4 year-olds (2016 year class), which is a very strong year class about to migrate out of the Barents Sea. Some herring were also recorded in the east close to the coast. Most of these were 3-year-olds. In the south-western part of the survey area NSSH was mixed with the local Kanin herring (*Clupea pallasii suworovi*). It is impossible to split these species acoustically, but the proportion of the Kanin herring in the total numbers was insignificant. These herring are included in age groups 6+ mostly. This is similar to the situation in 2008.

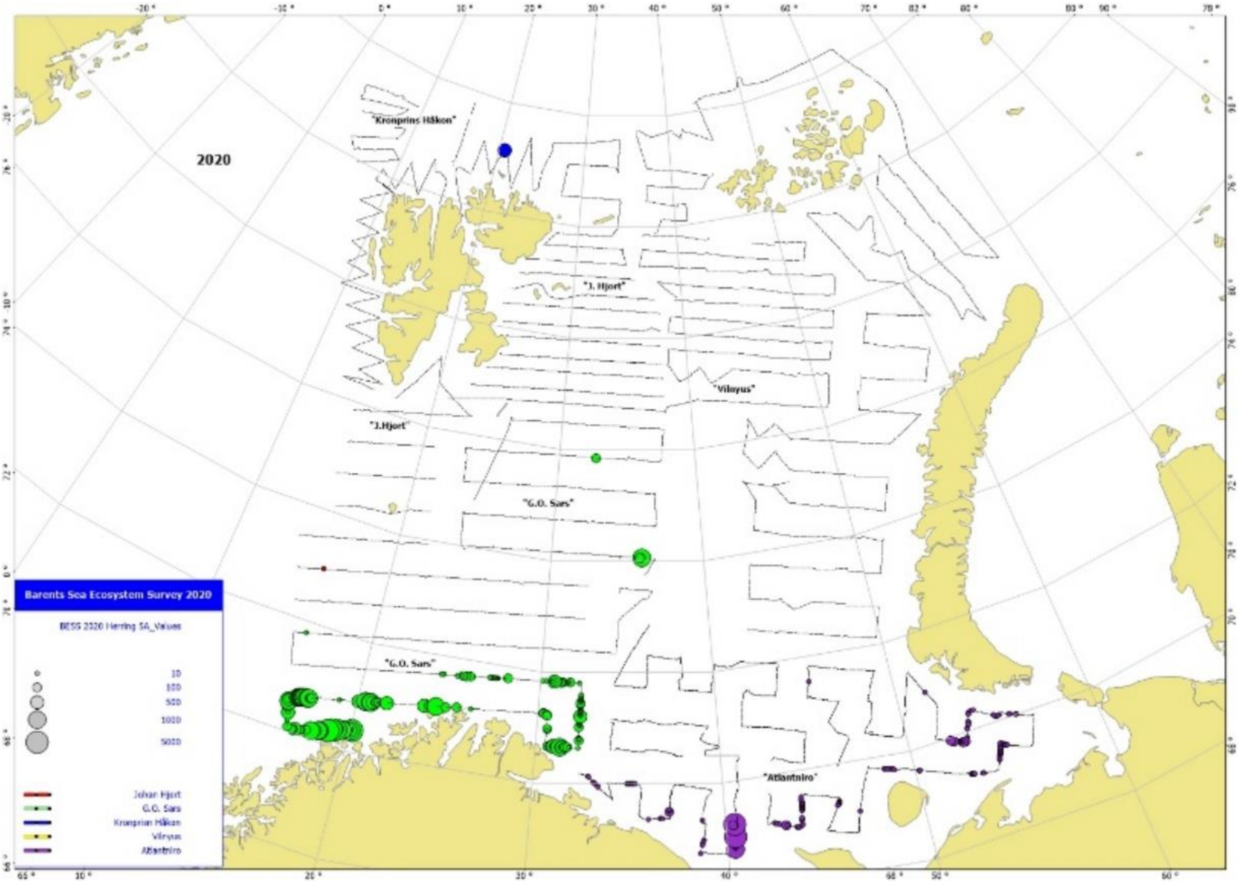

Figure 7.3.1.1 *Geographical distribution of herring in autumn 2020 based on acoustic recordings. Circle sizes correspond to* s_A *values* (m^2/nmi^2) *per nautical mile.*

7.3.2 *Abundance estimation*

The estimated total number and biomass of NSSH in the Barents Sea in the autumn 2020 is shown in Table 7.3.2.1, and the time series of abundance estimates is summarized in Table 7.3.2.2. Total numbers in 2020 was estimated at 13.52 billion individuals (Table 7.3.2.1). It is little lower than the long term level (Table 7.3.2.2). No 1-year-olds were sampled, and the abundance of 2-year-olds was only 0.23 billion individuals which is far below the long term average. The abundance of 3-year-olds (2017 year class) at 1.82 billion individuals was slightly below average, while the abundance of older age groups was more than 7 times higher than average, with a total dominance of the 4 year-olds belonging to the strong 2016 year class. These were mainly recorded in the south-west close to the wintering areas.

Table 7.3.2.1. *NSS herring. Acoustic estimate in the Barents Sea in August-October 2020*

Length, (cm)	Age/year class					Sum (10^9)	Biomass (10^3 t)	Mean weight (g)
	2018	2017	2016	2015	2014+			
	2	3	4	5	6+			
17-18	0.032					0.032	1.10	34.0
18-19	0.017					0.017	0.73	42.6
19-20	0.077					0.077	3.90	51.0
20-21	0.024					0.024	1.61	67.0
21-22	0.081	0.179				0.260	18.14	69.8
22-23		0.218	0.029			0.247	19.97	80.9
23-24		0.868	0.260			1.129	102.17	90.5
24-25		0.346				0.346	34.58	100.1
25-26		0.004	0.165			0.168	22.13	131.6
26-27		0.024	0.290			0.314	52.26	166.5
27-28			1.193			1.193	219.11	183.6
28-29			2.186			2.186	436.54	199.7
29-30		0.177	2.479			2.656	623.29	234.7
30-31			1.370	0.181		1.550	424.86	274.0
31-32			2.248	0.562		2.810	822.03	292.5
32-33			0.349	0.070		0.418	138.18	330.4
33-34					0.138	0.138	47.96	347.6
34-35					0.071	0.071	29.25	414.0
TSN (10^9)	0.231	1.816	10.569	0.813	0.209	13.636		
TSB (10^3t)	12.98	189.37	2481.28	237.00	77.21		2997.83	
Mean length (cm)	19.95	24.00	29.41	31.36	33.84	28.71		
Mean weight (g)	56.23	104.29	234.78	291.67	370.07			219.84

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

Table 7.3.2.2. *NSS herring. Summary of acoustic estimates by age in autumn 1999-2020. TSN and TSB are total stock numbers (10^9) and total stock biomass (10^3 tons) respectively.*

Year	Age 1		Age 2		Age 3		Age 4+		Total	
	TSN	TSB	TSN	TSB	TSN	TSB	TSN	TSB	TSN	TSB
1999	48.759	716	0.986	31	0.051	2			49.795	749
2000	14.731	383	11.499	560					26.230	943
2001	0.525	12	10.544	604	1.714	160			12.783	776
2002	**No data**									
2003	99.786	3090	4.336	220	2.476	326			106.597	3636
2004	14.265	406	36.495	2725	0.901	107			51.717	3252
2005	46.380	984	16.167	1055	6.973	795			69.520	2833
2006	1.618	34	5.535	398	1.620	211			8.773	643
2007	3.941	148	2.595	218	6.378	810	0.250	46.0	13.164	1221
2008	0.030	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			1.605	109
2012	2.031	36	1.078	66	1.285	195			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	34.950	820	2.138	141	3.465	412	0.982	210	41.537	1583
2018	**No data**									
2019	13.650	172	0.209	15.1	6.0	756	1.6	487	21.460	1430
2020			0.231	13.0	1.816	189	11.59*	2796	13.636*	2998*
Average	15.13	365	5.65	371	2.60	305	1.01	224	24.48	1267

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

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 were observed in the western part of the Barents Sea, in particular along the continental shelf slope (Fig. 7.4.1.1).

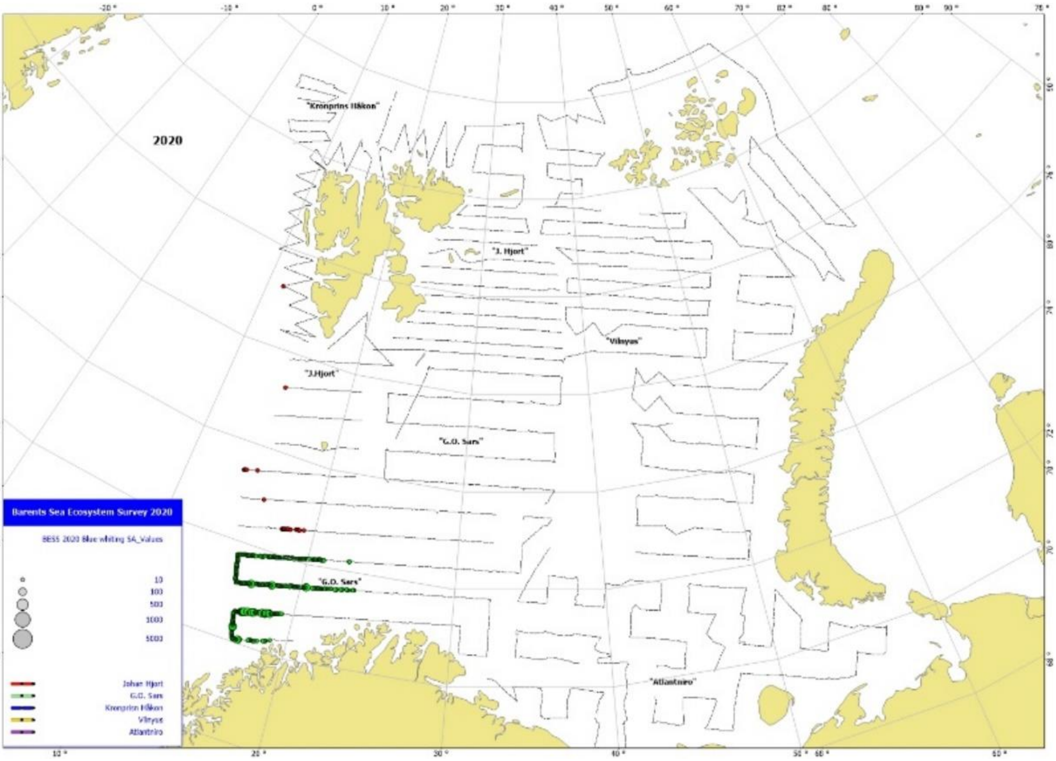

Figure 7.4.1.1. *Geographical distribution of blue whiting in autumn 2020 based on acoustic recordings. Circle sizes correspond to s_A values (m^2/nmi^2) per nautical mile.*

7.4.2 *Abundance by size and age*

The estimated total number and biomass of blue whiting in the Barents Sea in the autumn 2020 is shown in Table 7.4.2.1, and the time series of abundance estimates is summarized in Table 7.4.2.2. 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 2008 the estimated biomass dropped abruptly to only about 18% of the estimated biomass in the previous year, and it stayed low until 2012. From 2012 onwards it has been variable, but the last three years it has been low, and this year estimated biomass was the lowest on record.

The 2014 year class (6-year olds) has been dominant in the samples in recent years, but were outnumbered by both 5-year olds, 1-year olds and 2-year olds in 2020 (Table 7.4.2.1). Abundance in all age groups was below the long-term average (Table 7.4.2.2).

Table 7.4.2.1. *Blue whiting. Acoustic estimate in the Barents Sea in August-October 2020.*

Length (cm)	Age/year class											Sum (10^6)	Biomass (10^3 t)	Mean weight (g)
	1 2019	2 2018	3 2017	4 2016	5 2015	6 2014	7 2013	8 2012	9 2011	10 2010	11+ 2009+			
18-19	5.582											5.582	0.17	30.2
19-20	27.968											27.968	0.98	35.0
20-21	38.549											38.549	1.55	40.1
21-22	23.982											23.982	1.15	48.0
22-23	13.007	1.185										14.192	0.81	57.2
23-24		5.300	5.189									10.489	0.70	67.2
24-25		7.034										7.034	0.56	79.1
25-26	0.979	0.850	2.025									3.854	0.35	90.6
26-27	0.008	0.388	1.704	1.375	0.345	0.094						3.914	0.41	105.9
27-28		4.223				0.306						4.529	0.52	115.6
28-29			1.042	2.356	0.855	0.189						4.442	0.64	143.9
29-30			0.947	2.605	4.717	0.391	0.091					8.751	1.31	149.2
30-31				0.396	8.857	0.681						9.934	1.75	175.9
31-32					0.652	11.942	0.064					12.658	2.50	197.4
32-33					8.706	0.134						8.84	1.90	215.3
33-34									3.723			3.723	0.91	244.4
34-35				0.111	0.225	0.540	0.947	0.697	0.429	0.068	0.068	3.086	0.78	253.9
35-36						1.660	0.270					1.93	0.57	293.1
36-37										1.008	0.328	1.336	0.37	275.9
37-38						0.028	0.269	0.069				0.366	0.11	302.3
38-39						0.033	0.098	0.033	0.163	0.196	0.099	0.621	0.21	337.6
39-40						0.017						0.017	0.01	336.3
40-41						0.114	0.005					0.119	0.04	330.3
41-42											0.104	0.104	0.05	468.0
42-43														
43-44														
44-45								0.041				0.041	0.02	378
TSN (10^6)	110.075	18.980	10.907	6.843	24.357	16.129	1.744	0.840	4.315	1.272	0.598	196.061		
TSB (10^3 t)	4.68	1.59	1.00	0.97	4.48	3.32	0.46	0.22	1.07	0.36	0.19		18.35	
Mean length (cm)	20.6	24.8	25.3	28.7	31.0	31.9	35.0	35.4	33.8	36.7	37.5	24.4		
Mean weight (g)	42.5	83.6	92.0	141.9	184.0	206.1	264.8	267.2	248.9	284.2	316.9			93.6

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

Table 7.4.2.2. *Blue whiting. Acoustic estimates by age in autumn 2004-2020. TSN and TSB are total stock numbers (10^6) and total stock biomass (10^3 tons)*

Year	Age 1		Age 2		Age 3		Age 4+		Total	
	TSN	TSB	TSN	TSB	TSN	TSB	TSN	TSB	TSN	TSB
2004	669	26	439	33	1056	98	1211	159	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					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
2019	54	2	64	5	66	8	162	27	347	43
2020	110	5	19	2	11	1	56	11	196	18
Average	254	10	230	17	325	31	374	91	1204	118

Target strength estimation based on formula: TS = 20 log (L) - 65.2 (Recalculation by Åge Høines, IMR 2017)
Note:«+» <1

Table 7.4.2.3. *Summary of stock size estimates for Blue whiting in 2019-2020.*

Year class		**Age**	**Numbers (10^6)**		**Mean weight (g)**		**Biomass (10^3 t)**	
2019	2018	1	110.1	54.0	42.5	40.0	4.7	2.2
2018	2017	2	19.0	64.4	83.6	76.5	1.6	4.9
2017	2016	3	10.9	66.3	92.0	127.0	1.0	8.4
2016	2015	4+	56.1	162.0	197.6	152.3	11.1	27.4
Total stock in:								
2020	2019	Total	196.1	346.9	93.6	124.0	18.4	42.9

8 COMMERCIAL DEMERSAL FISH

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

This section provides data on the distribution for the main commercial fish species.
In 2020 the area covered was larger than in 2019. Indices based on the BESS data are used in annual assessments of cod, haddock, the deep-water redfish and Greenland halibut (chapter 8.1-8.2, 8.4-8.6) and indices by age and/or length are presented in the annual ICES AFWG reports. Preliminary indices are presented in Table 8.1.

