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Volume 1

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Joint IMR-PINRO report

SURVEY REPORT

FROM THE JOINT NORWEGIAN/RUSSIAN ECOSYSTEM SURVEY IN THE BARENTS SEA AUGUST-OCTOBER 2006

Volume 1

This report is written in memory of our esteemed colleague V.S Mamylov from PINRO who passed away last year. Victor was for many years central to the development and execution of the ecosystem survey and his death is a big loss for PINRO and the IMR-PINRO cooperative investigations.

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PREFACE

The fourth joint ecosystem survey was carried out during the period 8th of August to 5th of October 2006. This survey encompasses various surveys that previously have been carried out jointly or at national basis. Joint investigations include the 0-group survey, the acoustic survey for pelagic fish (previously known as the capelin survey), and the investigations on young Greenland Halibut north and east of Spitsbergen. Oceanographic investigations have always formed a part of these surveys, and studies on plankton have been included for many years. In recent years, observations of sea mammals, seabirds, bottom fishes, and benthos have been included. Consequently, from 2003, these surveys were called “ecosystem surveys”.

The present report from the survey will cover many but not all the aspects of the survey. The main focus is on the hydrographical conditions of the Barents Sea, the results from the 0-group investigations and from the acoustic investigation on pelagic fish (capelin, young herring, blue whiting and polar cod). Preliminary materials on sea mammals and seabird observations are also presented in volume 1 of the report. Results from the investigations on plankton, bottom fishes and benthos will not be fully covered in this volume of the report since the data has not been fully analyzed yet. The complete results from these investigations will be presented in volume 2 of the survey report. The 1st volume of the report was made during a meeting between scientists participating in the survey, in Kirkenes 30th September-04th October.

A list of the participating vessels with their respective scientific crews is given in Appendix I.

Besides the participants on the vessels, the following specialists took part in in preparing the survey report: K. Drevetnyak (PINRO), Yu. Kovalev (PINRO); J. E. Stiansen (IMR), B. Bogstad (IMR), S. Tjelmeland (IMR), A. Dolgov (PINRO).

SYNOPSIS

The main aim of the ecosystem survey was to map the distribution and abundance of the young and adult stages of several demersal and pelagic fish species, and in addition to gather information about hydrographical features, zooplankton, benthos, seabirds and sea mammals.

The water temperature in all observed areas was higher (+0.5-1 °C) than the long term mean and somewhat higher than in the same period 2005.

The 2006 year-class of capelin, haddock, herring, long rough dab and sandeel are rich. 0-group of eastern component of polar cod is near the average level. The 2006 cod and redfish year-class is below than average. 0-group of Greenland halibut, saithe, western component of polar cod, wolffishs and Gonatus were estimated as poor.

The total capelin stock was estimated near 0.8 million tonnes, which is 2.4 times higher than last years estimate. About 0.44 million tonnes were assumed to be maturing.

The polar cod stock was estimated to be 1.9 million tonnes, which is 0.14 million tonnes higher than last year, but by numbers it was two times lower then in 2005.

Juvenile Norwegian spring spawning herring was estimated in the southern part of the Barents Sea to be 0.643 million tonnes.

Blue whiting of age groups 1 to 14 were observed in the western and southwestern parts of the surveyed area, and the biomass of this stock component was estimated to be 0.770 million tonnes.

1 METHODS

Data on cruise tracks, hydrography, trawl catches, integrator values etc. were exchanged by use of e-mail, and these data were used during the day-to-day planning of the survey.

A team consisting of N.G. Ushakov (PINRO) together with E. Olsen and then H. Gjøsæter (IMR) on board “G.O. Sars” conducted a joint leadership over the investigations, undertaking a day-to-day planning of survey grid when necessary.

1.1 Hydrography

The oceanographic investigations consisted of measurements of temperature and salinity in depth profiles distributed over the total investigated area and along the sections Kola, Kanin Fugløya-Bjørnøya, Vardø-N and Bear Island-West. All vessels used CTD-zondes .

1.2 0-group fish investigations

The geographical distribution of 0-group fishes was estimated with a small mesh mid-water trawl (“Harstadtrål”). All vessels, which participated in the survey in 2006, used this type of mid-water trawl which was first recommended in 1980 (Anon. 1983). The standard procedure consisted of tows at 3 depths, each of 0.5 nautical miles, with the headline of the trawl located at 0, 20 and 40 m. Additional tows at 60 and 80m, also of 0.5 nm distance, were made when the 0-group fish layer was recorded deeper than 60m or 80m on the echo-sounder. Trawling procedure was standardized in accordance with the recommendations made in 1980. A smaller sized pelagic trawl was used during the first 20 years of the 0-group investigations. After 1985 the present gear has been used regularly. In the mid 1990s, Nakken and Raknes (1996) recalculated the indices from the first 20 years. Their new indices are based upon an estimate of how many 0- group cod and haddock that would have been caught if the new equipment had been used during the whole period from 1965. The indices of cod and haddock recalculated by Nakken and Raknes (1996) have been incorporated in the 0-group reports since 2001. Prozorkevich (2001) calculated abundance indices for 0-group herring since 1993. A new type of 0-group indices was presented for the first time in volume 2 of the 2004 report (Dingsør 2005). These indices, which are given both with and without correction for capture efficiency, are calculated by the method of stratified sample mean. This new method allows for confidence limits to be calculated, and makes better use of the total data than the indices used hitherto have made. When the new method has been carefully scrutinized and compared to previous methods, the new indices are meant to replace the Area Index after a short period of overlap between the two methods.

Most of the stations this year were taken 35 nautical miles apart. Area based abundance indices (ABI) were estimated by using the computer program Map Viewer. Mean values of abundance indices were calculated both for the period 1985-2006 and for the whole period 1965-2006.

1.2.1 Stratified sample mean estimator

The number of fish per nm^2, $\rho_{s,l}$, at length, l, at each station, s, are estimated by the following equation

$$\rho_{s,l} = \frac{f_{s,l} \cdot Keff}{a_s}$$

where $f_{s,l}$ is the calculated frequency of length l at station s, $Keff$ is the correction functions defined below, and a_s is the swept area found by

$$a_s = \frac{d_s \cdot ws}{1852}$$

where ws is the wingspread of the trawl and is set to 20 m and d_s is the effective trawl distance found as trawl total distance divided on the number of depth steps.

The stratified swept area estimate, is given by

$$\bar{y}_{st} = \sum_{i=1}^{L} A_i \bar{y}_i$$

where L is the number of strata, A_i is the covered area in the i-th stratum, and $\bar{y}_i$ is the average density in stratum i. The estimated variance of the stratified mean $\bar{y}_{st}$ is

$$\mathrm{var}(\bar{y}_{st}) = \sum_{i=1}^{L} A_i^2 \frac{s_i^2}{n_i}$$

where

$$s_i^2 = \frac{\sum_{s=1}^{n_i} (y_{i,s} - \bar{y}_i)^2}{n_i - 1}$$

The standard error of $\bar{y}_{st}$ is given by

$$\mathrm{se}(\bar{y}_{st}) = \sqrt{\mathrm{var}(\bar{y}_{st})}$$

and the confidence limits CL are found by

$$CL = \bar{y}_{st} \pm 1.96 \cdot \mathrm{se}(\bar{y}_{st})$$

The area is stratified by 22 strata (Fig. 2.5). To find the coverage of a stratum, the station positions are loaded into GIS software. A buffer zone of 20 nm is added to the border of the outer trawl points. The conic projection Albers equal-area, with center latitude at 75°N, center longitude at 30°E, and standard latitudes at 70° and 80°N, is used for area estimation.

The sampling trawl is highly selective for 0-group fish according to its species and length. It is possible to estimate the special correction function *Keff* for trawl capture efficiency by regressions on fish densities received during trawling and acoustic registrations of relatively "pure" concentrations. Correction functions for three species types are:

$$Keff_{gadoids} = 17.065 * \exp(-0.1932 * l)$$
$$Keff_{capelin} = 7.2075 * \exp(-0.1688 * l)$$
$$Keff_{herring} = 357.23 * \exp(-0.6007 * l)$$

where l is the length in cm. These correction functions can be applied directly to the observed length frequencies at each station. But since the functions above give unreasonably high numbers as l decreases, it was decided to set for $l < 4$ cm $Keff_{gadoids}$ constant to 8, $Keff_{herring}$ constant to 30 and $Keff_{capelin}$ constant to 4. There is currently no correction function for other fish species.

1.3 Acoustic survey for pelagic fish

The survey area was chosen based on general knowledge of the distribution of the target species, and on information about fish distribution from the first parts of the ecosystem survey.

The main area of capelin distribution was surveyed with course lines 35 nautical miles apart. In area of maximal capelin densities extra tracks were made with course lines about 17 nautical miles apart. All regions of the Barents Sea and adjacent areas of the Norwegian Sea were covered.

All participating vessels used ER-60 echo sounders (with ER-60 software, version 2.1.1). The Norwegian vessels used BEI, while the Russian vessels used FAMAS and BI-60 post-processing system. “G.O. Sars”, “J. Hjort” and “Jan Mayen” were equipped with transducers on adjustable keels that can be lowered in rough weather to avoid the damping effect of bubbles. Echo intensities per nautical mile were integrated continuously, and mean values per 5 nautical miles were recorded for mapping and further calculations. The echograms, with their corresponding s_A-values, were scrutinized every day. Contributions from the seabed, false echoes, and noise were deleted.

The corrected values for integrated echo intensity were allocated to species according to the trace pattern of the echograms and the composition of the trawl catches. Data from pelagic trawl hauls and bottom trawl hauls considered representative for the pelagic component of the stocks, which is measured acoustically, were included in the stock abundance calculations.

The echo sounders were watched continuously, and trawling was carried out whenever the recordings changed their characteristics and/or the need for biological data made it necessary. Trawling was thus carried out both for identification purposes and to obtain biological observations, i.e., length, weight, maturity stage, stomach data, and age.

The vessels gave the s_A-values in absolute terms based on sphere calibrations, that is, as scattering cross section in m^2 per square nautical mile. The acoustic equipment of the vessels was calibrated by standard spheres (see Appendix II).

1.3.1 Area coverage

The weather conditions were favourable during most parts of the survey, and consequently, an almost total coverage of the Barents Sea by a dense survey grid was achieved. Only in areas to the north of 81º N observations were limited by bad weather condition and some planned stations were not made due to incoming ice. In 2006 the survey was started from the south. “Smolensk” and “F. Nansen” worked in the eastern and central parts of the Barents Sea.. “G.O. Sars” and “Johan Hjort” surveyed the western, northwestern and central parts while “Jan Mayen” observed areas around Spitsbergen. See Fig. 2.1-2.4 for details of the realized survey track.

1.3.2 Computations of the stock sizes

The computations of number of individuals and biomass per length-and age group of the pelagic fish stocks were made using the stock size estimation program "BEAM" built on SAS GIS and developed at IMR. A strata system, dividing the Barents Sea in squares of 1º (latitude) x 2º (longitude), was used as basis for the calculation.

The mean s_A-value in each basic square was converted to fish area density ρ_A using the relation

$$\rho_A = \frac{s_A}{\overline{\sigma}}$$

and number of fish was found by multiplying with the area of the square. Numbers were converted to biomass by multiplying with observed mean fish weight in each length group.

The target strength relation for *capelin* is given by:

$$TS = 10 \cdot \log(\frac{\sigma}{4\pi}) = 19.1 \cdot \log L - 74.0$$

corresponding to a σ -value of $5.00 \cdot 10^{-7} \cdot L^{1.91}$

The target strength relation for *polar cod* and *blue whiting* is given by:

$$\mathrm{TS} = 10 \cdot \log(\frac{\sigma}{4\pi}) = 21.8 \cdot \log \mathrm{L} - 72.7$$

corresponding to a σ -value of $6.7 \cdot 10^{-7} \cdot L^{2.18}$

The target strength relation for *herring* is given by:

$$\mathrm{TS} = 10 \cdot \log(\frac{\sigma}{4\pi}) = 20.0 \cdot \log \mathrm{L} - 71.9$$

corresponding to a σ -value of $8.1 \cdot 10^{-7} \cdot L^{2.00}$

1.4 Bottom trawl survey

The number and biomass of fish per length group were calculated from bottom trawl catches using the "swept-area" method with a strata system developed at IMR. Number at age of various groundfish species will be presented in Vol. II of the report.

Acoustic registrations of bottom fish were carried out along all cruise tracks, with division of s_A-values by species based on trawl catches data.

1.4.1 Strata system used

A new strata system was constructed in 2004 covering the whole Barents Sea to include the total survey area. The new geographic system is also depth stratified using GEBCO depth data. Since this is the fourth total coverage of bottom fishes, it is not possible to compare the indices to corresponding indices in years before 2004. However, for the species cod, haddock and Greenland halibut, there are indices from approximately the same period in earlier years, at least for some regions of the Barents Sea. These indices will be presented in Vol. II of the report together with the age-based indices for 2006.

1.5 Plankton investigations

Data on phytoplankton abundance was obtained in several ways during the joint Russian-Norwegian Survey. On the Norwegian vessels G.O. Sars and Johan Hjort samples for chlorophyll ***a*** were obtained at nearly all CTD stations through filtration of water from water bottles at discrete depths from 0 – 100 m including a surface sample taken using a bucket. The total number of samples varied slightly depending on bottom depth at the specific localities. Phytoplankton was filtered using GFC filters, and samples were frozen for later analysis of chl **a** content at the IMR laboratory. For both vessels mentioned above phytoplankton nutrient samples were obtained from the same water bottles on most CTD stations, at depths from the surface to the bottom according to a predefined scheme as determined for the Ecosystem cruise and specific bottom depth of each station. On G.O. Sars a fluorometer was used as an additional instrument, connected to the CTD, logging chl ***a*** fluorescence as a continuous vertical profile along with temperature and salinity for all CTD stations. These data must however be calibrated with the help of chl ***a*** determined from the water bottle samples obtained at the same stations.

Samples for phytoplankton species composition and abundance have been obtained from the Norwegian vessels G.O. Sars and Johan Hjort. For every second or third station quantitative water samples were obtained from water bottles at 5, 10, 20 and 30 m depth. Procedures have been slightly modified compared to 2005. Immediate upon retrieval of the seawater rosette sampler, one 25 ml phytoplankton sample were taken from each bottle at the above mentioned depths. The samples were pooled in a dark light-protected 100 ml flask adding 2 ml lugol as fixative for later analysis. Slightly less frequent a 10 µm meshed phytoplankton net with a 0.1 m^2 opening was vertically operated from 0-30 m to obtain a qualitative phytoplankton sample. If the net itself showed no greenish colour (sign of phytoplankton) after retrieval, it was re-deployed once or twice to obtain a sufficient amount of phytoplankton to trace less abundant, but potentially important species. After gentle mixing of the water from the net cod-end, two dark light-protected 100 ml flasks were filled, each with approximately 80 ml seawater, then adding 2 ml lugol and 2.5 ml 20% formalin for fixation respectively.

Species identification of *Calanus finmarchicus* and its separation from *Calanus glacialis* and *Calanus hyperboreus* are challenging, particularly with regard to younger copepodite stages. On the Norwegian vessel G.O. Sars samples have been collected to address this issue. Individual specimens of the three species (mostly stage IV, V and VI) have been identified and stored on ethanol for later genetic analysis. Bulk samples from the northern (79˚N), central, western and south-western Barents sea have further been collected to act as a reservoir if more specimens should be needed for the planned analyses. The geographic separation of samples will hopefully help to extract clear examples of the target species. On board the Russian vessels information on phytoplankton abundance was obtained through a semi-quantitative approach. The phytoplankton conditions were analyzed from the zooplankton samples by visual estimation of micro-algae concentration and frequency of cell occurrence using a 5-unit scale - single (1) to mass (5) occurrence. Phytoplankton composition was determined to genus. Zooplankton sampling on the Norwegian vessels was carried out by WP-2 plankton nets with a 0.25m^2 opening and 180 µm mesh size. Usually two hauls were made at each station, one was taken from the bottom to the surface and the other one from 100 m to the surface. Additional stratified sampling was carried out daily by the Mocness multinet planktonsampler. No Juday net sampling were conducted from the Norwegian vessels during the joint Ecosystem cruises in 2006, although the aim is to extend the comparison exercises betweeen WP2 and Juday nets using a dual net system. This can hopefully be prepared for 2007. The sampling on the Russian vessels was carried out by Juday-nets with 0.1 m^2 opening and 180 µm mesh size. Depth intervals for plankton sampling were bottom-200m, 200-100m, 100-50m and 50-0m on “F. Nansen” and bottom-100m, 100-50m and 50-0m- on “Smolensk”.

On board the Norwegian vessels samples were normally split in two, one part was fixated in 4% borax neutralized formalin for species analysis and the other one was size-fractioned as follows; >2000 µm, 2000-1000 µm and 1000-180 µm size categories. These size-fractionated samples were weighed after drying at 60°C for 24 hours. Large organisms like medusa, krill, shrimp, fish and fish larvae were counted and their length or size measured separately before drying and weighing.

Processing of Juday net samples from the Russian vessels included preliminary species identification and abundance determination, including wet weight determination of biomass from each haul. A more detailed processing of species and stage composition as well as numerical abundance will be undertaken in the laboratory according to standard procedures. Dry weights will be derived using a conversion factor of 0.2. All zooplankton data will be presented as biomass or numbers per 1 m^2 surface.

Final plankton results will be presented in 2nd volume of the survey report.

1.6 Stomach investigations

According to agreement at the Russian-Norwegian meeting in March 2006 capelin stomachs were collected at the Norwegian (G.O. Sars) and Russian vessels (Smolensk and F. Nansen) in August-September 2006. Near 400 capelin stomachs were collected by Norwegian and Russian vessels. The samples were collected and treated as was discussed at the Meeting in April 2006. All samples were fixated in 4% formalin until later analysis in the laboratory at PINRO. Stomachs will be processed by PINRO zooplankton specialists according to standard procedures. The results will be presented in March 2007.

Also stomach samples of cod were taken according to standard protocol on all participating vessels.

1.7 Sea mammals and birds investigations

Marine mammals and bird observations (species and numbers observed) were recorded onboard the R/V "G.O. Sars", "Jan Mayen" and "Johan Hjort" from the Norwegian side, and onboard "F. Nansen" and "Smolensk" from the Russian side.

Onboard the Norwegian vessels visual observations were made by three observers (one dedicated for collecting sea bird and two for marine mammal observations) simultaneously from the vessel bridges, the marine mammal observers covering a 180° sector (90° each) and the sea bird observer covering one 90° sector. The ship-following sea bird species, such as gulls and northern fulmars, were counted every half hour.

Onboard the Russian research vessels observations of marine mammals and sea birds were carried out by one observer covering a full sector of 360° from the top of the vessel about 12-15 m above the sea surface level.