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), but cod was practically absent in the area between the north-eastern part of Svalbard (Spitsbergen) and Franz Josef Land, where large concentrations have been found in previous years. This is similar to the situation last year.

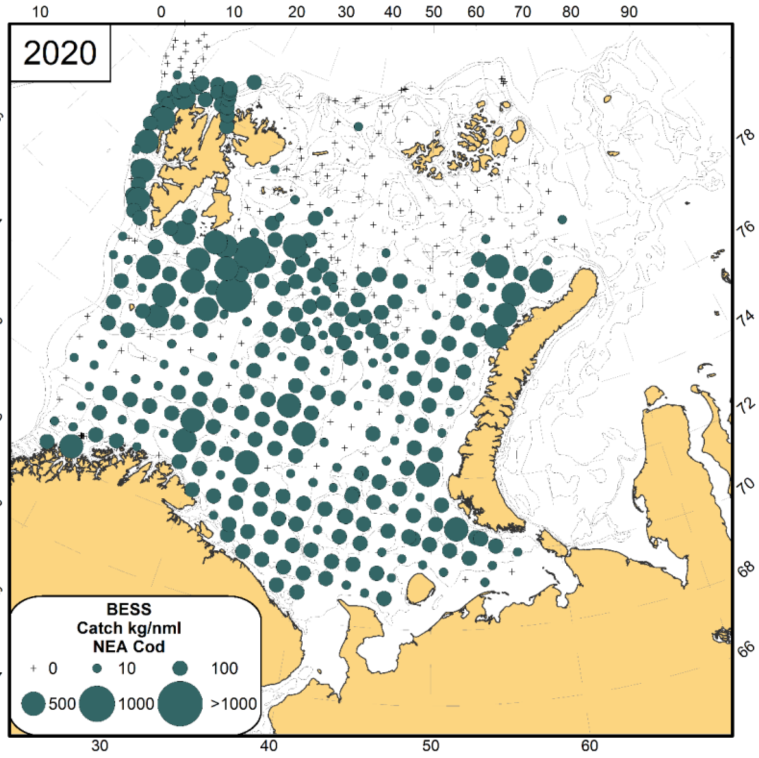

Figure 8.1.1 *Distribution of cod (Gadus morhua), August-October 2020*

8.2 Haddock (*Melanogrammus aeglefinus*)

Within the area surveyed, the haddock distribution in 2020 was similar but appear more restricted compared to 2019, and the catch rates in the south-eastern Barents Sea were lower. Main concentrations of haddock were found along the along Murman coast (Fig.8.2).

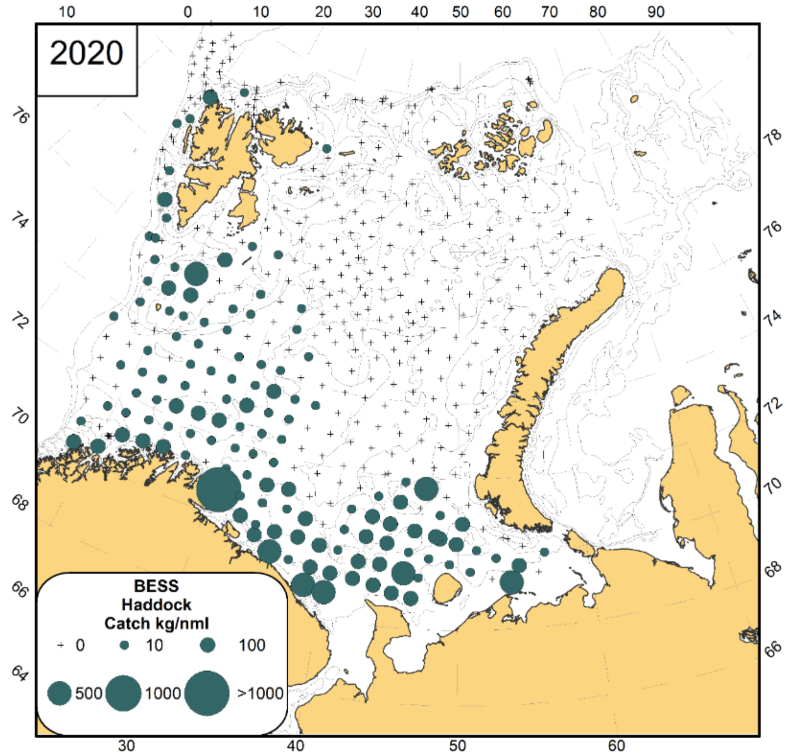

***Figure 8.2.1** Distribution of haddock (Melanogrammus aeglefinus), August-October 2020*

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). High catch rates were found in the south-west.

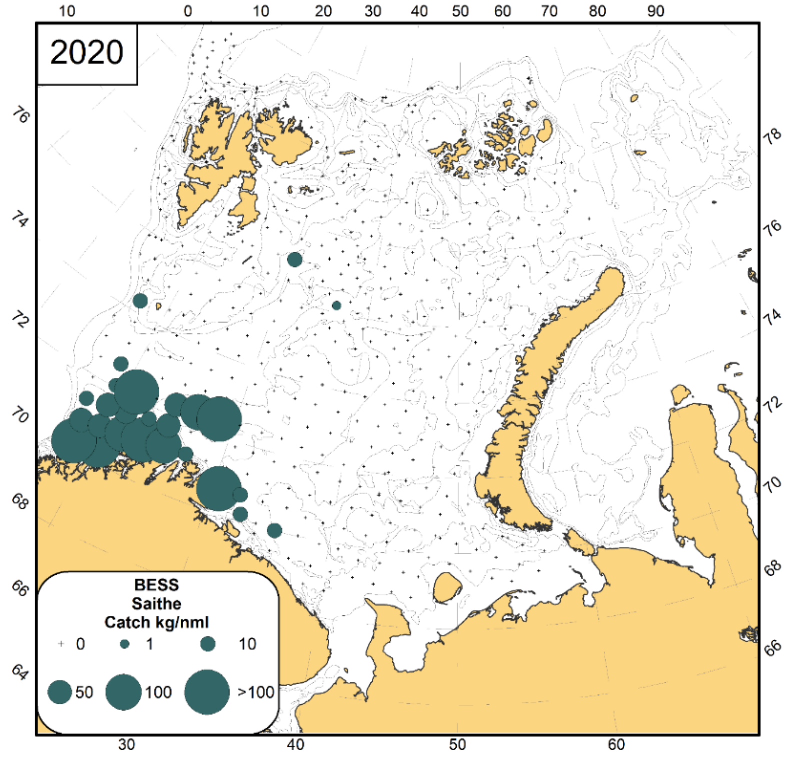

***Figure 8.3.1** Distribution of saithe (Pollachius virens), August-October 2020*

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 (Table 8.1). 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 was similar. The main concentrations of G. halibut were observed around Svalbard (Spitsbergen), to the west of Franz Josef Land, and in the Bear Island Trench. Noticeably there were substantial registrations of G. halibut in an area towards the Yermak Plateau that has not been covered in previous surveys.

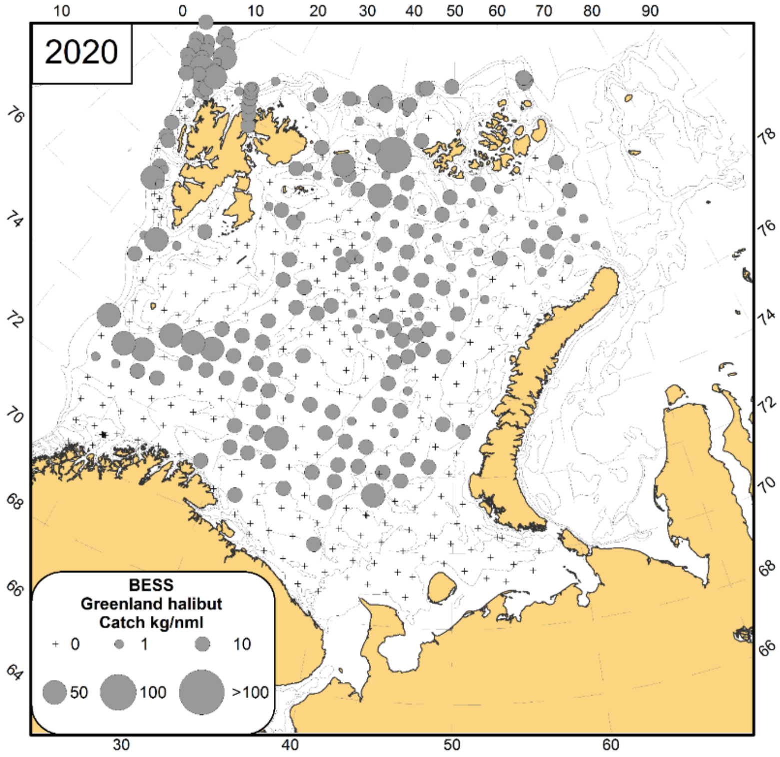

Figure 8.4.1 *Distribution of Greenland halibut (Reinhardtius hippoglossoides), August-October 2020*

8.5 Golden redfish (*Sebastes norvegicus*)

In 2020, centres of abundance for golden redfish were observed along the coast of the Troms region in Norway and along the Murman coast (Fig. 8.5.1). In between, the fish were more seaward than in 2019, like in 2017 and 2016. In the North, the centre of abundance was further south again than in 2019, west of Svalbard (Spitsbergen) rather than north-west.

This pattern resembles very much the distribution in 2018, but catch was overall lower north of Svalbard (Spitsbergen). Out in the open Barents Sea and west of Bear Island abundances were rarely greater than than 5 kg/nml. As in earlier years observations in the eastern Barents Sea, were few and of low abundance.

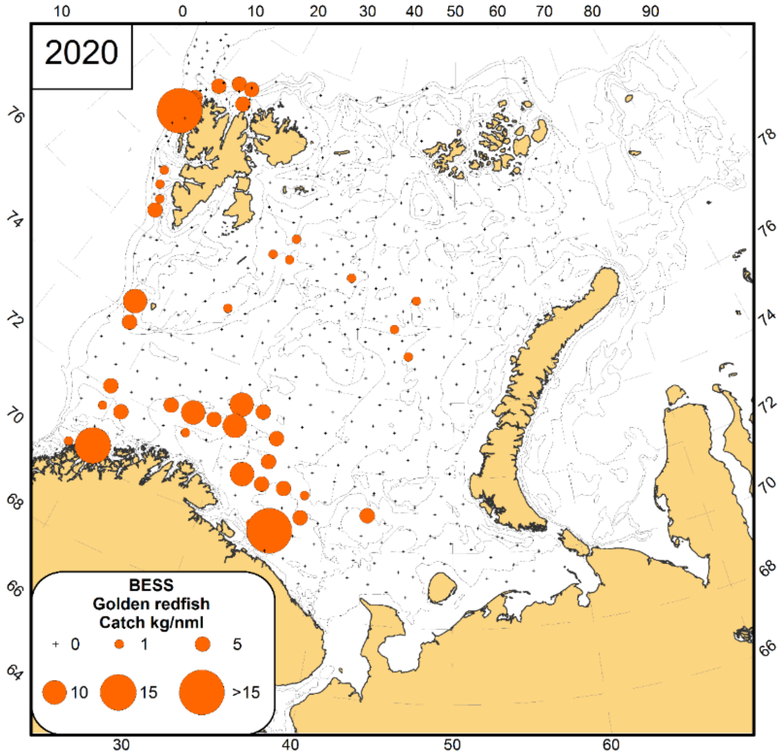

Figure 8.5.1 *Distribution of golden redfish (Sebastes norvegicus), August-October 2020*

8.6 Deep-water redfish (*Sebastes mentella*)

Observations of deep-water redfish were very much like the previous year, except west and south-west of Spitsbergen were catches were considerably more common and also higher. As in previous years, deep-water redfish were only absent from an area north of Bear Island and in the south-eastern part of the Barents Sea. (Fig. 8.6.1).

Highest catches of deep-water redfish were concentrated in the area south and south-east of Bear Island, particularly along the Bear Island Trench. Peak abundances were observed further west in this general area than in 2019.

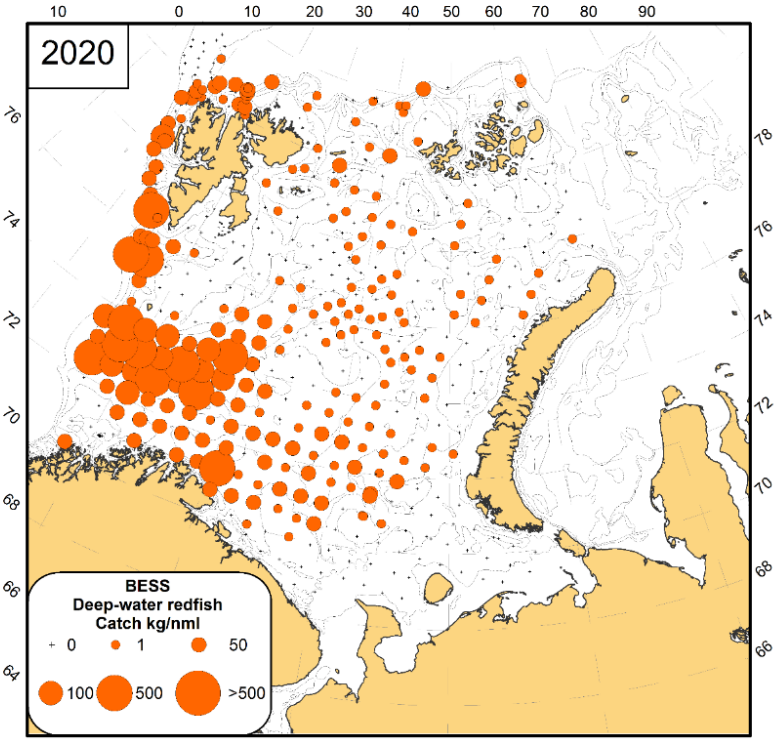

***Figure 8.6.1** Distribution of deep-water redfish (Sebastes mentella), August-October 2020*

8.7 Long rough dab (*Hippoglossoides platessoides*)

As usual, long rough dab were found in the entire area surveyed (Fig. 8.7.1) and the distribution is comparable with 2019. The abundance and biomass indices were very similar to 2019 (Table 8.1).

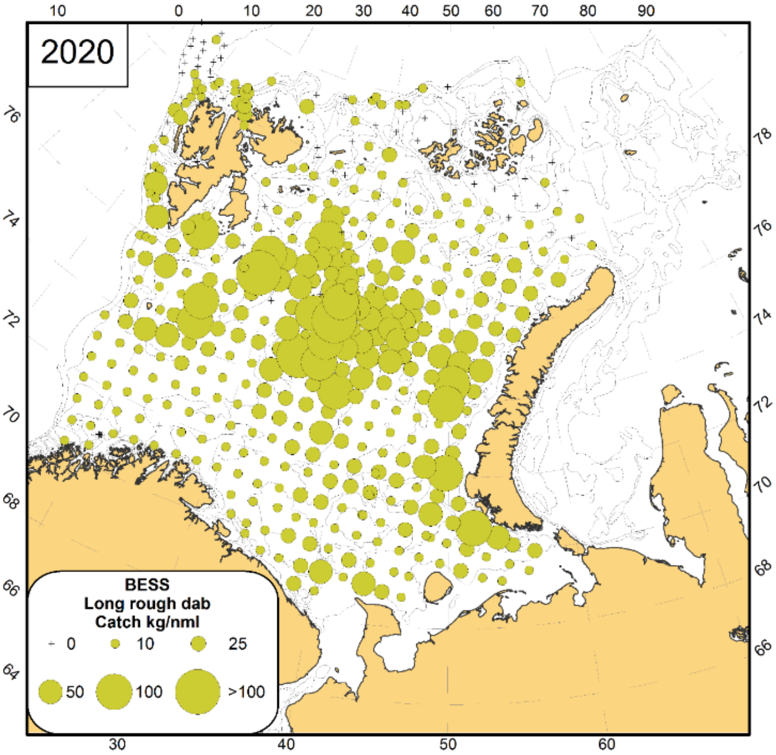

***Figure 8.7.1** Distribution of long rough dab (Hippoglossoides platessoides), August-October 2020*

8.8 Plaice (*Pleuronectes platessa*)

Almost the entire distribution area of plaice was covered in 2020 except coastal waters in Russian Economic Zone. (Fig. 8.8.1). Abundance and biomass indices in 2020 were significantly lower than in 2019 (Table 8.1).

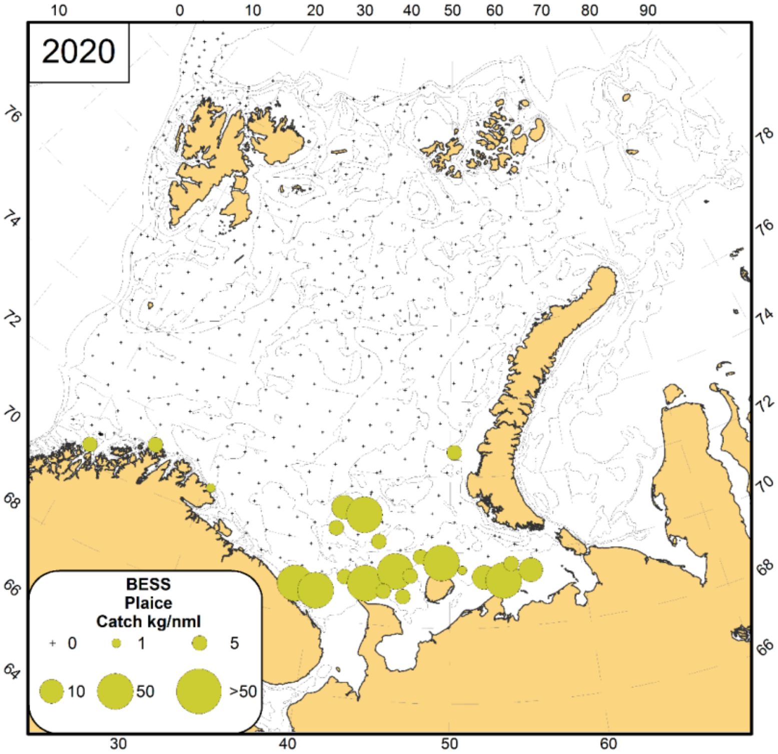

Figure 8.8.1 *Distribution of plaice (Pleuronectes platessa), August-October 2020*

8.9 Atlantic wolffish (*Anarhichas lupus*)

Atlantic wolffish is the most numerous of the three species of wolffishes inhabiting the Barents Sea, while it due to its smaller size has the lowest biomass of the three species. Abundance and distribution of Atlantic wolffish in 2020 (Fig 8.9.1) was generally similar to 2019.

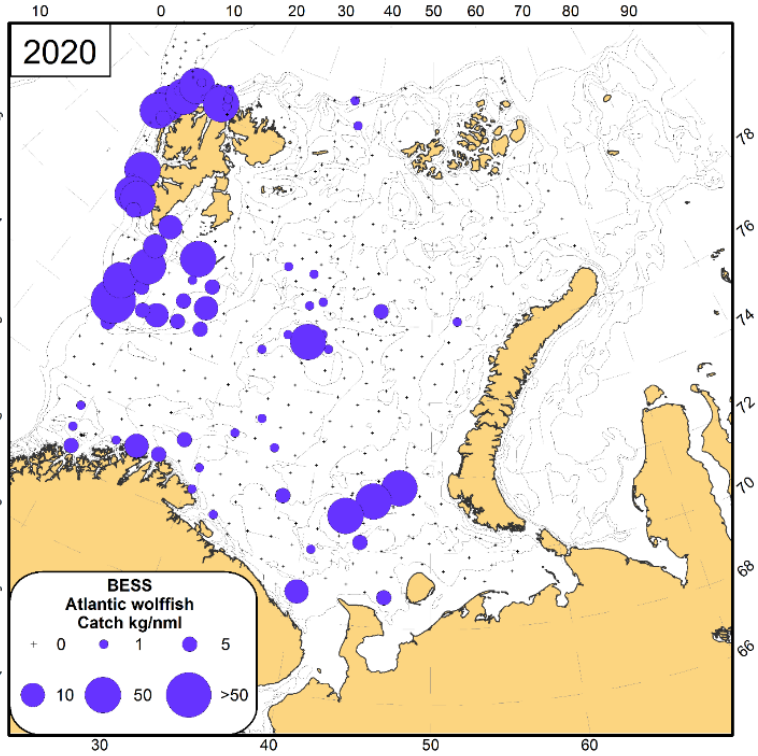

Figure 8.9.1 *Distribution of Atlantic wolffish (Anarhichas lupus), August-October 2020*

8.10 Spotted wolffish (*Anarhichas minor*)

Spotted wolffish is the most valuable commercial wolffish species. In 2020 the abundance and biomass of spotted wolffish was somewhat higher than in 2019, and the distribution similar (Fig. 8.10, Table 8.1).

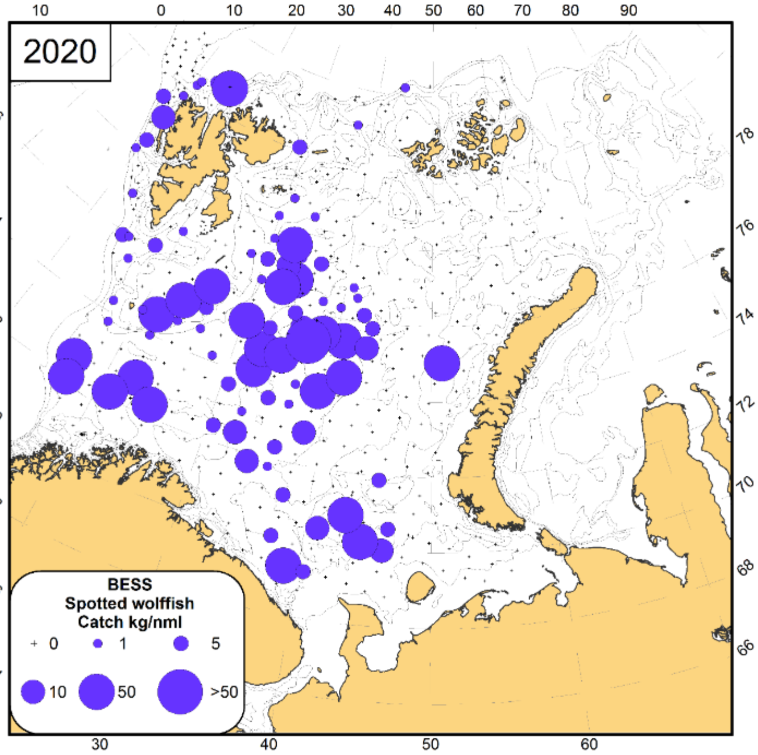

Figure 8.10.1 *Distribution of spotted wolffish (Anarhichas minor), August-October 2020*

8.11 Northern wolffish (*Anarhichas denticulatus*)

In 2020 the distribution of spotted wolffish was almost the same as in previous years (Fig. 8.11.1). The abundance was identical and biomass was lower than in 2019 (Table 8.1).

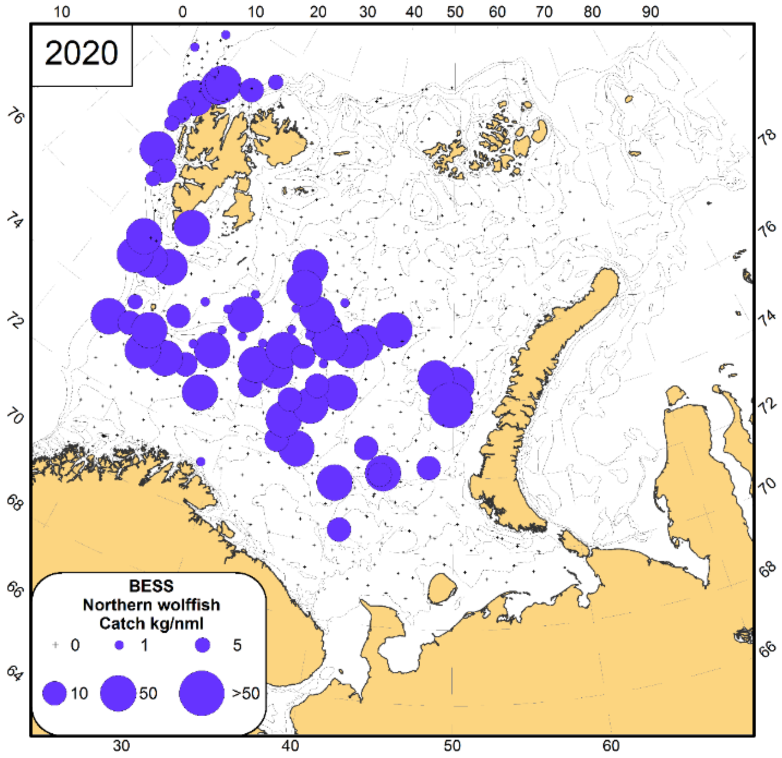

***Figure 8.11.1** Distribution of northern wolffish (Anarhichas denticulatus), August-October 2020*

Table 8.1. *Abundance (N, 10^6 individuals) and species biomass(B, 10^3 tonnes) of the main demersal fish in the Barents Sea (not including 0-group).* poor coverage in the eastern Barents Sea, indices only calculated for the redfishes and saithe.*

Species		Year																
		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018*	2019	2020
Atlantic wolffish	N	15	16	26	42	25	20	17	20	22	27	12	33	40	30		37	44
	B	7	6	11	11	14	8	17	13	9	30	12	37	24	29		20	27
Spotted wolffish	N	12	11	12	12	13	9	7	9	13	13	8	12	13	14		15	22
	B	31	26	46	42	51	47	37	47	83	84	51	86	40	63		51	55
Northern wolffish	N	3	3	2	3	3	3	3	6	8	12	6	9	8	8		13	13
	B	26	26	19	25	22	31	25	42	45	52	34	63	51	63		76	65
Long rough dab	N	2951	2753	3705	5327	3942	2600	2520	2507	4563	4932	3046	3624	3369	4604		3627	3443
	B	306	272	378	505	477	299	356	322	584	565	413	438	402	538		472	454
Plaice	N	53	19	36	120	57	21	34	36	21	36	170	107	37	17		146	94
	B	43	11	19	55	29	13	21	26	13	29	121	79	29	19		101	37
Golden redfish	N	13	23	16	20	42	12	22	14	32	75	45	9	34	34	73	27	26
	B	9	11	16	11	17	11	4	5	8	20	13	5	24	18	21	21	8
Deep-water redfish	N	263	330	526	796	864	1003	1076	1271	1587	1608	927	894	1527	1705	1298	1126	1086
	B	104	137	219	183	96	213	112	105	196	256	208	214	319	212	260	313	291
Greenland halibut	N	182	335	430	296	153	191	186	175	209	160	43	79	82	134		166	276
	B	39	56	77	86	76	90	150	88	86	94	53	52	40	74		61	55
Haddock	N	757	1211	3518	4307	3263	1883	2222	1068	1193	734	1110	1135	1604	1321		2213	799
	B	261	342	659	1156	1246	1075	1457	890	697	570	630	505	836	303		678	391
Saithe	N	36	31	28	70	3	33	5	9	14	18	3	105	58	282	30	58	291
	B	40	26	49	98	7	29	9	10	13	33	6	153	54	193	24	80	301
Cod	N	1513	1012	1539	1724	1857	1593	1651	1658	2576	2379	1373	1694	1767	1880		2068	775
	B	1074	499	810	882	1536	1345	2801	2205	1837	2132	1146	1425	1087	1397		1477	779

9 FISH BIODIVERSITY

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

9.1 Fish biodiversity in the pelagic compartment

Due to limited resources the fish biodiversity in the pelagic compartment was not possible to estimate from the 2020 survey in time for this report. If possible, the time series will be continued in next year survey report.

9.2 Fish biodiversity in the demersal compartment

Norway pout (*Trisopterus esmarkii*). The distribution of Norway pout in 2020 was similar to 2020, except their absence in the central part of the area and eastwards to the south-western part of the Novaya Zemlya in 2020 (Fig. 9.2.1). The highest concentrations of this species were found traditionally in the south-western part of the Barents Sea.

The maximum catch and the average catch of Norway pout (51.0 kg/nautical mile and 0.4 kg/nautical mile respectively) in 2020 were noticeably less than in 2019 (192.4 kg/nautical mile and 1.8 kg/nautical mile respectively). Total abundance (515.2 million individuals) and biomass (14.6 thousand tonnes) of Norway pout were considerably lower in 2020 than in 2019 (1949.2 million individuals) and biomass (51.1 thousand tonnes) (Table 9.2.1).

Norway redfish (*Sebastes viviparus*). In 2020 Norway redfish was distributed in the same area as in 2019 (Fig. 9.2.2). This species occurred in the south-western area of the survey along the Norwegian coast and in the south-western part of Svalbard (Spitsbergen). Several redfish individuals were also caught in the south-central part of the Barents Sea.

The maximum catch of Norway redfish in 2020 (124.4 kg/nautical mile) was some less than in 2019 (153.7 kg/nautical mile), and the average catch was the same (0.8 kg/nautical mile). Total abundance and biomass indices of this species in 2020 (155.7 million individuals and 22.6 thousand tonnes) were higher than in 2019 (142.5 million individuals and 15.5 thousand tonnes) (Table 9.2.1).