Observer activity was limited by weather conditions. When the weather conditions were not sufficient for good quality observations (sea conditions more than 6 on the Beaufort Scale or much reduced visibility due to fog or precipitation) searching was not carried out. Observers were actively searching along transects between stations only, and not during station work.

1.8 Benthos observations

1.8.1 Purpose

The purpose of the benthos investigation was to

- Sample material for description of benthic habitats and communities in the Barents Sea from the bycatch of the Campelen trawl, and supply this bycatch investigation with increased mapping by a small 2m Beamtrawl together with video transects at dedicated stations. This should lead to criteria for selection of suitable monitoring locations in the Norwegian EEZ and improved procedures for providing results on benthos relevant for an ecosystem approach to management of marine resources in the Barents Sea.
- To continue established time series of benthic community monitoring by grab (RU and NO) together with Sigsby-trawl (RU) and 2m Beamtrawl (NO) sampling.
- Make a full fauna analyses of "Nucula" (Hydro petroleum investigation)

1.8.2 Criteria for selection of sampling locations

Bycatch of invertebrates were recorded from all bottom trawl hauls of the Russian RV Fritjof Nansen and Smolensk and the Norwegian RV G.O. Sars, Johan Hjort, Jan Mayen. Increased benthic sampling was made on G.O. Sars at stations located as a line from coastal areas of North Cape and north of Hopen dypet. Also the Russian RV Fritjof Nansen had increased benthic mapping. The sampling of the established time series was made at locations already decided by PINRO from previously established monitoring stations.

Selected stations of the “Nucula” field was based on detailed topographic map, whereas VMS satellite tracking data from the Norwegian Fisheries Directorate was used to identify areas with high fishing activity.

1.8.3 Gear and methods

The following gears were used during the ecosystem cruise:

- Video rig (documents epibenthic habitats and megafauna),
- Beam trawl and Sigsby trawl (collect animals that live on the seafloor),
- van Veen grab (provides samples to quantify animals that live upon and in the sediments),

The combination of different sampling gear shall provide a picture of the surface living animals (video and trawl) and animals from inside the sediment (grab).

1.8.4 Bottom trawl

At G.O. Sars the benthic invertebrate bycatch from all hauls with bottom trawl (Campelen) was processed to species level onboard. Species difficult to identify was photographed and preserved in alcohol for later identification. All other animals were made available for MAR BANK for bio-prospecting. The “juvenile-sac” of the Campelen trawl was preserved and brought to Tromsø for later processing.

The other Norwegian vessels sorted and measured the bycatch into large invertebrate groups which consequently was recorded in REGFISK. On the Russian vessels all or some of the bycatch was identified to species or sorted into larger taxa and consequently recorded in BIOFOX. More work need to be done in order to increase the availability to and standardizing benthos data from REGFISK and BIOFOX. The Campelen bottom trawling was lasting approximately 15 minutes and covered 10.000 to 13.000 m^2.

1.8.5 van Veen grab

Quantitative collecting of macro-zoobenthos was carried out with 5 times 0,1 m^2 van Veen grabs at each of the established stations of benthic community monitoring selected by PINRO. The samples were sieved in running seawater using a 1 mm sieve. Sieved bottom organisms with remains of sediments were fixed in 4% neutralized solution of formaldehyde. Borax was used as a buffer. Onboard F. Nansen, dominating species and forms of macro-zoobenthos were recorded in the observation log during sieving and fixing of the samples.

1.8.6 Epibenthos trawls

Qualitative sampling of zoobenthos was carried out with a modified Sigsby trawl (F. Nansen and Smolensk) and a small Beamtrawl (G.O. Sars). The Sigsby trawl had a steel frame of 1x0.35 m. The mesh size of the inner cover in the net was 10 mm, with a cod-end part with 5 mm mesh size knotless netting. The Beamtrawl have an opening of 2 m and a net similar to the Sigsby trawl (inner cover in the net =10 mm mesh, cod-end = 4 mm mesh size).

Trawling duration was set to 5 (Beamtrawl) or 10 min (Sigsbytrawl) at a vessel speed of approximately 1.5 knots. During towing of Beamtrawl and Sigsby trawl a bottom area covering for both gears are corresponds approximately 463 m^2.

The samples were sieved trough 10 mm and 5 mm (F. Nansen and Smolensk) or 5 mm (G.O. Sars) sieves. Organisms collected in the Sigsby trawl were sorted out and processed onboard. Dominating invertebrates were counted and length measured. Organisms that required further taxonomic identification were fixed in 75% ethyl alcohol and 4% formalin for later examination. The samples from the Beamtrawl were fixed on 4% formaldehyde for sorting and identification in the laboratory on land.

1.8.7 Video survey

Video records were provided onboard G.O. Sars with IMR's own tethered video camera (TVC). This is a platform consisting of a video camera with pan and tilt control, two lights, and a metal frame with weights, connected to a cable from the ship. The TVC is deployed while the ship is allowed to slowly drift with the current, and was kept close (1 - 2m) to the seabed for at least 20 minutes at approximately 05 knots. Total observed bottom area during one setting varied between 300-600 m^2 depends of distance from camera to bottom. Logs for the deployments included GMT time, geographic positions, depth and general description of the habitat (substrate type and dominating epifauna) was made simulations.

2 RESULTS AND DISCUSSION

Altogether, the joint survey carried out 205 vessel*days, compared to 208 in 2005 and 215 in 2004. Totally the vessels sailed about 24525 nautical miles alltogether. In total, the Norwegian vessels carried out 571 trawl hauls and the Russian vessels 428 trawl hauls, so in total 999 hauls were made during the survey (while 1108 hauls were made in 2005).

Survey routes with trawl stations; hydrographical stations, plankton stations and benthos sampling stations are shown in Fig. 2.1, 2.2, 2.3 and 2.4 respectively.

2.1 Hydrographical conditions

Figs. 2.1.1-2.1.4 shows the temperature and salinity conditions along the oceanographic sections: Kola, Kanin, Bear Island-West and Bear Island-East. The mean temperatures in the main part of these sections are presented in Table 2.1.1. A new time-series data from Norwegian sections Vardø-North and Fugløya-Bear Island have been continued in this table from last year. Anomalies have been calculated using the long-term mean for the period 1954-1990. Horizontal distribution of temperature and salinity are shown for depths of 0, 50, 100, 200 m and near the bottom in Figs. 2.1.5-2.1.14.

In general the temperature was above the long-term mean throughout the Barents Sea. The surface water temperatures were higher than the long-term mean by 0.5-1.5°C on average in the whole investigated area (Fig. 2.1.15). Maximum positive temperature anomalies were observed to the south and south-east of the Spitsbergen Archipelago, to the north-west of Cape Kanin and to the east of Kolguev Island. However, in some areas in the north-eastern and southern parts of the survey area negative temperature anomalies (down to -0.6°C) were found. In the bottom layer, positive anomalies of water temperature were found practically in all of observed areas except the eastern part, where waters with negative temperature anomalies (down to -1.3°C) were found (Fig. 2.1.16).

The water salinity in the survey area was in general slightly higher (by 0.1 on average) than the long-term mean except for much saltier surface waters in the eastern and northern parts of the Barents Sea, and to the north-west of the Kanin Peninsula also.

The maximal horizontal temperature gradients (0.15°C per nautical mile) were observed to the east of Bear Island in the Polar Front at 50 m depth (Fig. 2.1.17).

There were found positiv temperature anomalies on all the sections. On the Fugløya-Bjørnøya section the highest temperatures and salinities for the whole time series were obtained. The Kola section is divided into three parts. The inner part represents the Murmansk Coastal Current and contains mostly coastal water masses, the central part represents the Murmansk Current and usually contains both coastal and Atlantic water masses, and the outer part represents the Central Branch of the North Cape Current and contains mostly Atlantic water masses. In all three parts of Kola section the temperature anomalies in the 0-50 m layer were 1.0, 1.1 and 1.3°C, respectively. In the 0-200 m layer the corresponding anomalies were 1.0, 1.4 and 1.3°C. The Kanin section is divided into two parts. The inner part represents the

Kanin Current and had temperature positive anomalies of 1.8 and 1.9°C in the 0-50 m and 0-200 m layers, respectively. The outer part represents the Novaya Zemlya Current and had positive temperature anomalies of 1.3°C in the 0-200 m layer. The Bear Island-West Section is divided into three parts representing the middle, east-marine and east-coastal branches of the Norwegian Current. Temperatures in the 0-50, 0-200 m and 0-500 m layers were all high. The anomalies in the first two parts for all three depth layers ranged between 1.1 and 1.5°C. In the east-coastal part the temperature anomalies in the 0-50 and 0-200 m layers were 2.2 and 1.9°C, respectively. The central part of the Bear Island-East Section represents the Northern Branch of the North Cape Current, which mostly contains Atlantic water masses. The temperature anomalies in 0-50 m and 0-200 m layers were 1.1 and 1.3°C, respectively.

Compared to 2005 the surface temperature in southern, eastern and central parts of the sea was lower (on average 0.8-1.8°C), with the highest deviation in the southern part (more than by 2°C lower in 2006). But in northern and north-western parts the surface temperature was higher (on average 1.0-2.0°C), with the highest deviation to the south-east of the Spitsbergen Archipelago (more than by 3°C higher in 2006). The bottom temperatures were between approx. 0.3 and 1.3°C higher in 2006 than in 2005 in most of the Barents Sea except the northern and eastern parts, where waters were colder than in 2005. The water temperature at depths of 50, 100 and 200 m was in general higher in 2006 than in 2005 in most of the survey area.