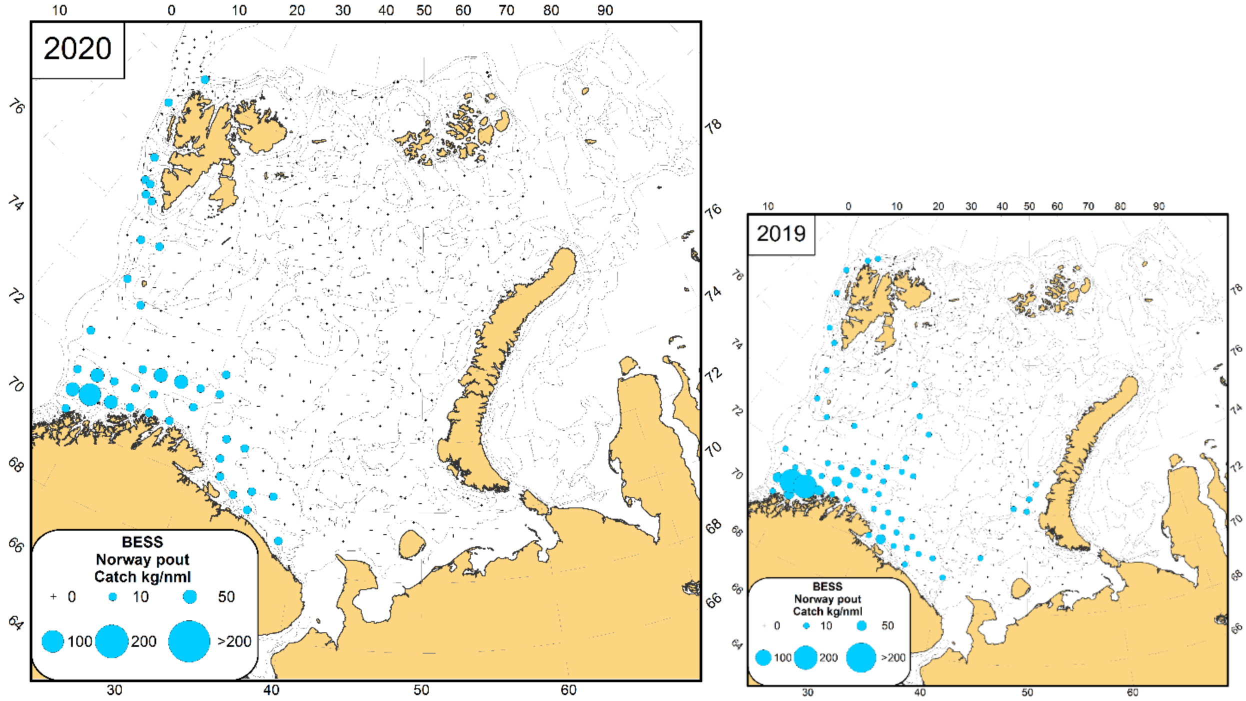

Figure 9.2.1 *Distribution of Norway pout (Trisopterus esmarkii), during the BESS 2020 and BESS 2019.*

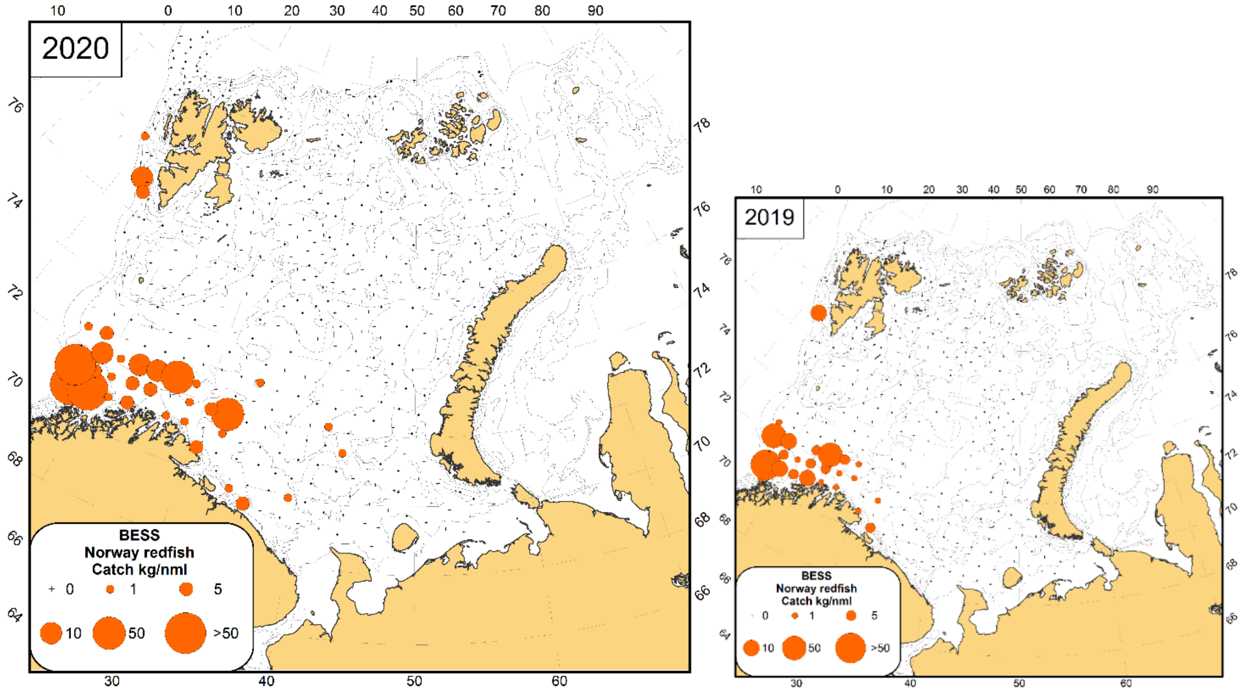

Figure 9.2.2 *Distribution of Norway redfish (Sebastes viviparus), during the BESS 2020 and Bess 2019.*

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 2006-2020 (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
2019	1949.2	51.1	142.5	15.5
2020	515.2↓	14.6↓	155.7↑	22.6↑

Thorny skate (*Amblyraja radiata*) and **Arctic skate (*Amblyraja hyperborea*)** were selected as indicator species to study how ecologically similar fishes from different zoogeographic groups respond to changes of their environment.

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

In 2020 thorny skate was distributed in the wide area from the north-west to the south-west and south-east Barents Sea where warm Atlantic and Coastal Waters dominated (Fig. 9.2.3). Thorny skate was observed in 32.5 % of the bottom stations.

Thorny skate was distributed within a depth of 36-628 m, and the highest biomass occurred at depth 50-350 m (63.0 % of total biomass). The mean catch and the average catch in 2020 were the lowest in 2014-2020 (Table 9.2.2). The estimated total biomass and abundance of thorny skate in 2020 was also lower compared to 2019 (Table 9.2.2).

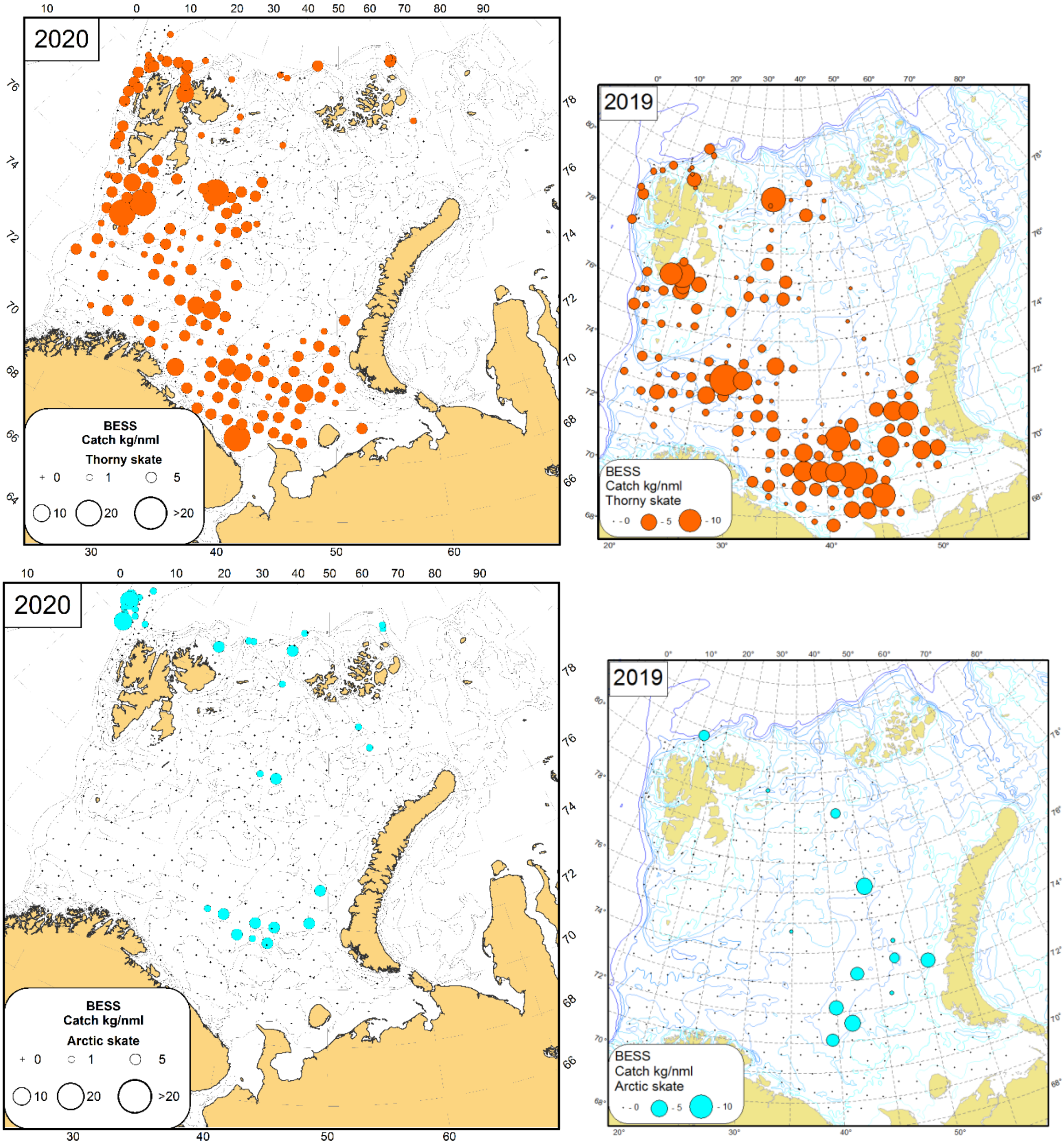

Figure 9.2.3 *Distribution of thorny skate (Amblyraja radiata) (above) and Arctic skate (Amblyraja hyperborea) (below), during the BESS 2020 and BESS 2019.*

Table 9.2.2. *Mean abundance (N, individuals per nautical mile) and biomass (B, kg per nautical male) catches, total abundance (N, million individuals) and biomass (thousand tonnes) of thorny skate during BESS 2020*

	Mean catch		**Total abundance**	
	N	B	N	B
2014	1.4	1.2	34.4	30.0
2015	1.1	1.0	31.8	30.5
2016	1.0	0.9	30.7	28.2
2017	1.8	1.3	52.0	39.7
2019	2.0	1.4	57.0	41.3
2020	0.8↓	0.7↓	31.7↓	31.1↓

Note: – 2018 is not included due to the poor area coverage

Arctic skate was mainly found in deep trenches in the central and the northern Barents Sea (Fig. 9.2.3). Arctic skate was found only in the 6.7 % of the bottom stations, and it was distributed much deeper at depth of 150-916 m. The highest biomass of this species was observed at 250-300 m (20.2 %) and 800-916 m (48.1 %).

The mean catch (in terms of biomass and abundance) of Arctic skate in 2020 was approximately the same as in 2019, and less than in 2016-2017 (Table 9.2.3). The estimated total biomass and abundance of Arctic skate in 2020 was also less than in 2019 (Table 9.2.3).

Table 9.2.3. *Mean abundance (N, individuals per nautical mile) and biomass (B, kg per nautical male) catches, total abundance (N, million individuals) and biomass (thousand tonnes) of Arctic skate during BESS 2020*

	Mean catch		**Total abundance**	
	N	B	N	B
2014	0.2	0.3	3.7	6.7
2015	0.07	0.1	1.6	1.9
2016	0.2	0.2	8.6	4.0
2017	0.3	0.3	4.9	4.4
2019*	0.07	0.09	2.0	2.3
2020	0.12↑	0.11↑	1.8↓	1.8↓

* – 2018 was not included due to the poor coverage

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 BESS 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 BESS in 2020 (Fig. 9.3.1). So, rainbow smelt *Osmerus mordax dentex* were caught in the south-east of the survey area. Lutken’s eelpout *Lycodes luetkenii* and threadfin seasnail *Rhodichthys regina* were found in deepwater areas on the slope in the north of the Barents Sea. Megrim *Lepidorhombus whiffiagonis* which is known from the Atlantic coasts off northern Africa to Norway, was caught on the south-western border of the survey area. Occurrence of deal fish *Trachipterus arcticus* is also interesting as this species usually occurs in more southern areas.

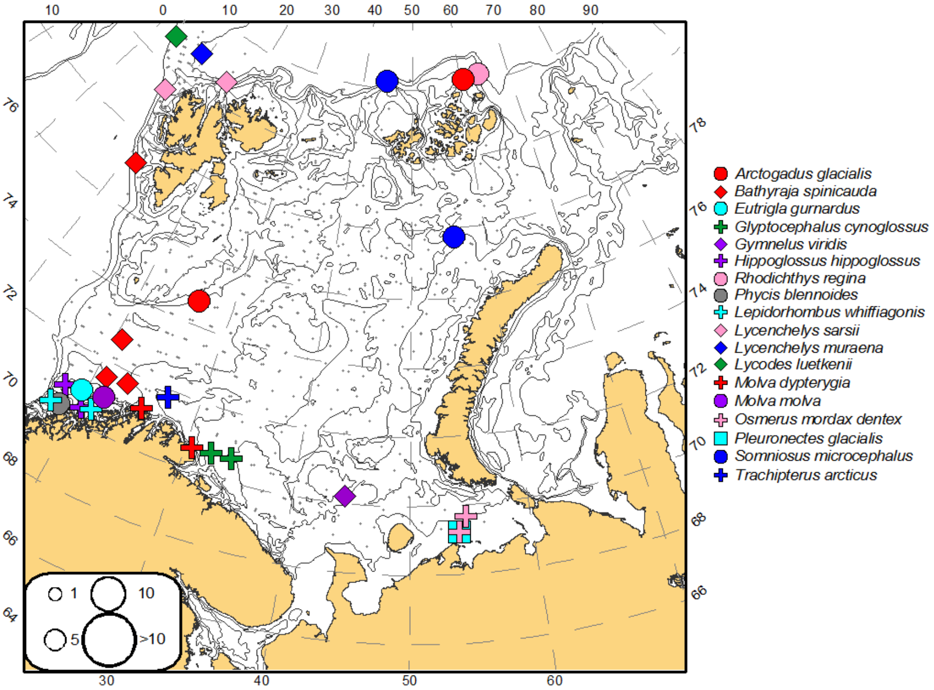

Figure 9.3.1 *Distribution of species which are rare in the Barents Sea and which were found in the survey area in 2020.*

9.4 Zoogeographic groups

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

During the BESS 2020 totally 95 fish species from 29 families were recorded in the catches, and some taxa were only recorded at genus or family level. 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).
The median and maximum catches of non-commercial fish from different zoogeographic groups are shown in Table 9.4.1.

Widely distributed (only ribbon barracudina *Arctozenus risso* represents this group), **south boreal** (e.g. grey gurnard *Eutrigla gurnardus*, silvery pout *Gadiculus argenteus*, angler fish *Lophius piscatorius*) and **boreal** (e.g. round skate *Rajella fyllae*, Sars' wolf eel *Lycenchelys sarsii*, silvery lightfish *Maurolicus muelleri*) species were mostly found in the central, south-western and western part of the survey area where warm Atlantic and Coastal Water dominate (Fig. 9.4.1). The median and maximum catches of species of the widely distributed, south boreal and boreal zoogeographic group was higher than in 2019 (Table 9.4.1). Moreover, maximum catch of boreal species was the highest since 2013.

Mainly boreal species (e.g. lesser sandeel *Ammodytes marinus*, snakeblenny *Lumpenus lampretaeformis*, common dab *Limanda limanda*) were widely found throughout the survey area (Fig. 4.2.1). The catches of species belonging to the mainly boreal group (median and maximum) in 2020 were the lowest since 2013 (Table 9.4.1).

Arctic-boreal species (e.g. Atlantic poacher *Leptagonus decagonus*, ribbed sculpin *Triglops pingelii*) were found in the central and northern part of the Barents Sea (Fig. 9.4.1). The median catch of species of the Arctic-boreal zoogeographic group was lower in 2020, than in 2019, but the maximum catch was higher (Table 9.4.1).