2.2 Distribution and abundance of 0-group fish.

The distribution of various species of 0-group fish are shown in Figs 2.2.1 – 2.2.9. Area based indices from 1965-2006 are shown in Table 2.2.1. Abundance indices from 1980-2006 are shown in Tables 2.2.2 to 2.2.3. The density grading in the figures is based on the catches, measured in number of fish per square nautical mile. More intensive colouring indicates denser concentrations. The coverage of 0-group fish distributions towards north was good, but the western borders were not found for all the species. Length frequency distributions of the main species are given in Table 2.2.4.

2.2.1 Capelin

0-group capelin were distributed in a much wider area compared to the last years. The distribution and abundance of 0-group capelin has increased in most parts of the Barents Sea. Dense concentrations were found in the central and western parts of the sea and close to Spitsbergen. Scattered concentrations were mainly registered in the south-eastern areas. Nevertheless some dense patches were observed near the coast of Novaja Zemlja. Size of the 2006 year-class is well above the long-term average and the year-class can be characterized as strong.

2.2.2 Cod

0-group cod had the same wide distribution as the previous years with the main distribution in the western part of the sea. Densest concentrations were found in the southwestern part between 12º-32º E. The individual size of the 0-group cod was above the average. Total density decreased significantly compared to the last four years. Abundance of 0-group cod seem to be lesser than in 2004 and 2005 and below the average level. The year-class can be characterized as below average.

2.2.3 Haddock

The 0-group haddock were distributed in the same area as last year. Areas with dense concentrations decreased slightly and they were found in the southwestern part of the sea from 15º E to 36º E, from the coast to 74 º N. There were also found an area with dense concentrations west of Spitsbergen.. The number of 0-group haddock decreased compared to the two previous years, but was well above the average level. The year-class can be characterized as strong.

2.2.4 Herring

Compared to the previous year the 0-group herring were found closer to the coast from 15º E to 40 º E with densest concentrations from 20 º E to 35 º E . Small scattered areas were found around Spitsbergen. The 2006 year-class of herring seems to be strong, however, smaller than the 2004 year-class, but well above the level of the 2005 year-class.

2.2.5 Polar cod

The eastern component of polar cod had almost the same distribution as in 2005 but with larger areas with high density. The distribution of 0-group polar cod seems to extend even further north than the survey area. However, the abundance index of eastern polar cod is higher than what was found last year and close to the long-term average level.
The western component of 0-group polar cod was distributed in a smaller area with lower density than last year. The 2006 year-class of the western component of polar cod is below the average level.

2.2.6 Saithe

The 0-group saithe were found in a smaller area than previous year. Most of the saithe was found in the south-western part of the area in scattered concentrations. The 2006 year-class is below the long-term average and can be characterized as weak.

2.2.7 Redfish

A significant increase in the number of 0-group redfish was seen this year. Both the total distribution and the area with dense concentration increased. Most of the redfish were found in the western part of the Barents Sea and to the west and north of Spitsbergen. The number of 0-group redfish is the highest compared to the last ten years but some below the long-term average.

2.2.8 Greenland halibut

As in 2005, 0-group Greenland halibut were found only in low concentrations to the west, south and north of Spitsbergen. The 0-group index is lesser than average and the 2006 year-class of Greenland halibut seem to be poor.

2.2.9 Long rough dab

Compared to the two previous years a gradual increase in the total distribution of 0-group long rough dab was observed. 0-group long rough dab was found mostly in scattered concentrations from the south-eastern coast of Spitsbergen across the Barents Sea to the south-eastern areas. Some small areas with dense concentrations were observed in south-eastern part. The 2006 year-class is slightly above the long term average.

2.2.10 Wolffish

0-group wolffish were only found in scattered concentrations around Spitsbergen. It seems to be a poor year-class. No index is calculated for these species. Due to that only a few scattered areas with 0-group wolffish were found.

2.2.11 Sandeel

The main distribution of this species is found in the south-eastern part of the Barents Sea. Here the area of distribution has increased significantly compared to last years. However, this seems to be a species which increasing importance in the Barents Sea and smaller areas with dense concentrations were also found in the central and western parts of the sea. The year-class seems to be strong, but no index is calculated for this species.

2.3 Distribution and abundance of pelagic fish

2.3.1 Capelin

2.3.1.1 Distribution

The geographical density distribution of the total stock and for age 1 fish is shown in Figs. 2.3.1 and 2.3.2. Total distribution of capelin was located in the central parts of the Barents Sea and to the west of Spitsbergen. The main concentrations were found between 74º40’ and 77°20´N and from 26° to 42°E. Small isolated areas with very scattered echo recordings were located to the west of Spitsbergen and near 79ºN, 35ºE. The northern boundary of the main distribution area was located near the same latitude as it was found last year and extended north to 79°N to the east of Spitsbergen. Young capelin were distributed mainly to the south of 76°N in scattering layers near the bottom at daytime and near surface during night. In south-eastern part there were often caught significant quantity of young capelin, where echo-recordings were absent. (See section 3).

Echogram of capelin distribution is shown in Figure 2.3.3.

2.3.1.2 Abundance estimate and size by age

A detailed stock size estimate is given in Table 2.3.1, and the time series of abundance estimates is summarized in Table 2.3.2. The main results of the abundance estimation in 2006 are summarised in the text table below. The 2005 estimate is shown on a shaded background for comparison.

Summary of stock size estimates for capelin

Year class		Age	Number (10^9)		Mean weight (g)		Biomass (10^3 t)	
2005	2004	1	60.1	26.9	4.8	3.7	289.0	99.6
2004	2003	2	21.7	13.0	16.1	14.3	348.6	185.9
2003	2002	3	5.6	1.8	24.8	20.8	138.2	36.8
2002	2001	4	0.3	0.07	30.6	25.8	10.5	1.7
Total stock in:								
2006	2005	1-4	87.7	41.8	9.0	7.8	786.4	324.0
Based on TS value: 19.1 log L – 74.0, corresponding to $\sigma = 5.0 \cdot 10^7 \cdot L^{1.91}$								

The total stock is estimated at about 0.8 million tonnes, about 2.4 times higher than the stock estimated last year. About 56% (437 thousand tonnes) of this stock is above 14 cm and considered to be maturing. The 2005 year class (1-group) consists, according to this estimate, of about 60 billion individuals. This estimate is about 2.2 times higher than that obtained for the 1- group last year. The mean weight is estimated at 4.8 g, which is 1.3 g higher than that measured last year, and the long-term average. The biomass of the 2005 year class is about 0.29 million tonnes. It should be kept in mind that, given the limitations of the acoustic method concerning mixed concentrations of small capelin and 0-group fish near-surface distribution, the 1-group estimate might be more uncertain than that for older capelin.

The estimated number of fish in the 2004 year class (2-group) is about 22 billion, that is about 1.6 times higher compared of the 2003 year class measured last year. The mean weight at this age is 16.1 g (14.3 g in 2005), and consequently the biomass of the two years old fish is about 0.35 million tonnes. The mean weight is higher than in recent years and is 5.7 g above the long-term average (Table 2.3.2).

The 2003 year class is estimated at about 5.6 billion individuals with mean weight 24.8 g, giving a biomass of about 0.14 million tonnes. The mean weight is on 4 g higher than that for the 2005, and is 6.2 g above the long-term average. The 2002 year class (now 4 years old) is estimated at 0.03 billion individuals. With a mean weight of 30.6 g this age group makes up only about 10.5 thousand tonnes. A few capelin older than four years were found.

2.3.1.3 Survey mortality

Table 2.3.3 shows the number of fish in the various year classes, and their “survey mortality” from age one to two. As there has been no fishing on these age groups, the figures for total mortality constitute natural mortality only, and probably reflect quite well the predation on capelin. As can be seen from the table, the mortality was high prior to 1988, but then a substantial decrease occurred in 1988-89. This coincided with a considerable increase in the stock size caused by the rich 1989 year class. From 1990, the mortality again increased, up to 85% in 1992-93. This increase is in accordance with the observation of an increasing stock of cod, which were preying on a rapidly decreasing stock of capelin. The mortalities calculated for the period 1996-2002 varied between 20 and 52% and indicate a somewhat lower level of mortality. In 2003 a considerable increased natural mortality was observed, at the level (around 85%) observed in 1985-86 and in 1992-93 and this high level was continued from 2003 to 2005. In 2006, the natural mortality decreased to 19.3%. The results of the calculation for the year classes 1988, 1992, and 1994 shows, however, that either the one-group are underestimated or the two-group is overestimated these years. Knowing that the measurement of the 1-group is more uncertain than the older age groups due to limitations in the acoustic method, the first mentioned possibility is the most probable.

2.3.2 Polar cod

Compared to recent years, the polar cod distribution was almost completely covered. The geographical density distribution of the total stock and for age 1 fish are shown in Figs. 2.3.4 to 2.3.5. The main concentrations were found along west and south coast of Novaja Zemlja. Only in the north-eastern areas a definite boundary of the polar cod distribution was not allocate. During the trawl survey for Greenland halibut in the areas around Spitsbergen considerable amounts of polar cod was caught by bottom trawl in the studied areas. Towards Frans Josef Land it was found only in scattered concentrations. This situation is common during the autumn, when the polar cod stock is widely distributed in the northern part of the Barents Sea.

2.3.2.1 Distribution

The densest registrations of polar cod were found in a wide area along Novaja Zemlja between 74º and 76°30´N and from 75º to 78°N between 40° - 45°E. Local concentrations were also observed near 76ºN and 47º15´E and along south coast of Novaja Zemlja between 53º-56ºN. In western and northern fjords of Spitsbergen there were also rather dence concentrations also. This species had a wide distribution, mainly to the east of 37ºE. Figure 2.3.6 shows typical acoustic registrations of polar cod.

2.3.2.2 Abundance estimation

The stock abundance estimate by age, number, and weight was calculated using the same computer program as for capelin.

A detailed estimate is given in Table 2.3.4, and the time series of abundance estimates is summarized in Table 2.3.5. The main results of the abundance estimation in 2006 are summarized in the text table below. The 2005 estimate is shown on a shaded background for comparison.

Summary of stock size estimates for polar cod

Year class		Age	Number (10^9)		Mean weight (g)		Biomass (10^3 t)	
2005	2004	1	16.2	71.7	11.2	8.7	180.8	626.6
2004	2003	2	45.1	57.1	28.3	18.0	1277.4	1028.2
2003	2002	3	12.1	3.7	36.9	32.5	445.9	120.2
2002	2001	4	0.7	0.2	51.6	43.6	37.2	7.6
Total stock in								
2006	2005	1-4	74.0	132.9	26.2	13.6	1941.2	1803.3
Based on TS value: 21,8.1 log L – 72.7, corresponding to $\sigma = 6.7 \cdot 10^7 \cdot L^{2.18}$								

The number of individuals in the 2005 year-class (the one-year-olds) is about 73% lower than the one- group measured last year. Therefore, the biomass of the 2005 year-class is 3.5 times lower even though their mean weight is about half times higher than of the one-year-olds measured last year. The abundance of the 2004 year class (the two-year-olds) is 45.1 billions. This is almost 21% lower than the two-group found last year but on 10 g mean weight was higher. The biomass has, therefore, increased 1.2 times compared to the 2002 year-class estimated last year. The three-years-old fish (2003 year class) is about 12.1 billions that is 3.3 times larger than the three-group estimated last year and has 4.4 g higher mean weight. Consequently, the biomass of this age group has increased on 3.7 times compared to that for the corresponding age group during the 2005 survey. The four-year-olds (2002 year class) are scarcely found but some larger than in last year. The total stock, estimated at 1.9 million tonnes, is at the same level as in 2005 and 2001 and corresponds to stable population condition.

2.3.2.3 Survey mortality

Table 2.3.6 shows the “survey-mortality rates” of polar cod in the period 1985 to 2006. The mortality estimates are unstable during the whole period. Although unstable mortalities may indicate errors in the stock size estimation from year to year, the impression remains that there is a considerable total mortality on young polar cod. Prior to 1993, these mortality estimates represent natural mortality only, as practically no fishing took place. In the period 1993 to 2005 catches were at a level between 0 and 50 000 tonnes. Since there has been a minimum landing size of 15 cm (from 1998, 13 cm) in that fishery, a considerable amount of this could consist of two- and even one-year-olds, and this may explain some, but only a small part of the high total mortality. From 2003 to 2004 there are negative survey mortalities both for age groups 1-2 and for 2-3, confirming the impression expressed in the 2003 report that the 2003 estimate for various reasons was an underestimate. In 2006 in both age groups (1 - 2 and 2 - 3) survey mortality of polar cod was near 7% lower than it was found in previous year.

2.3.3 Herring

The youngest age groups (age 0+ to 3+) of the Norwegian spring spawning herring stock are found in the Barents Sea at irregular intervals. It is difficult to assess the stock size during autumn, due to various reasons. The age groups 1-3 are found mixed with 0-group herring and other 0-group fish, and these age groups are difficult to catch in the sampling trawl used during this survey. Besides, the herring schools are partly found near the surface, above the range of the echo sounders. The stock size estimates of herring are therefore considered less reliable than those for capelin and polar cod.

2.3.3.1 Distribution

The distribution of young herring is shown in Figure 2.3.7. Herring was divided into eastern and western components. Eastern juvenile herring with predominance of 2 year olds were distributed over a large area between 22°- 45°E and up to 74°N. West of 22°E 3 year olds and older herring dominated. The aggregations with highest density of young herring were recorded in the southern part of the sea between 22°- 33°E and 38º-45ºE. East of 46°E herring were not found, in contrast to in 2005. The distribution area of herring in 2006 resembles that of the past few years.

2.3.3.2 Abundance estimation

The estimated number and biomass of eastern (east of 22°E) herring from the Barents Sea per age- and length group is given in Table 2.3.7. The main results of the abundance estimation in 2006 are summarised in the text table below. The 2005 estimate is shown on a shaded background for comparison.

Summary of abundance estimates of the portion of the herring stock found in the Barents Sea.

Year class		Age	Number (10^9)		Mean weight (g)		Biomass (10^3 t)	
2005	2004	1	1.6	46.4	21.1	21.2	34.2	983.7
2004	2003	2	5.5	16.2	72.0	65.2	398.4	1054.5
2003	2002	3	1.3	7.0	121.8	114.0	152.3	795.2
2002	2001	4	0.4		157.1		58.2	
Total stock in:								
2006	2005	1-3	8.8	69.5	73.3	40.8	643.0	2833.4
Based on TS value: $20.0 \log L - 71.9$, corresponding to $\sigma = 8.1 \cdot 10^{-7} \cdot L^{2.00}$								

Total abundance was estimated at 8.8 x 10^9 fish and biomass at 0.64 x 10^6 t. The majority of fish (about 63 % by number) was from the 2004 year-class. But from the last year this initially rich year-class decreased about 88%. The 2003 year-class also decreased by 92% since last year. The majority of the2002 year-class has probably left the Barents Sea, and only small amounts of four-year-old herring were detected. The biomass of young herring was 23 times lower than last year. The drastic reduction of young herring detected is probably too large to be explained by natural mortality only. An overestimation in 2005 or an underestimation in 2006 seems likely, but this is at present unknown. Another possible evidence of decreasing young herring is in their migration out from the Barents Sea due to maturation.

2.3.4 Blue whiting

In the southwestern part of the Barents Sea blue whiting were observed. In recent years, the blue whiting have seemingly expanded its distribution area towards northeast, partly entering the Barents Sea. Since this species is now a major component of the Barents Sea ecosystem, a quantitative estimation of this species has been attempted during the previous two surveys, although only a small part of the total distribution area of this species is covered. The target strength used for blue whiting is uncertain, and the estimate should to a greater extent than the other estimates be considered as a relative quantity only.

2.3.4.1 Distribution

The distribution of blue whiting (all age groups) is shown in Figure 2.3.8. As in 2005 the distribution area stretches from the western border of the covered area east to a line between North Cape and Spitsbergen. In addition, lower concentrations were detected along the coast of Finnmark east to Vardø.

2.3.4.2 Abundance estimation

The estimated number and biomass of blue whiting per age- and length group is given in Table 2.3.8. Total abundance was estimated at 8.1 x 10^9 fish and biomass at 0.77 x 10^6 t, compared to 1.4 x 10^6 t in 2004 and 1.1 x 10^6 t in 2005. As in last year the main bulk of this stock component consisted of 2000-2004 yearclasses at age 2-6. Older fish at age 7-10 were found in small quantites and insignificant numbers of fish up to 14 years of age were found.

2.3.5 Sandeel

2.3.5.1 Distibution

Compared to previous years ingridibal increasing of sand eel distribution was obsered in south-eastern and central parts of the Barents Sea. Both dence and scattered concentrations of 0-group and older fish were found from 69˚ to 70˚ N between 42˚-55˚ E and from 72˚30´ to 75˚30´ N between 21˚-32˚ E. Some dence concentrations were observed cloused to Varanger peninsula coast also (Fig. 2.3.9). Maximal their catch consisted of 11.3 thousand specimens per 1 nm. Most of 0-group sandeel were with length of 1-8 cm (mean length 3.9 cm). Length of older fish was 4-13 cm (mean length 10.8 m).

Due to absent of target strength of sand eel calculation of abundance estimation were not made.

2.4 Demersal fish

Figures 2.4.1-2.4.12 shows the distributione of demersal fish. Appedix 4 lists the numer of fish sampled during the survey. Biomass age-based assessments will be included in Vol. 2 of the survey report.

2.4.1 Cod (Fig. 2.4.1)

The total distribution area of cod in the Barents Sea was covered. At this time of the year, towards the end of the feeding period, the distribution of cod is wide. Cod reach the limits of its natural habitat and single fishes were caught as far north as 80-81° N. Two main concentrations were observed; one in the south-eastern areas from Murman Shallow to the slope of Goose Bank and Novaya Zemlya archipelago, and the other in the northern area south-eastwards and eastwards of Spitsbergen archipelago. Compared to the observations last year very small changes were found in the distribution patterns in 2006

2.4.2 Haddock (Fig 2.4.2)

The haddock distribution was covered well by the survey. Haddock were distributed in the warm water masses and along the coast of Norway and Russia between 17-47°E and to a lesser degree to the west of Spitsbergen. Dense concentrations were found between 35-44°E along Murman Coast and to the north of Norwegian coast. The catches of haddock as well as the distribution area increased considerably in 2006 comparing to the surveys in 2004 and 2005.

2.4.3 Saithe (Fig 2.4.3)

Saithe were distributed in the warm water masses and along the coast of Norway and Russia between 18-40° E. Compared to the survey in 2005, the distribution area with the highest densities moved westwards in 2006.