Mainly Arctic (e.g. Arctic staghorn sculpin *Gymnocanthus tricuspis*, Atlantic spiny lumpsucker *Eumicrotremus spinosus*, polar sculpin *Cottunculus microps*) and **Arctic** (e.g. Arctic alligatorfish *Aspidophoroides olrikii*, pale eelpout *Lycodes pallidus*, leatherfin lumpsucker *Eumicrotremus derjugini*) species were mainly found on the northern part of the Barents Sea (Fig. 9.4.1). Species of these groups mostly occur in areas influenced by cold Arctic Water, Spitsbergen Bank Water and Novaya Zemlya Coastal Water. Median and maximum catches of mainly Arctic species in 2020 were lower than in 2019 (Table 9.4.1). Median catch of Arctic species in 2020 was lower than in 2019, whereas the maximum catch was the highest since 2013 (Table 9.4.1).

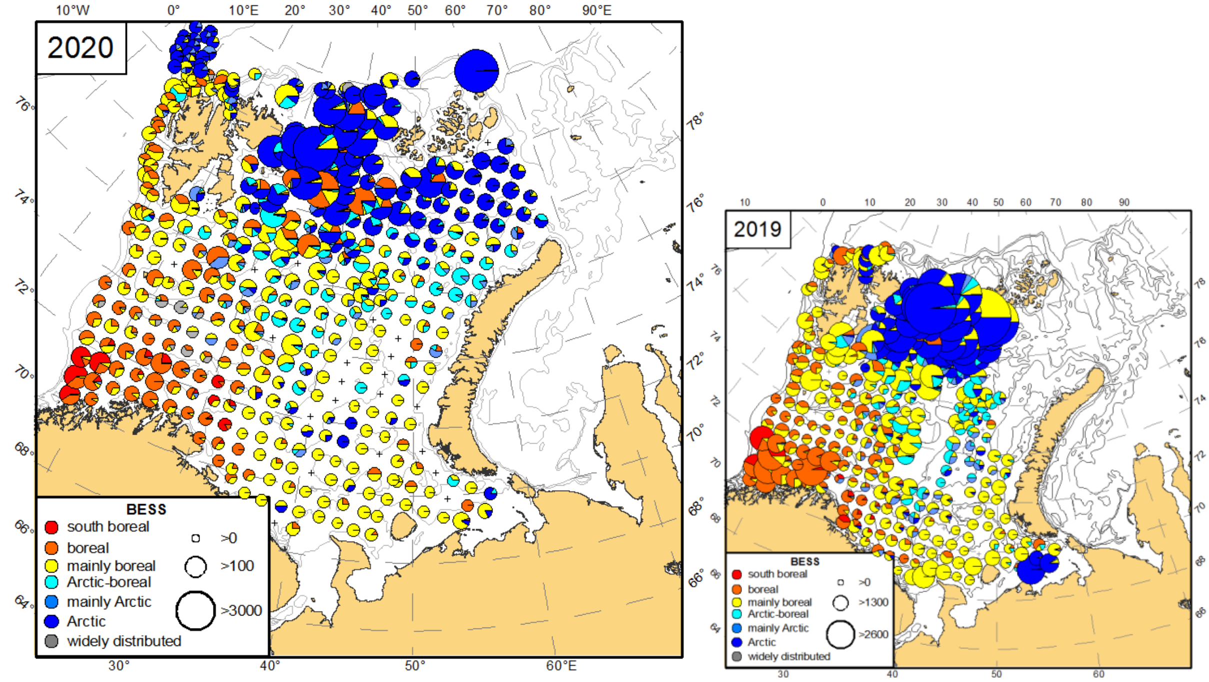

***Figure 9.4.1** Distribution of non-commercial fish species from different zoogeographic groups during the BESS 2020 and BESS 2019. The size of circles corresponds to abundance (individuals per nautical mile, only bottom trawl stations were used, both pelagic and demersal species are included)*

Table 9.4.1. *Median and maximum catch (individuals per nautical mile) of non-commercial fish from different zoogeographic groups (only bottom trawl data were used, both pelagic and demersal species are included)*

Zoogeographic group	Median catch							Maximum catch						
	2013	2014[1]	2015	2016[2]	2017	2019[3]	2020	2013	2014[1]	2015	2016[2]	2017	2019[3]	2020
Widely distributed	0.2	0.1	0.09	0.5	0.2	0.02	0.1↑	17.1	14.3	10.0	36.7	7.5	1.3	11.0↑
South boreal	0.8	0.9	1.2	1.4	3.2	2.6	2.7↑	171.4	105.7	216.3	135.0	372.9	312.0	357.0↑
Boreal	7.1	8.7	8.7	18.3	15.0	14.2	17.9↑	230.0	478.6	660.0	743.8	792.9	735.6	1646.1↑
Mainly boreal	48.9	36.4	71.4	55.3	53.7	54.3	23.7↓	982.5	3841.4	1587.1	2962.5	2945.0	1406.1	464.8↓
Arctic-boreal	25.4	8.6	14.0	8.8	19.3	15.0	8.9↓	3326.9	371.6	1502.4	283.8	571.3	297.5	573.1↑
Mainly Arctic	10.2	1.7	1.9	3.3	4.9	7.2	1.9↓	656.3	60.9	53.8	123.2	282.5	828.8	156.2↓
Arctic	70.8	7.4	31.5	29.1	78.5	108.5	93.7↓	3013.8	386.4	832.2	808.6	2731.1	2968.8	6770.6↑

[1] – Coverage in the northern Barents Sea was highly restricted

[2] – The survey started in the north

[3] – 2018 are not included due to the poor coverage of the Russian Zone

10 COMMERCIAL SHELLFISH

10.1 Northern shrimp (Pandalus borealis)

D. Zakharov, C. Hvingel

During the survey in 2020 461 trawl hauls were completed – 317 of them contained northern shrimp. The biomass of shrimp varied from several grams to 113.4 kg/nml with an average catch of 4.6±0.4 kg nml (Table 10.1.1). Average values are reported with standard error (*SEM).*

Table 10.1.1. *The catch characteristics of the Northern shrimp (include SEM) during BESS in 2005-2020*

Year	Total number of station	Number of station with shrimp	Mean catch, ind./nml	Mean catch, 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
2019	323	254	1577.5±3.1	9.1±0.2
2020	461	317	717.2±77	4.6±0.4
Total	**6017**	**4516**	**1892.02±19.06**	**10.09±1.09**

As in previous years the densest concentrations of shrimp in 2020 were registered in central part of the Barents Sea, around Svalbard (Spitsbergen) and in the Franz Victoria Trough (Fig. 10.1.1).

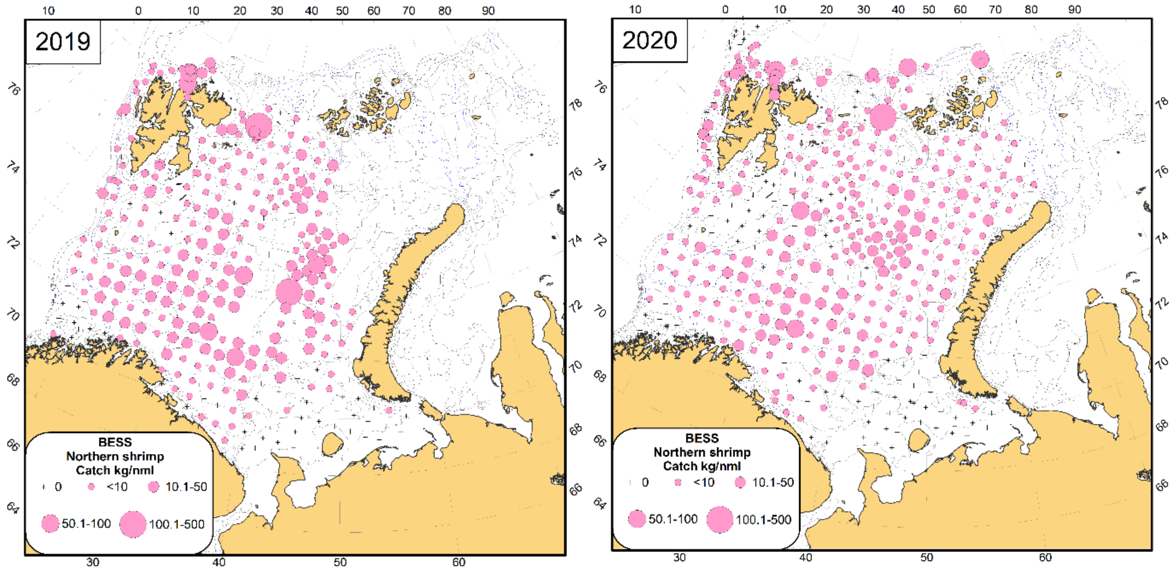

Figure 10.1.1 Distribution of the Northern shrimp (*Pandalus borealis*) in the Barents Sea, August-October 2019-2020

Biological analysis of the northern shrimp was conducted in 2020 by Russian scientists in the eastern part of the survey area. As in 2019, the bulk of the population of the eastern Barents Sea shrimp was made up of smaller individuals, i.e males with a carapace length of 10-27 mm in addition to females with a carapace length of 17-30 mm (Fig. 10.1.2). In 2020 proportion of males and females was almost equal.

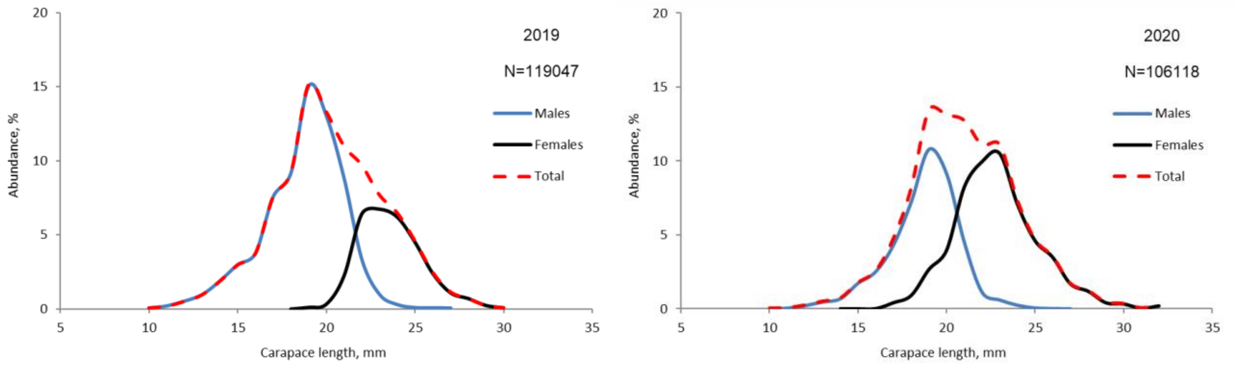

Figure 10.1.2. *Size and sex structure of catches of the Northern shrimp (Pandalus borealis) in the eastern Barents Sea 2019-2020*

10.2 Red king crab (Paralithodes camtschaticus)

Text by: N. Strelkova, A.M. Hjelset,
Figures by: D. Zakharov, N. Strelkova

During BESS-2020 the red king crab was recorded in 22 of 461 trawl catches: in two stations in Norwegian water and in 20 stations in Russian part of survey (Table 10.2.1). Compared to previous years in 2020 there was not recorded any expansion of red king crab range to north or east directions (Fig. 10.2.1).

Despite the identical coverage of the red king crab area by stations, in 2020 compared to 2019 both the number of recording and the total catch were significantly lower (Table 10.2.1, Fig. 10.2.1). As in previous years, the most abundant catches were recorded in Russian water near peninsula Kanin Cap.

Table 10.2.1. *The total catches of the red king crab during BESS 2005-2020.*

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

* reduced coverage of the red king crab area

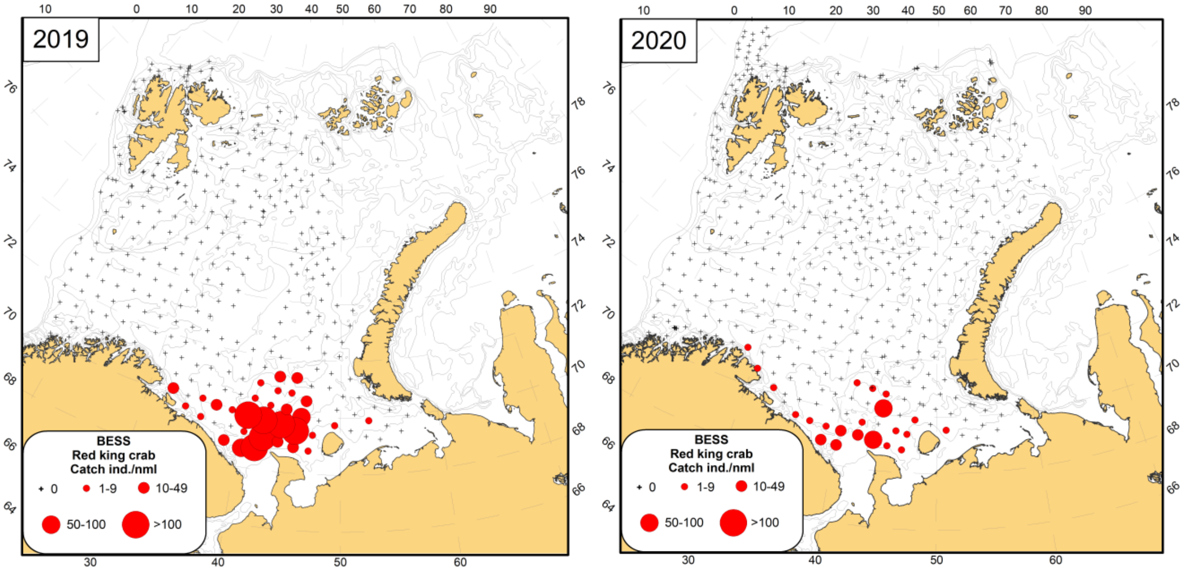

Figure 10.2.1 *Distribution of the red king crab (Paralithodes camtschaticus) in the Barents Sea in August-October 2019 and August-November 2020*

The biomass of red king crab catches in 2020 varied from 1.5 to 174.3 kg/haul (1.8-187.4 kg/nm) compared with 1.4 to 189.8 kg/haul (2.1-382.1 kg/nm) in 2019. The average biomass was 24.9±8.4 kg/haul (26.9±9.0 kg/nm) compared with 53.7±8.0 kg/haul (93.4±14.7 kg/nml) in 2019.

The abundance of crab in 2020 ranged from 1 to 50 ind./haul (0.9-53.8 ind./nm) given an average crab abundance of 10.6±3.3 ind./haul (11.4±3.5 ind./nm) compared with 1- 251 ind./haul (1.1-504.0 ind./nm) and 30.9±6.2 ind./haul (52.7±11.3 ind./nm) in 2019.

The size structure of the red king crab population in 2020 characterized by domination of two groups of crabs with carapace width 110-130 and 190-210 mm. (Fig. 10.2.2).