2.4.4 Greenland halibut (Fig 2.4.4)

Mainly young age groups of Greenland halibut were observed because the adult part of the stock was distributed outside of the survey area. Main concentrations were located in the deeper part of the Spitsbergen slope and in the area between Spitsbergen and Franz Josef Land archipelago, as well as between Bear Island and Hopen Island. Catches of Greenland halibut were taken as far east as 51° E and north as 81°15' N. The catches of Greenland halibut in 2006 increased in the area east of Spitsbergen compared to the survey in 2005.

2.4.5 Redfish (*Sebastes marinus*) (Fig. 2.4.5)

Sebastes marinus were distributed mostly in southern part of the Barents Sea from coastal areas until 74°30′ N between 24°-37° E. To the west of Spitsbrgen until 79° N only very scattered concentrations were registered.

2.4.6 Redfish (*Sebastes mentella*) (Fig. 2.4.6)

Sebastes mentella were mainly distributed in the western and north-western parts of the survey area. Most dense concentrations were located along the shelf slope from the Norwegian coast to west of Spitsbergen until 79°30′ N. Some scattered catches were even at 81°15′ N to the north of Spitsbergen. To the east of 37° E redfish were not found.

2.4.7 Long rough dab (Fig. 2.4.7)

The distribution of long rough dab was wider than the distribution of other species. It was practically found in all areas, and its catches were quite significant in most cases. Catches of LRD were taken as far east as 60° E and north as 81° N.

2.4.8 Wolffishes (Fig. 2.4.8-2.4.10)

Total distributions of each taken separately wolffishes were near the same as observed in previous year. However the catchrates of wolffishes were larger than last year in the whole distribution area but in not big quantities.

2.4.9 Non-target species (Figs 2.4.11-2.4.12)

A list of all fish species caught in the survey is given in Appendix 4. Two species were chosen as indicator species to demonstrate the distribution patterns of fishes from the different zoogeographic groups, the thorny skate *Amblyraja radiata* and Norway pout *Trisopterus esmarkii*. More detailed descriptions will be found in volume two of the survey report.

2.4.9.1 Thorny skate (Fig. 2.4.11)

The species was widely distributed in the Barents Sea excluding the northern areas near Franz Josef Land archipelago, as well as the north-western Norwegian coast. The biggest catches were observed in the central part of the Barents Sea, in the area between Spitsbergen and the Bear Island as well as in the southeastern part of the Barents Sea near the Kanin Peninsula.

2.4.9.2 Norway pout (Fig 2.4.12)

The species was distributed only in the southwestern part of the Barents Sea near Norway and to a lesser extent along the Murman coasts. Its distribution is similar to the distribution of the warmest Atlantic water, but the catchrates were higher in 2006 than in previous years. Single specimens were found near the southern coast of Spitsbergen.

2.5 Phytoplankton

Data on fluorescence, chlorophyll **a**, nutrients and phytoplankton species composition data are now being processed and analyzed at the IMR laboratory. A summary and some preliminary results will be available for volume 2 of the report.

2.6 Zooplankton

The map of zooplankton sampling localities and sampling gear (Russian and Norwegian vessels) is shown in figure 2.3. The main results of zooplankton observations will be presented in volume 2 of Joint Ecosystem Survey Report after working up data in the laboratories.

From figure 2.3 it is apparent that the investigated area is covered reasonably well as seen from a zooplankton point of view. The table below gives an overview of total standard zooplankton hauls for different types of zooplankton sampling gear during the Ecosystem survey. A total of 26 zooplankton samples were analyzed with respect to species composition and abundance onboard Johan Hjort and G.O. Sars during the Ecosystem cruise 2006. Additionally near bottom plankton samples were taken by special plankton net attached on upper part of bottom Campelen trawl on Smolensk and F. Nansen (analogue of Juday net with opening diameter of 500 cm and mesh size of 564 μm).

Total number of standard zooplankton hauls obtained during the Norwegian and Russian surveys in the Barents Sea in August-October 2006

Type of gear	Norwegian vessels		Russian vessels	
	«G.O.Sars»	«J.Hjort»	«F.Nansen»	«Smolensk»
WP-2	195	93	-	-
Juday	-	-	121	37
MOCNESS	93	28	-	-

Juday net samples were not collected from the Norwegian vessels G.O. Sars and Johan Hjort in 2006. Species composition, abundance and biomass from WP2 and Juday nets collected at the same stations in 2004 and 2005 have been partly analyzed and compared. Preliminary analysis has shown a significant variability in stage composition of key species of *Calanus*. A more extensive comparison and analysis are now being undertaken based on data from 2004 and 2005, including Russian data from 2006 where they exist to help quantify this variability. The agreement on comparative collection of zooplankton samples by WP-2 and Juday net on Norwegian and Russian vessels (c.f. Meeting in April 2005/May 2006) will be followed up by both parties with regard to working up samples, exchange of raw data, analysis and publication in relevant reports, symposia or international refereed journals. It is suggested that current and past effort is strengthened with additional sampling and also new approaches in future surveys with the ultimate goal of a unified sampling approach.

It is recommended for 2007, based on experience during field sampling in 2005 and from preliminary comparisons based on data from 2004, that a Bongo-like rig should be built that can hold both a WP2 and a Juday net for better performance and more efficient comparisons between the sampling gear. This way the problems concerning variability between consecutive net hauls can be reduced.

To better address issues on the population characteristics of dominant *Calanus* copepod species in general and the Barents Sea in particular, key zooplankton samples were obtained by WP2 nets from RV G.O. Sars. Individual specimens and bulk samples of three *Calanus* species (stage IV-VI) have been fixated in absolute alcohol (ethanol) to be analyzed by genetic techniques. Individual specimens of *C. finmarchicus* sampled from the central southern Barents Sea have also been stored on RNA-later, an aqueous tissue storage reagent that stabilizes and protects cellular RNA. Preliminary qualitative inspection of the samples from the central part of the Barents Sea, already demonstrate the presence of a mixture of *C. glacialis* and *C. finmarchicus* that is hard to separate with conventional methods.

2.7 Sea mammals and birds

A total of 455 observations of 1,766 thousands individuals of marine mammals comprising 18 identified species were recorded from the research vessels “Johan Hjort”, “G.O. Sars”, “Jan Mayen, “F. Nansen” and “Smolensk”. In addition two observations of 3 polar bears were made west of Franz Josef Land and one observation of a basking shark was made southwest of Bear Island, the latter being one of the most northerly records made of this species. The numbers of individuals observed by species are listed in Table 2.7.1. The most abundant species in terms of individuals were the white-beaked dolphins (53% of total number of individuals observed), which were observed over large parts of the surveyed area but predominantly in the southern and eastern Barents Sea. Its sibling species, the white-sided dolphin which is usually considered a more oceanic species, was also recorded with a few observations in the southeastern Barents Sea. These dolphins usually occur in groups of 5-15 individuals which often show ship-seeking behaviour. In the southeastern Barents Sea a couple of rare observations were made of common and striped dolphins, which are both thought to be associated with warmer water and represent occasional occurences in northern waters due to influx of warm water masses.

Of the baleen whales (24% of the total number of individuals observed), fin and humpback whales were most numerous (Table 2.7.1). Humpback whales were observed west of Spitsbergen and in the Bear and Hopen Islands areas. Fin whales were observed in shallow areas or along shelf slope to the west of Spitsbergen, and otherwise in the central and northern Barents Sea. Minke whales were observed throughout the survey area but apparently in lower abundances than is usually the case at this time of the year (Fig. 2.7.1). One observation of the rare bowhead whale was recorded in the northern part of the Barents Sea. Last year several sei whales were observed west and east of Spitsbergen and in the central Barents Sea, however, this year only one individual was identified to the west of Spitsbergen. Blue whales were observed west of Spitsbergen. This is now an area where blue whales seem to visit quite regularly.

A few sperm whales were observed along the continental slope towards the Norwegian Sea. A group of white whales was observed in the southeastern Barents Sea.

Harp seals and walruses were observed north of Spitsbergen, which are their expected main distributional area at this time of the year. However, the number of harp seals recorded this year was much less than last year when very large groups were met with.

About 26000 sea birds from 26 different species were recorded onboard the vessels “G. O. Sars”, “Johan Hjort”, “Jan Mayen” and “Nansen” (Table 2.7.2). Northern fulmar was the single most observed species comprising 51% of all observations. Northern fulmar and the gull species follow the ship, especially after trawling. The dominance of these species in terms of abundance is therefore probably over-estimated (see table). The ship followers were counted as point observations every ten minutes. The other species were counted continuosly along strip-transects when the ship steamed with a constant speed and direction.

The alcids were observed throughout the study area, but the abundance and species distribution varied geographically. Brunnich’s guillemot was the most common alcid species. Highest concentrations of alcids were found in the northeastern area. This was due to huge concentrations of Brünnich’s guillemots. In the southern Barents Sea puffins and common guillemots dominated while little auks and brunnich’s guillemots were found in the north. Little auks had generally a more western distribution than the Brunnich’s guillemots.

Northern fulmars were observed in most of the study area, however, highest concentrations were found in the western part. Kittiwakes dominated the abundances in the northern areas. Great black-backed gulls and herring gulls were observed in the southern Barents Sea. A few Glaucous gulls were mainly observed in the central Barents Sea.

Four species of skuas were observed; great, pomarine, long-tailed and arctic skua. Of these, pomarine skua was the far most abundant species. It was found in the eastern part of the Barents Sea. Arctic skua was found mainly in the western parts.