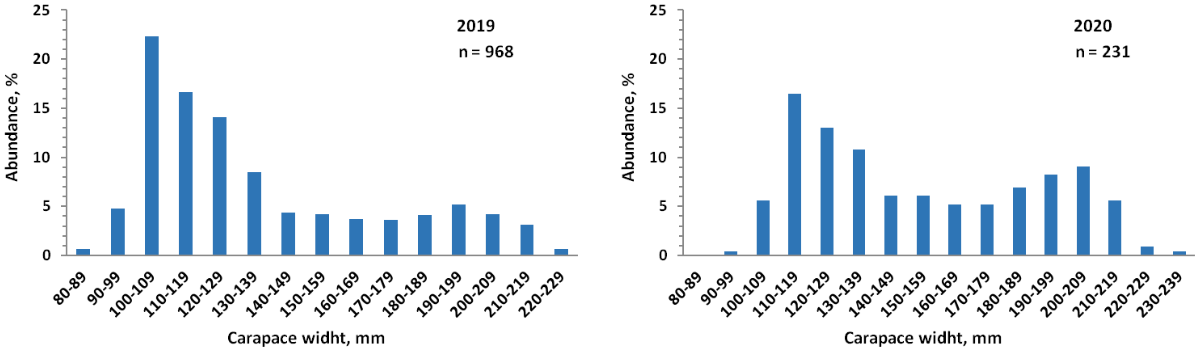

Figure 10.2.2 *Length distribution of the red king crab in the Barents Sea in August-October 2019 and August-November 2020 (by BESS data).*

10.3 Snow crab (Chionoecetes opilio)

Text by: N. Strelkova, A.M. Hjelset

Figures by: D. Zakharov, N. Strelkova

In 2020 the snow crab were recorded in 141 out of 461 trawl catches. Compared to previous years, the total catch of snow crab significantly decreased despite an increase in total number of stations (Table 10.3.1)

In 2017 the snow crab was for the first time recorded in the water of Svalbard (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. In 2019 and 2020 snow crab was not recorded in the water around Svalbard (Spitsbergen) despite the similar dense of stations.

In 2020 there was not recorded any new expansion in distribution of snow crab area to the south and west compared to previous years (Fig. 10.3.1).

Within the survey area the biomass of snow crab in 2020 varied from 0.002 to 36.7 kg/haul (0.003-40.8 kg/nm) with an average of 3.1±0.3 kg/haul (3.7±0.3 kg/nm) compared with 0.002-60.4 kg/haul (0.003-83.1 kg/nm) and 4.9±1.0 kg/haul (6.6±1.3 kg/nm) in 2019 (Fig. 10.3.1, Table 10.3.1).

The abundance in 2020 ranged from 1 to 436 ind./haul (1-520 ind./nml) with an average of 31.2±3.1 ind./haul (37.5±3.7 ind./nm) compared with 1-402 ind./haul (1-1775 ind./nm) and 113±42 ind./haul (145±25 ind./nm) in 2019 (Fig. 10.3.1, Table 10.3.1).

Table 10.3.1. *The total and mean (per nautical mile) catches of snow crab during BESS in 2005-2020*

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

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

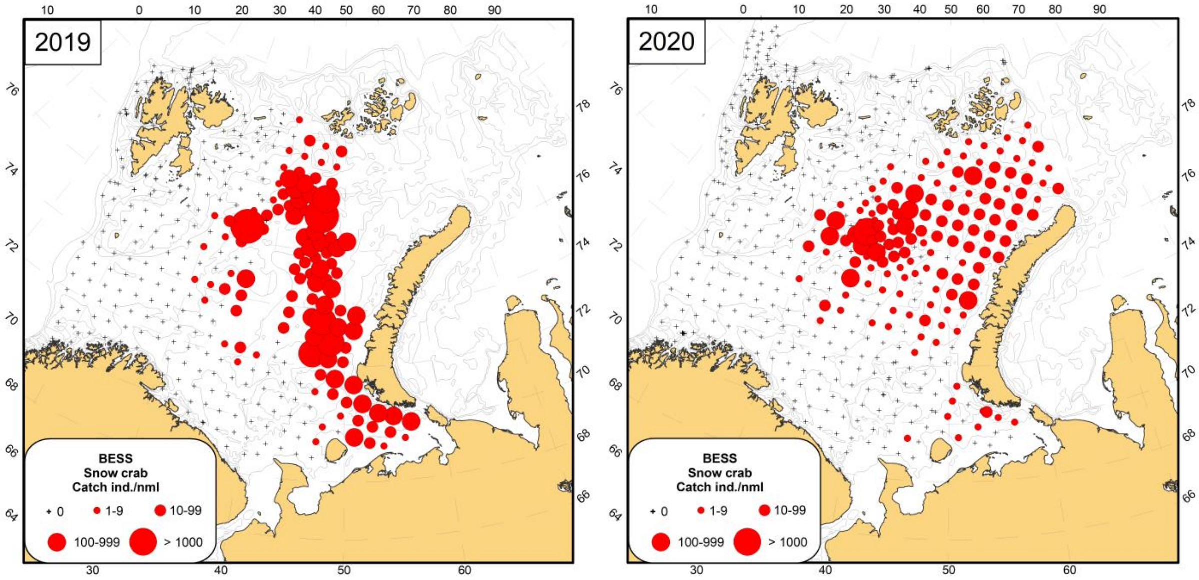

Figure 10.3.1 *Distribution of the snow crab (Chionoecetes opilio) in the Barents Sea in August-October 2019 and August-November 2020.*

Due to reduced coverage of survey area in 2019, the comparison of data between 2019 and 2020 is not valid for the Barents Sea totally and possible only for part of the crab area.

The size structure of the snow crabs caught in 2020 is domination of females with 50-59 mm carapace width and males with carapace width 60-69 mm (Fig. 10.3.2 B). The annual increase in carapace width of juvenile crabs (size group 10-19 mm in Fig. 10.3.2) and middle-size females (size group 40-49 mm in Fig. 10.3.2) was about 10 mm, while of middle-size males (size group 40-49 mm in Fig. 10.3.2) – about 15-20 mm (from 40-49 mm to 50-69 mm) (Fig. 10.3.2).

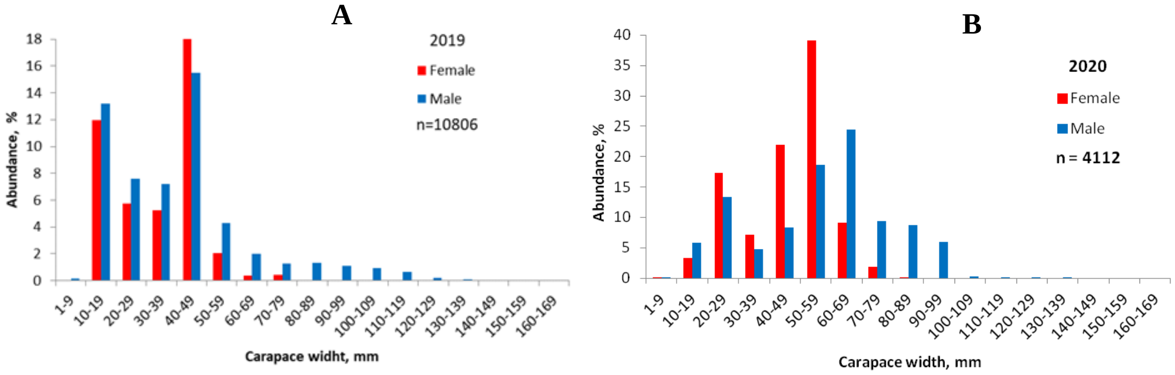

__Figure 10.3.2__ Size and sex structure of the snow crab in the Barents Sea in August-October 2019 (A) and August-November 2020 (B) based on BESS data.

10.4 Iceland scallop (Chlamys islandica)

Text by: I. Manushin, L.L. Jørgensen
Figures by: I. Manushin

The Iceland scallop was recorded in 97 of 431 trawl catches in 2020. The survey showed a wide distribution of scallops in the Barents Sea. The deepest record in 2020 was at 784 m, but the most abundant catches were recorded in the shallow banks and elevations of the bottom: Spitsbergen Bank, Central Bank, Great Bank, Kanin Bank, Goose Bank (Fig. 10.4.1). The disappearance of scallops to the west of Svalbard (Spitsbergen) area reflects the peculiarity of this survey - one of the Norwegian ships did not identify these mollusks. The biomass of scallops in 2020 varied from 1.5 to 2.565 g/haul (0.002-3.1 kg/nml). The average biomass is 122±33 g/haul (146±40 g/nml) (Table 10.4). The abundance ranged from 1 to 375 ind./haul (1-455 ind./nml). The average abundance of scallops is 12±4 ind./haul (15±5 ind./nml).

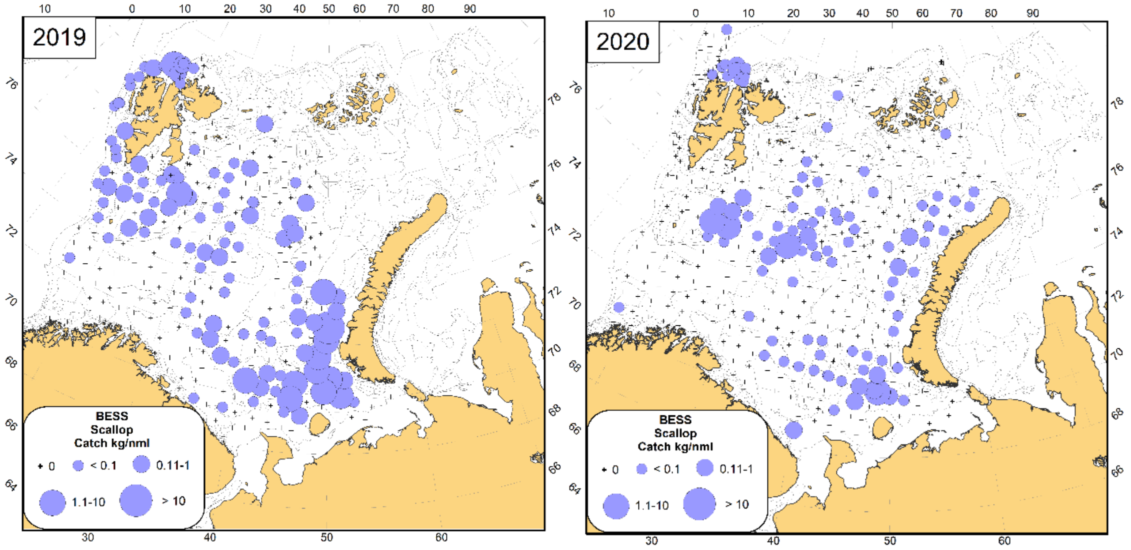

__Figure 10.4.1__ Distribution of Iceland scallop (Chlamys islandica) in the Barents Sea, August-November 2019-2020

Table 10.4. *Annual parameters of scallop catches in the Barents Sea based on BESS data*

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

* - survey area was not cover complete

11 BENTHIC INVERTEBRATE COMMUNITY

Text by: N. Strelkova, L. L. Jørgensen
Figures by: D. Zakharov, N. Strelkova

The list of benthic experts onboard Russian and Norwegian RVs is shown in the Table 1.

In 2020, bycatch records of megabenthos was made from 429 bottom trawl hauls across five RVs during the BESS. Megabenthos was processed to closest possible taxon with abundance and biomass recorded on four out of five ships. This was done by four benthic experts from PINRO&AtlantNIRO, and by five experts from IMR. Onboard RV "Johan Hjort" was processed megabenthos to large benthic groups only, because benthic experts was absent.

11.1 Species diversity

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

In 2020 was 65.6 % (versus 68.7 % in the previous year) of the catch identified all the way to species-level (Table 11.2.).

Table 11.1. *The measures obtained in BESS since 2005.*

Year	Number stations	Total		Average abundance, 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	15.4	4887.8	89.2	404	574
2019	305	1292902	19.0	4239.0	62.5	427	621
2020	429	898168	10.7	1719.1	30.4	401	611
Total	5967	15 329 686	232.0	3067.2*	48.1*	298*	444*

* 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 2020*

Research vessels	"G.O. Sars"	"Kronprins Haakon"	"Johan Hjort"	"Vilnyus "	“AtlantNIRO ”	**Total**
Number of processed hauls	64	49	78	136	102	**429**
Phyllum	12	14	12	13	10	**15**
Class	24	24	19	22	22	**28**
Order	75	74	19	67	63	**93**
Family	150	163	18	122	109	**232**
Species	240	242	15	192	136	**401**
Total number of taxa	353	354	60	248	204	**611**
Percentage of species identification*	**68.0**	**68.4**	**25.0**	**77.4**	**66.7**	**65.6**

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

A total of 611 invertebrate taxa (401 identified to species level) was record in 2020 and stayed at the same overall high level as in the previous year (Table 11.1), despite the absence of benthic experts onboard RV “Johan Hjort” (Table 11.2).

Despite different interannual area coverage, the quantitative distribution of taxa within phyla was very similar in 2019 and 2020 (Fig. 11.1.1).

In 2020 had Mollusca the highest number of taxa (146 taxa) followed by Arthropoda (122 taxa), and Echinodermata (91 taxa) (Fig. 11.1.1 B). Among the mollusks, 51 % of taxa belonged to Gastropoda (75 taxa), 33 % – to Bivalvia (48 taxa), 13 % to Cephalopoda (19 taxa) and the remaining 3 % were distributed between Solenogastres, Polyplacophora and Scaphopoda.

The Artropoda phylum were primarily presented by Malacostraca (77 % of the taxa belonged to Decapods and Amphipods) and Pycnogonida (18 %). Among the Echinoderms the most diverse group was Asteroidea (46 % of taxa).

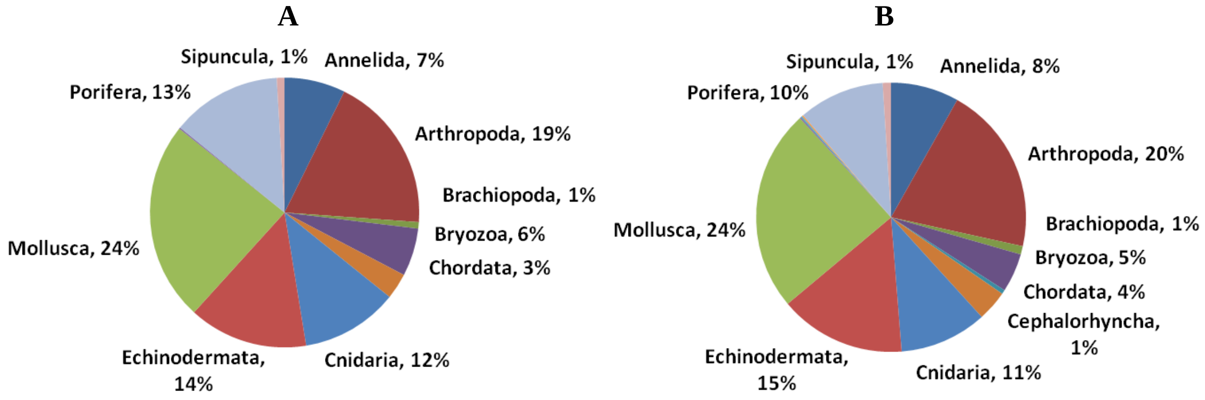

Figure 11.1.1 *The number of taxa give as % among megabenthic phyla in the Barents Sea, August-October 2019 (**A**) and September-November 2020 (**B**)*

The species density in the terms of the number of taxa in standard trawl catches ranged from 1 to 135 with average of 26.8±1.4 taxa per trawl-catch.

The low level of diversity (less than 20 taxa per haul) was recorded in the south-eastern part of the survey area and in the western part of the sea, due to lack of the skill benthos experts onboard the RV “Johan Hjort” (Fig. 11.1.2).