The observed distributions of marine mammals and birds shown in Figs. 2.7.1-2.7.5 are not effort corrected. Due to unfavourable weather and light conditions observers were active parts of the survey time only, which may yield biased distribution maps.

2.8 Benthos investigations

The five vessels involved in the ecosystem survey sampled in different areas of the Barents Sea. Bottom trawl (Campelen) was used on all ships in the whole survey area, but taxonomic experts for benthos were on F. Nansen and on G.O. Sars only. The samples collected with all gears except bottom trawl are currently being processed at PINRO and IMR. The Norwegian RVs recorded bycatch data within 33 large animal groups presented in table below. More detail data will be provided in Volume 2.

Groups of benthofauna for selection of bycatch

Data-base records:			
PORIFERA	NATANTIA	ECHIURA	CRINOIDEA
HYDROIDER	BRACHYURA	PYCNOGONIDA	ASTEROIDEA
ALCYONIIDAE	ANOMURA	CIRRIPEDIA	OPHIUROIDEA
ACTINIARIA	POLYPLACOPHORA	MYSIDA	ECHINOIDEA
MADREPORIA	BIVALVIA	CUMACEA	HOLOTHUROIDEA
POLYCHAETA	SCAPHOPODA	ISOPODA	ASCIDIACEA
SIPUNCULIDA	GASTROPODA	AMPHIPODA	
PRIAPULIDA	CEPHALOPODA	BRACHIOPODA	
EUPHAUSIIDAE	NEMERTINI	BRYOZOA	

The total biomass and abundance of all registered invertebrates bycatch (exept Pandalus borealis “deep sea prawn”, Paralithodes camtschaticus “king crab” and Chionoecetes opilio “snowcrab”) was summarised per station and presented in Figure 2.8.1. The abundance data are flowed by the fact that colony species such as Porifera and Bryozoans are not recorded in abundances, and that big catches of species was not counted, but only biomass measured.

Figure 2.8.1 shows the biomass-hotspots on the shallow banks and along the continental sloope from the Norwegian Sea and into the Barents Sea. The biomass-hotspot of the Spistbergen and Goose bank were in accordance with Zenkevitch 1956, while to the south of Novaya Zembla (Pechora Sea) and from southern part of Kanin-Kolguev elevation biomass values were low compared to a recorded biomass-hotspot in Zenkevitch 1956.

The abundance data (Fig. 2.8.2) shows that the highest abundances were caught by the demersal Campelen trawl at the Spitsbergen bank and in the eastern part of the Barents Sea. The lowest numbers of individuals were recorded in the southernmost part of the Barents Sea what, among others, shows the lack of Porifera records, given a high biomass but excluded from the abundance database due to the colony life form.

Following presented data are shows that the sponges make up large part of the biomass in the southeastern Barents Sea (Fig. 2.8.3). The echinoderms, i.e. sea stars, sea urchins, brittlestars, sea cucumbers and sealiljes, make up large proportions of biomass in central and northern part of the Barents Sea (Fig.2.8.4). The crustacean biomasses are to be found mainly in central and eastern Barents Sea (Fig. 2.8.5), when solely focusing on non-commercial species, i.e. all other species than Pandalus borealis (deep sea prawn), the red king crab and the snow crab. As the crustaceans, the molluscs (bivalves and snails) are presented with largest biomasses in the north-eastern part of the Barents Sea (Fig. 2.8.6).

The largest benthos biomasses (~3 tonnes, excluding king crab and deep sea prawn) were recorded at any station in the Barents Sea. Most of it were made up by Porifera (sponges) and located in the south-western Barents Sea (Johan Hjort; 18 – 31 August). North of Hopen depression large biomasses of brittlestars (20 – 30 kg) were taken by Campelen trawl on G.O. Sars. Echinoderms (Sea cucumbers, seastars and sea urchins) made up large individual numbers per station (up to 16.000) and were mainly found in large numbers in the Hopen depression by G.O. Sars.

2.8.1 King Crab (Paralithodes camtschaticus)

The distribution area for king crab was mainly located close to the coast (between 27-45° E). High catches of king crab were caught in the eastern area (Fig 2.8.7). Up to 280 kg of red king crab was recorded by RV Smolensk in the south-eastern part of the Barents Sea. The westernmost record was from north of Porsanger fjord. Several trawl stations close to the shore and inside the fjords need to be made in order to make a realistic distribution map of the red king crab. This is not possible with the large boats participating in the ecosystem cruise network.

2.8.2 Snow crab (Chionoecetes opilio)

Snow crab was registrated at about 20 stations in central and eastern part of the Barents Sea only (Fig 2.8.8). Compare to previous years the area distribution area of this spesies rather increased.

2.8.3 Shrimp (Pandalus borealis)

Deep water shrimp was found in 444 trawl hauls. In total shrimps were distributed as in previous years 2004 and 2005. Dense concentrations of shrimp were found in areas of the West Deep, South-Cape Deep, along eastern slope of Central Deep and around Northern Spitsbergen. In shallow waters of Spitsbergen Bank and in the eastern part of survey area shrimps were not found. In 2006 the mean catch of shrimp estimated as 16.6 kg/nm. It is higher than in 2004 (13.19 kg) and 2005 (16.49kg). The maximum catch has been registred as 180 kg/nm. (Fig.2.8.8)

Swept area method for capelin estimation

The experimental using of swept area method for more precise estimation of scatter capelin was continued this year. This method has been proposed by V.S. Mamylov in 2004 (Mamylov, 2004).

As known, the acoustic method possibilities for fish detection as in “near the bottom”, as in “near the surface layers”, are too much limited according to “the echosounder acoustic dead zone”. In this connection the trawl method (or swept area method) is often applied for the density estimation of fish, distributed close to bottom or close to surface.

In autumn 2006, as in previous years, capelin distribution “close to surface”, especially at night time, was typical for the south-eastern part of the Barents Sea. There were often situations when the catches of capelin in near-surface pelagic hauls achieved several hundreds specimens but acoustic s_A values were near zero. In this case using of the trawl method for capelin estimation in near-surface layer seems to be good enough adjustable method. Based on the r/v “Smolensk” data, the near-surface capelin estimations by the trawl and acoustic methods were made for the south-east part of the Barents Sea.

Acoustic estimation was made by the classical method with using of the mean s_A values per each WMO square with summarized capelin length distribution from trawl catches within each square. The trawl estimation was made by usual “swept area method”, taking into account a regular distribution of pelagic hauls with distance of 35 nm from each others. Equation for calculation on each 35x35 nm^2 square is:

$$N_i = \frac{Catch_i \cdot 1852 \cdot 35 \cdot 35 \cdot K_i \cdot K_{TR}}{L_{eff} \cdot D_{TR}} ,$$

where N_i – abundance of the i-length group fishes inside of each 35x35 nm^2 square;
$Catch_i$ – the number of i-length group fishes in the trawl catch;
K_i – theoretical length-dependent catchability index assumed for the sampling trawl (Mamylov, 2004);
$K_{TR} = (H_{TRmax} + dH_{TR} – H_{TRmin})/dH_{TR}$ (numbers of trawl horizons for each haul);
Leff – the horizontal trawl opening assumed to be equal 15 meters according to the trawl sonar Wesmar-770 data;
D_{TR} – distance of trawling (nm).

The results of capelin estimation by the acoustic and trawl methods are in table below. The using of trawl method for capelin estimation gives a higher number of capelin than the acoustic method. This result confirms the enough validity of trawl method in case of scatter capelin distribution in upper layers.

Results of capelin estimation by acoustic and trawl methods in south-east of the Barents Sea (Area 84413 n.m.^{2}) Ecosystem Survey 2006, r/v "Smolensk"

L,cm	q	w, g	Acoustic estimation		Trawl estimation	
			N, 10^6	W, tonn	N, 10^6	W, tonn
6.0 – 6.4	57	0.6	213.1	136.5	94.8	60.7
6.5 – 6.9	374	0.9	927.2	788.8	550.3	468.1
7.0 – 7.4	1215	1.1	1383.0	1531.0	1565.5	1733.1
7.5 – 7.9	1077	1.4	991.1	1402.7	1220.9	1727.9
8.0 – 8.4	1125	1.8	798.4	1422.5	1113.6	2004.4
8.5 – 8.9	1050	2.3	667.4	1476.6	904.7	2080.8
9.0 – 9.4	1093	2.6	416.3	1130.1	823.0	2139.7
9.5 – 9.9	1210	3.2	301.8	994.3	804.3	2573.7
10.0 – 10.4	1095	4.1	266.5	1055.4	632.5	2593.4
10.5 – 10.9	1351	4.8	227.6	1073.8	681.6	3271.6
11.0 – 11.4	871	5.6	208.2	1160.9	381.5	2136.5
11.5 – 11.9	571	6.5	128.6	841.5	218.5	1420.2
12.0 – 12.4	376	7.6	83.3	634.8	126.1	958.4
12.5 – 12.9	214	8.5	43.4	383.0	62.6	532.0
13.0 – 13.4	27	10.4	11.7	119.0	8.0	82.7
13.5 – 13.9	56	11.7	14.0	162.6	16.4	191.8
14.0 – 14.4	76	13.0	10.4	138.8	22.1	287.0
14.5 – 14.9	72	14.9	28.0	423.0	20.9	311.1
15.0 – 15.4	88	16.0	14.2	242.1	25.6	409.6
15.5 – 15.9	111	19.1	24.8	476.3	32.3	616.3
16.0 – 16.4	19	21.5	5.3	113.6	5.6	120.7
16.5 – 16.9	11	27.9	7.7	185.0	3.3	92.6
17.0 – 17.4	15	25.3	4.1	111.0	4.5	114.6
17.5 – 17.9	8	29.8	5.7	168.1	2.5	75.4
18.0 – 18.4						
18.5 – 18.9	4	36.4	2.6	93.2	1.3	46.6
TOTAL:			6784.5	16264.5	9322.3	26049.0