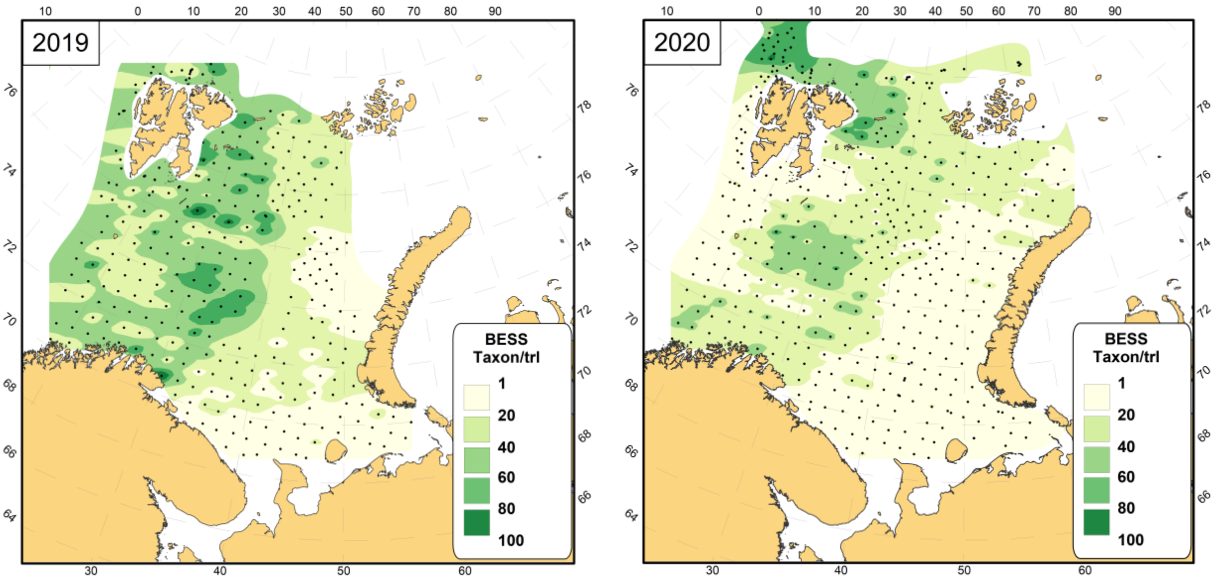

Figure 11.1.2 *The number of megabenthic taxa per trawl-catch in the Barents Sea in August-October 2019 and in August-November 2020*

The most frequently taken species by trawl in the Barents Sea in 2020 were the sea stars *Ctenodiscus crispatus* (taken by 59% of the trawl-hauls), *Pontaster tenuispinus* (43%), and *Icasterias panopla* (29%), the brittle stars *Ophiacantha bidentata* (40%), *Ophiopholis aculeate* (36%), *Ophiura sarsii* (33%), and *Ophioscolex glacialis* (32%), and the decapod crustaceans *Sabinea septemcarinata* (58%), and *Chionoecetes opilio* (33%), and the snail *Colus sabini* (33%).

11.2 Abundance (number of individuals)

The number of megabenthos individuals in the trawl catches (excluding the pelagobenthic species *Pandalus borealis*) ranged from 1 to 265775 (1-288572 ind./n.ml) with an average of 1488±870 ind. per trawl-catch (1719±947 ind./n.ml). This is less than the half of what was recorded in 2019 (Table 11.1). This significant decrease in abundance is mainly observed in the eastern part of the Barents Sea, within Russian sector (Fig. 11.2.1).

The largest catch in number of individuals (about 265.000) included a sea-squirt identified as Ascidiacea g. sp. within the Chordata. This catch was made on the shallow Spitsbergen bank and north of Bear Island in the western part of the Barents Sea (Fig. 11.2.1). The lowest abundances (less than 100 ind. per hall) was recorded in the south-eastern part of the sea within the Russian part of the survey. The two catches with high numbers of Ascidiacea changed the distribution from being dominated by Echinodermata in 2019, to be dominated by Chordata (Ascidicea) followed by Echinoderms in 2020 (Fig. 11.2.2).

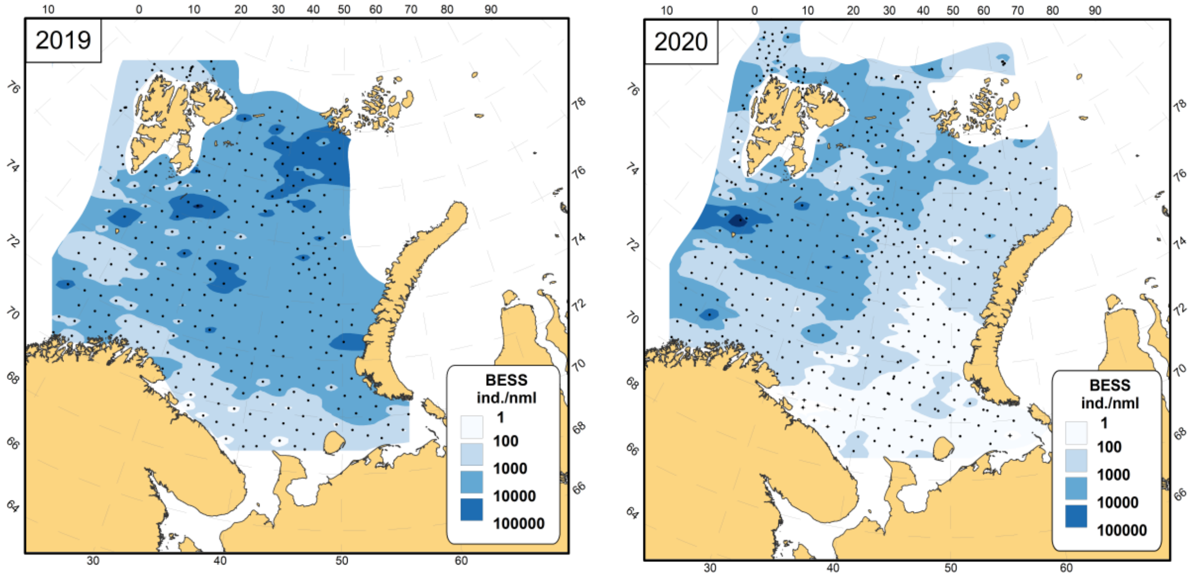

***Figure 11.2.1** The number of individuals of megabenthos (excluding Pandalus borealis) in the Barents Sea in August-October 2019 and September-November 2020*

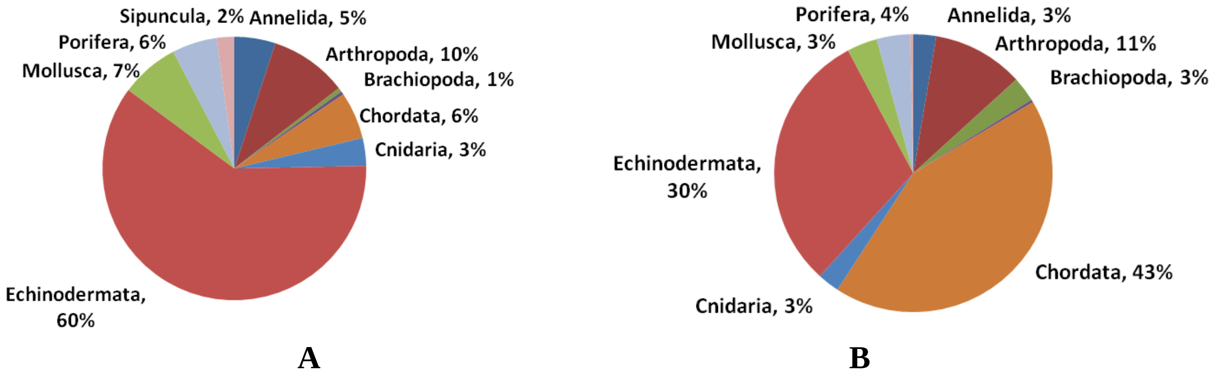

***Figure 11.2.2** Distribution of abundance (excluding Pandalus borealis) across the main megabenthic groups (%) in the Barents Sea, August-October 2019 (A) and September-November 2020 (B)*

The ten most abundant species within the survey area (in the term of total number of ind.trawl catch during BESS 2020) were the sea stars *Ctenodiscus crispatus* (9.4% of total abundance), and *Pontaster tenuispinus* (1.2%), the brittle stars *Ophiacantha bidentata* (3.0%), *Ophiopleura borealis* (2.5%), *Ophiura sarsii* (1.4%), *Ophiopholis aculeata* (1.4%), Brachiopods *Macandrevia cranium* (2.5%), shrimps *Sabinea septemcarinata* (2.4%), sponges of genera *Thenea* (1.2%), and polychaetes *Brada inhabilis* (1.0%).

11.3 Biomass

As in previous years, the main part of the total biomass was pretended by Sponges, Echinoderms, and Crustaceans (total 95 %) in 2020 (Fig. 11.3.1) and the increase in the proportion of sponges (Porifera) resulted from the dense sponge aggregation in the upper part of the continental slope north of Franz Josef Land (north-eastern Barents Sea) covered by the Russian RV "Vilnius" in 2020, and not in 2019.

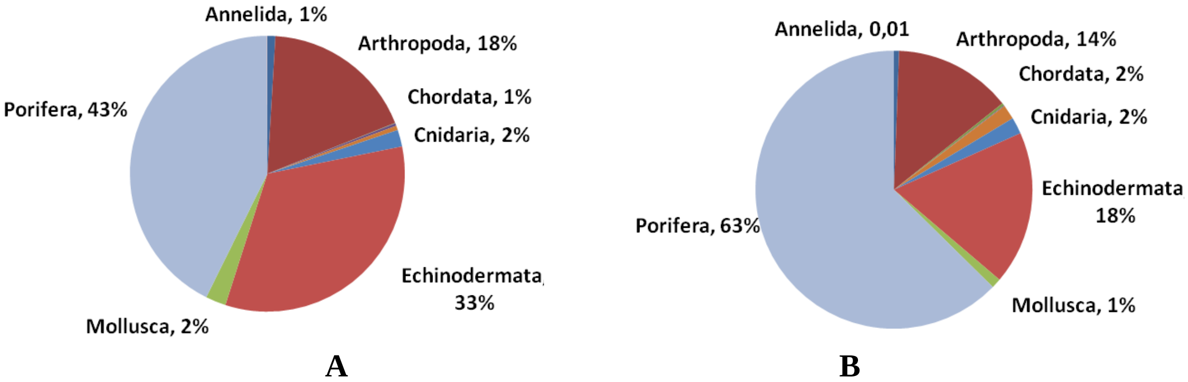

Figure 11.3.1 *Distribution of biomass (excluding* Pandalus borealis*) across the main megabenthic groups (%) in the Barents Sea, August-October 2019(A) and September-November 2020 (B)*

The megabenthos biomass taken by the trawl (excluding the semipelagic species *Pandalus borealis*) in 2020 variate from 0.002 to 1254 kg (0.002-2416 kg/nml) with an average of 20.3±5.6 kg per trawl-catch (30.4±10.5 kg/nml). This was only half the amount of biomass taken in 2019 (Table 11.1). According to Figure 11.3.2 was this decrease in total biomass mainly observed in the eastern part of the Barents Sea within the Russian part of the survey, despite the large sponge catches in the north east.

Trawl catches with biomass of more the 1 t per trawl howl was, as in previous year, observed in the south-western part of the Barents Sea in the depth of 267-329 m (Fig. 11.3.2) and dominated by tree species of *Geodia* sponges (*G. barretti*, *G. atlanthica*, and *G. macandrewii*). A trawl howl of more than 500 kg biomass, dominated by sponges (*G. parva* and *G phlegrae*), was recorded on 617 m depth to north of Franz Josef Land. Patches of high biomass (115-194 kg per hall) north of Bear Island (48-61 m) was mainly dominated by sea cucumber (probably *Cucumaria frondosa*) and sea-squirts.

Nearly half of the megabenthic biomass (47.9%) belonged to the *Geodia* sponges (*G. barretti*, *G. atlanthica*, *G. macandrewii*, *G. parva*, *G phlegrae*, and *G. hentcheli*). Other top-dominant species in biomass was sponges of the genera *Stelletta* (7.7 % of the total biomass), crabs *Paralithodes camtschaticus* (6.3%), and *Chionoecetes opilio* (5.1%), sea-cucumber *Cucumaria frondosa* (3.5%), and the basket-stars of the *Gorgonocephalus* genera (3.4 %).

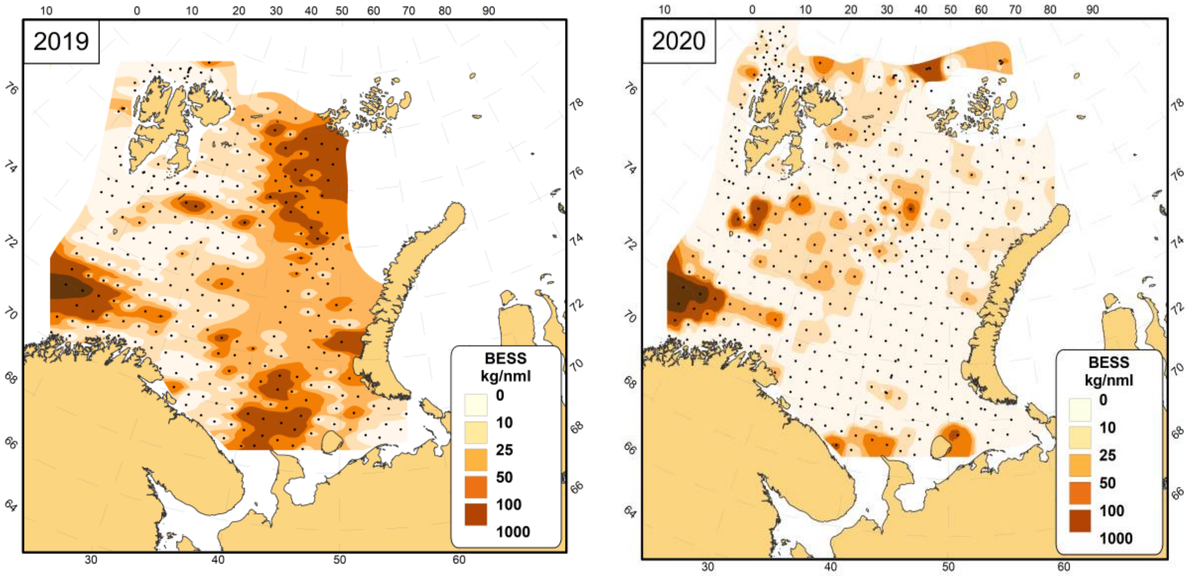

***Figure 11.3.2** Biomass distribution of megabenthos (excluding Pandalus borealis) in the Barents Sea in August-October 2019 and in September-November 2020*

The spatial distribution pattern of the main taxonomic groups in 2020 (Fig. 11.3.3) was similar to 2019 and characterized in biomass by the dominant echinoderms in the north and eastern part of the Barents Sea, of decapods crustatians in central (*Chionoecetes opilio*), and in south-eastern part of the sea (*Paralithodes camtchaticus*, and *Sabinea septemcarinata*). The south-western part of the Barents Sea and the area west and north on the continental slope was characterize by dense aggregations of the Geodiidae and Stellettidae sponges.

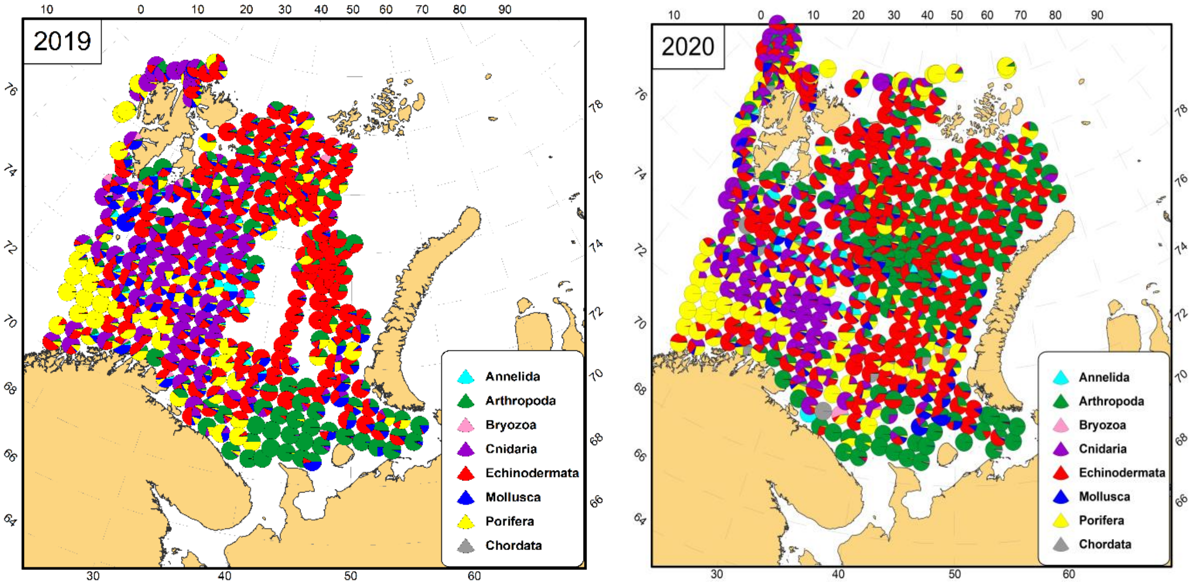

***Figure 11.3.3** Biomass distribution of main taxonomic groups per station in the Barents Sea (excluding Pandalus borealis), August-October 2019 and September-November 2020*

12 MARINE MAMMALS AND SEABIRDS

12.1 Marine mammals

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

During the BESS 2020, marine mammal observers were onboard all Norwegian RVs. The Russian marine mammal observations were carried out by one RV "Vilnius" and therefore the Russian part of the BESS were covered partly. The south-eastern regions of the Barents Sea were not investigated. Additionally, RV "Vilnius" started later than usually, in the end of September. This influences both comparability of the results with previous years as well as synoptic considerations. In total, 4 159 individuals of 12 marine mammal species were observed, of these 169 individuals were not identified to species level. The distributions of marine mammals are given by numbers in Table 12.1.1 and locations in Figures 12.1.1-12.1.2.

As in previous years, white-beaked dolphin (*Lagenorhynchus albirostris*) was one of the most abundant and widely distributed species. More dolphins were recorded north of 74°N compared to the previous year.

Table 12.1.1. *Number of marine mammal individuals observed during the BESS in 2020.*

Name of species	Total	%
Fin Whale	315	7.6
Humpback Whale	308	7.4
Minke Whale	235	5.6
Unidentified whale	37	0.9
White-beaked dolphin	1071	25.7
Harbour Porpoise	5	0.12
Killer Whale	7	0.17
Sperm Whale	7	0.17
White whale	2000	48.1
Unidentified dolphins	132	3.2
Harp Seal	34	0.8
Walrus	1	0.02
Ringed seal	2	0.05
Polar bear	5	0.13
Total sum	4159	100

Besides white-beaked dolphin other toothed whales observed included sperm whale (*Physeter macrocephalus*), harbour porpoise (*Phocoena phocoena*), killer whale (*Orcinus orca*) and white whale (*Delphinapterus leucas*). Sperm whales were observed in the western areas (west of 35°E) of the Barents Sea and at deeper waters at the continental slope. The harbor porpoises were recorded in the southern coastal parts of the research area. A large wintering aggregation (about 2000 individuals with density about 200-300 ind./km) of white whale was observed south of Franz Josef Land (78º 46´N, 45º 39´E) on 08 October 2020. A similar aggregation of these animals was observed by PINRO during an aerial survey in September 2004. However, the aggregation in 2020 was situated further south-east than the earlier observation. Killer whales were recorded close to the white whale aggregation.

The baleen whale species minke (*Balaenoptera acutorostrata*), humpback (*Megaptera novaeangliae*) and fin (*Balaenoptera physalus*) whales were also abundant in the Barents Sea in 2020. The baleen whales were recorded only in the north-west of the Russian study area as a result of lack of coverage in the south and late coverage of the north-eastern Barents Sea.

Minke whales were widely distributed in the western research area. The densest aggregation of minke whale were overlapping with capelin and polar cod concentration in the central areas of the Barents Sea.

As in the previous year, the humpback whale was recorded mainly in the western area, and south-east and east of the Svalbard (Spitsbergen). In 2020, the distribution of this species was wider and humpback whales were also found in the central areas. The higher densities of humpback whales were recorded in areas of high aggregations of mature capelin, and often together with fin and minke whales.

In 2020, the distribution of fin whale in the western areas was similar to the previous year. In the north-eastern regions, this species was recorded eastwards to about 50°E.

Blue whales (*Balaenoptera musculus*) were not observed in 2020, like in previous years.

During the survey, the pinnipeds harp seal (*Phoca groenlandica*), ringed seal (*Phoca hispida*) and walrus (*Odobenus rosmarus*) were observed. The main concentrations of harp seals were found in the area of newly formed ice (northwards of 81°N). Walrus and ringed seal were observed north of 80 °N.

In addition to pinnipeds, 5 polar bears (*Ursus maritimus*) have been recorded north of the Franz Josef Land.

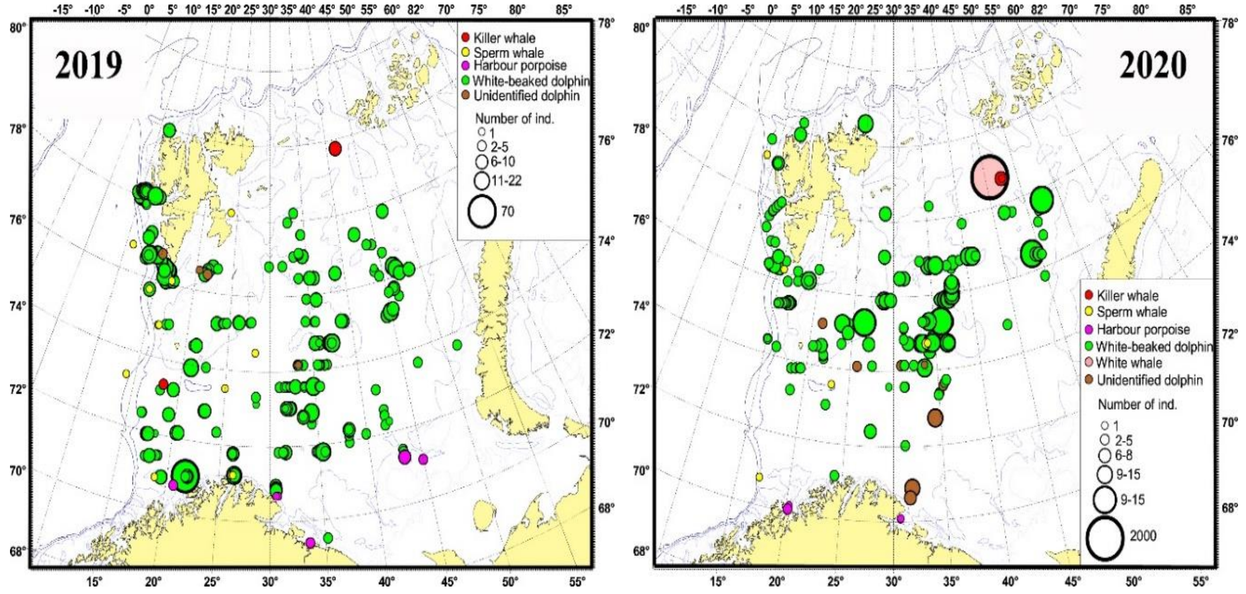

Figure 12.1.1. *Distribution of toothed whales in BESS 2019 and 2020*

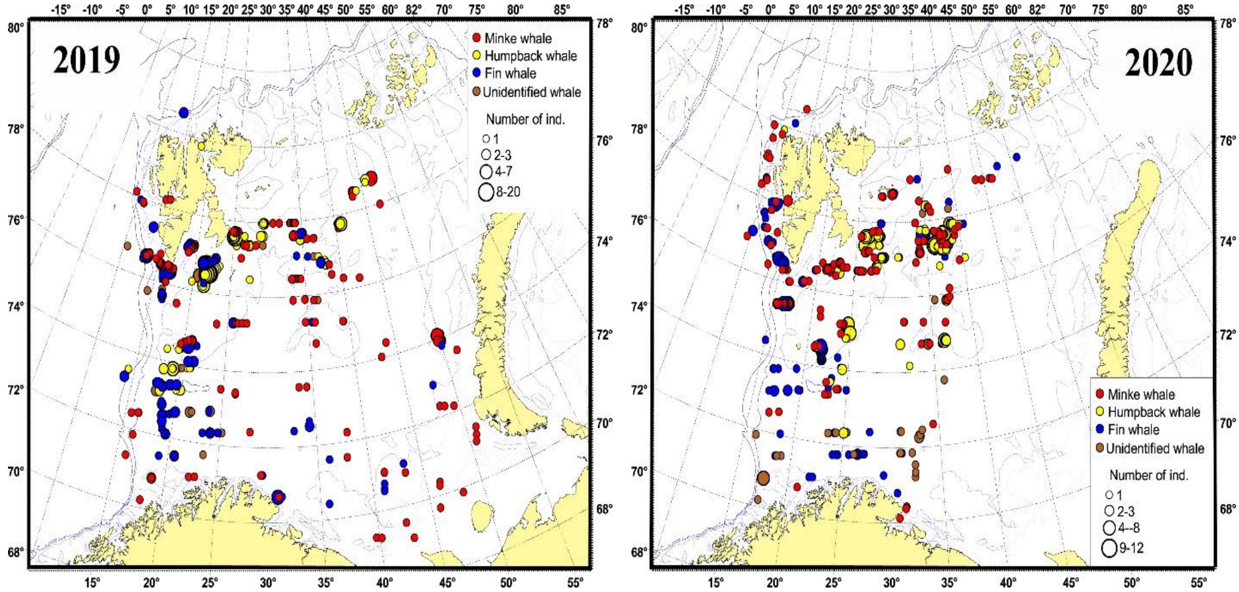

Figure 12.1.2. *Distribution of baleen whales in BESS 2019 and 2020*

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 RVs "Kronprins Haakon", "G.O. 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.

Onboard RV "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 RVs: "Kronprins Haakon", "G.O. Sars" and "Johan Hjort", was 8382 km. Total transect length covered by the RV "Vilnus", was 3437 km. A total of 53 093 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 2019 survey. Alcids were observed throughout the study area but the abundance and species distribution varied geographically. Little auks were found in the far north area between Spitsbergen and Franz Josef Land, Brünnich's guillemots were found in the central and northern part of the Barents Sea, Atlantic puffins (*Fratercula arctica*) were found in the western part and common guillemots (*Uria aalge*) were mainly found in the south. Among the ship-followers, black-backed gulls (*Larus marinus*) and herring gull (*Larus argentatus*) were found in the south. Glaucous gull (*Larus* *hyperboreus*) was found around Spitsbergen and in the south-eastern area. Kittiwakes and Northern fulmars were found throughout the study area, but with highest density of kittiwakes in the eastern and northern areas.

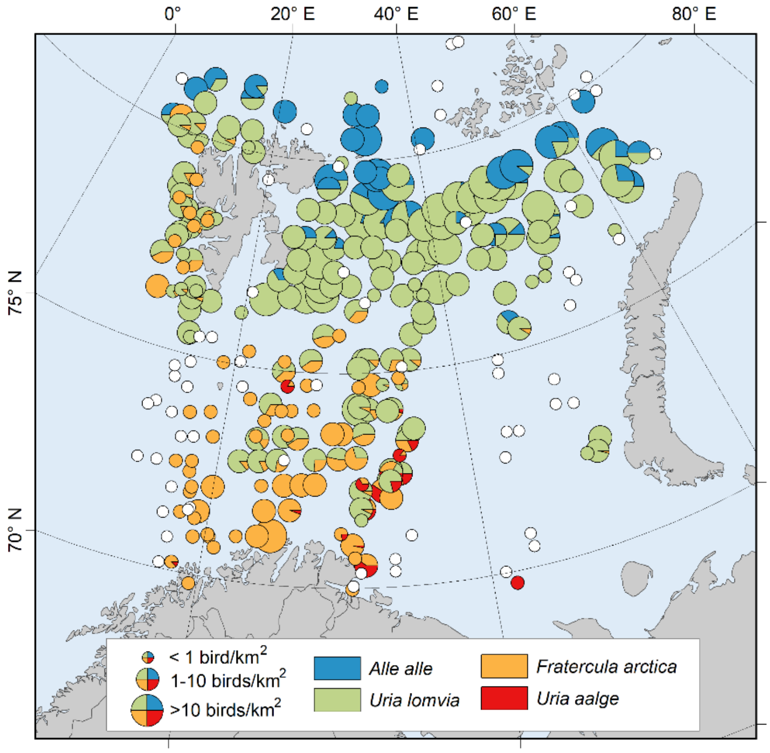

Figure 12.2.1. *Density of auk species along seabird transects in 2020. White circles are zero density.*

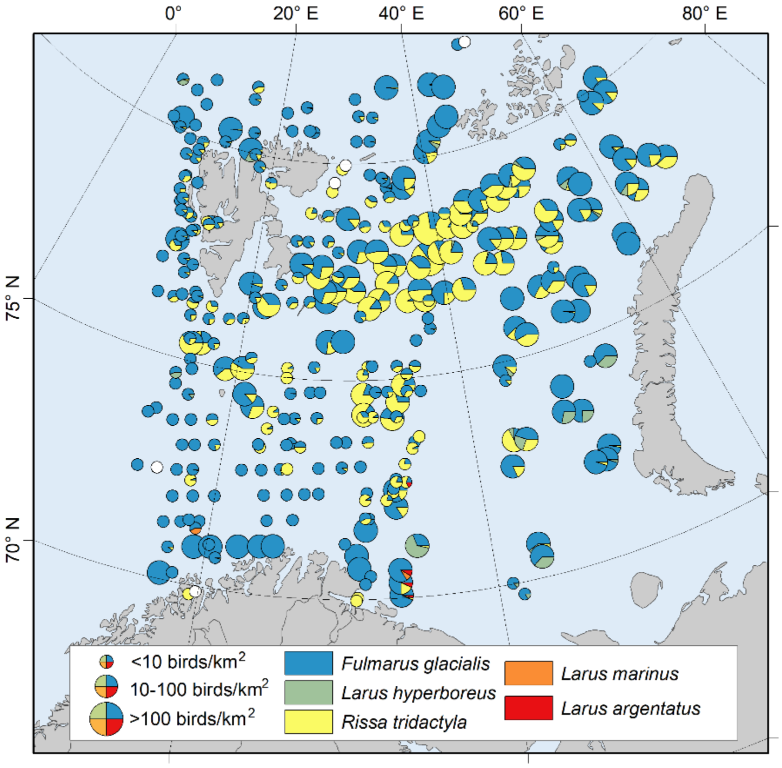

Figure 12.2.2. *Density of the most common gull species and Northern fulmar along seabird transects in 2020. Note that because these species are attracted to and tend to follow the ship, densities are systematically over-estimated.*

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