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Tables

Table 2.1.1. Mean water temperature[1] in the main parts of standard oceanographic sections in the Barents Sea and adjacent waters in August-September 1965-2006. The sections are: Kola[2] (column 1-3), Kanin (column 4[3]-5[4]), North Cape-Bear Island (column 6[5]), Bear Island – West (column 7[6]), Vardø – North (column 8) and Fugløya – Bear Island (column 9)

Year	Section and layer (depth in metres)								
	1	2	3	4	5	6	7	8	9
	0-50	50-200	0-200	0-bot.	0-bot.	0-200	0-200	50-200	50-200
1965	6.7	3.9	4.6	4.6	3.7	5.1	-	-	-
1966	6.7	2.6	3.6	1.9	2.2	5.5	3.6	-	-
1967	7.5	4.0	4.9	6.1	3.4	5.6	4.2	-	-
1968	6.4	3.7	4.4	4.7	2.8	5.4	4.0	-	-
1969	6.7	3.1	4.0	2.6	2.0	6.0	4.2	-	-
1970	7.8	3.7	4.7	4.0	3.3	6.1	-	-	-
1971	7.1	3.2	4.2	4.0	3.2	5.7	4.2	-	-
1972	8.7	4.0	5.2	5.1	4.1	6.3	3.9	-	-
1973	7.7	4.5	5.3	5.7	4.2	5.9	5.0	-	-
1974	8.1	3.9	4.9	4.6	3.5	6.1	4.9	-	-
1975	7.0	4.6	5.2	5.6	3.6	5.7	4.9	-	-
1976	8.1	4.0	5.0	4.9	4.4	5.6	4.8	-	-
1977	6.9	3.4	4.3	4.1	2.9	4.9	4.0	3.6	4.9
1978	6.6	2.5	3.6	2.4	1.7	5.0	4.1	3.2	4.9
1979	6.5	2.9	3.8	2.0	1.4	5.3	4.4	3.6	4.7
1980	7.4	3.5	4.5	3.3	3.0	5.7	4.9	3.7	5.5
1981	6.6	2.7	3.7	2.7	2.2	5.3	4.4	3.4	5.3
1982	7.1	4.0	4.8	4.5	2.8	5.8	4.9	4.1	6.0
1983	8.1	4.8	5.6	5.1	4.2	6.3	5.1	4.8	6.1
1984	7.7	4.1	5.0	4.5	3.6	5.9	5.0	4.2	5.7
1985	7.1	3.5	4.4	3.4	3.4	5.3	4.6	3.7	5.6
1986	7.5	3.5	4.5	3.9	3.2	5.8	4.4	3.8	5.5
1987	6.2	3.3	4.0	2.7	2.5	5.2	3.9	3.5	5.1
1988	7.0	3.7	4.5	3.8	2.9	5.5	4.2	3.8	5.7
1989	8.6	4.8	5.8	6.5	4.3	6.9	4.9	5.1	6.2
1990	8.1	4.4	5.3	5.0	3.9	6.3	5.7	5.0	6.3
1991	7.7	4.5	5.3	4.8	4.2	6.0	5.4	4.8	6.2
1992	7.5	4.6	5.3	5.0	4.0	6.1	5.0	4.6	6.1
1993	7.5	4.0	4.9	4.4	3.4	5.8	5.4	4.2	5.8
1994	7.7	3.9	4.8	4.6	3.4	6.4	5.3	4.8	5.9
1995	7.6	4.9	5.6	5.9	4.3	6.1	5.2	4.6	6.1
1996	7.6	3.7	4.7	5.2	2.9	5.8	4.7	3.7	5.7
1997	7.3	3.4	4.4	4.2	2.8	5.6	4.1	4.0	5.4
1998	8.4	3.4	4.7	2.1	1.9	6.0	-	3.9	5.8
1999	7.4	3.8	4.7	3.8	3.1	6.2	5.3	4.8	6.1
2000	7.6	4.5	5.3	5.8	4.1	5.7	5.1	4.2	5.8
2001	6.9	4.0	4.7	5.6	4.0	5.7	4.9	4.2	5.9
2002	8.6	4.8	5.8	4.0	3.7	-	5.4	4.6	6.5
2003	7.2	4.0	4.8	4.2	3.3	-	-	4.7	6.2
2004	9.0	4.7	5.7	5.0	4.2	-	5.8	4.8	6.4
2005	8.0	4.4	5.3	5.2	3.8	6.7	-	5.0	6.2
2006	8.3	5.3	6.1	6.1	4.5	-	5.8	5.3	6.9
Average (1965-2006)	7.5	3.9	4.8	4.4	3.3	5.8	4.8	4.3	5.8

[1] Earlier presented temperatures have been slightly adjusted (Tereshchenko, 1992).
[2] Murmansk Current; Kola section (70º30´N-72º30´N, 33º30´E).
[3] Kanin section (68º45´N-70º05´N, 43º15´E).
[4] Kanin section (71º00´N-72º00´N,43º15´E).
[5] North Cape Current; North Cape-Bear Island section (71º33´N, 25º02´E – 73º35´N, 20º46´E).
[6] West Spitsbergen Current; Bear Island – West section (74º30´N, 06º34E – 15º55´E).

Table 2.2.1. Abundance indices (area method) of 0-group fish in the Barents Sea and adjacent waters in August-September 1965-2005

Year	Capelin[1]	Cod[2]	Haddock[2]	Herring[3]	Polar cod		Redfish	Greenland halibut	Long rough dab
					West	East			
1965	37	11	13	-	0		159	-	66
1966	119	2	2	-	129		236	-	97
1967	89	62	76	-	165		44	-	73
1968	99	45	14	-	60		21	-	17
1969	109	211	186	-	208		295	-	26
1970	51	1097	208	-	197		247	1	12
1971	151	356	166	-	181		172	1	81
1972	275	225	74	-	140		177	8	65
1973	125	1101	87	-	26		385	3	67
1974	359	82	237	-	227		468	13	93
1975	320	453	224	-	75		315	21	113
1976	281	57	148	-	131		447	16	96
1977	194	279	187	-	157	70	472	9	72
1978	40	192	110	-	107	144	460	35	76
1979	660	129	95	-	23	302	980	22	69
1980	502	61	68	-	79	247	651	12	108
1981	570	65	30	-	149	93	861	38	95
1982	393	136	107	-	14	50	694	17	150
1983	589	459	219	-	48	39	851	16	80
1984	320	559	293	-	115	16	732	40	70
1985	110	742	156	-	60	334	795	36	86
1986	125	434	160	-	111	366	702	55	755
1987	55	102	72	-	17	155	631	41	174
1988	187	133	86	-	144	120	949	8	72
1989	1330	202	112	-	206	41	698	5	92
1990	324	465	227	-	144	48	670	2	35
1991	241	766	472	-	90	239	200	1	28
1992	26	1159	313	-	195	118	150	3	32
1993	43	910	240	188	171	156	162	11	55
1994	58	899	282	120	50	448	414	20	272
1995	43	1069	148	73	6	0	220	15	66
1996	291	1142	196	378	59	484	19	5	10
1997	522	1077	150	390	129	453	50	13	42
1998	428	576	593	524	144	457	78	11	28
1999	722	194	184	242	116	696	27	13	66
2000	303	870	417	213	76	387	195	28	81
2001	221	212	394	77	110	146	11	32	86
2002	327	1055	412	315	179	588	28	34	173
2003	630	694	705	277	164	337	57	9	58
2004	288	983	977	639	62	355	98	29	35
2005	348	972	1103	205	154	273	247	8	89
2006	983	463	733	390	190	277	360	9	233
1985-2006	346	687	370	288	117	294	307	18	117
1965-2006	307	493	254		109	248	367	17	97

[1] Assessments for 1965-1978 in Anon. 1980 and for 1979-1993 in Ushakov and Shamray 1995.
[2] Indices for 1965-1985 for cod and haddock adjusted according to Nakken and Raknes (1996).
[3] Calculated by Prozorkevich (2001).

Table 2.2.2 0-group abundance indices (in millions) with 95% confidence limits, not corrected for capture efficiency

Year	Capelin Index	Confidence limit		Cod Index	Confidence limit		Haddock Index	Confidence limit		Herring Index	Confidence limit		Redfish Index	Confidence limit	
1980	217454	149174	285735	66	38	94	67	42	93	5	1	9	282673	0	707218
1981	110142	59430	160855	49	34	65	14	7	22	3	0	9	156507	0	371639
1982	181125	45504	316745	498	359	638	537	390	683	49	12	87	169453	10618	328287
1983	100817	54303	147331	3979	1746	6213	1362	895	1830	32830	12326	53334	53589	26931	80247
1984	73228	45396	101061	5905	1900	9911	1285	877	1692	4258	1570	6946	43094	14054	72133
1985	24191	0	48833	15113	7622	22605	692	397	987	7858	1389	14328	319308	119797	518818
1986	13519	668	26370	1870	1289	2450	472	273	672	9	0	18	110738	0	228698
1987	600	134	1066	167	85	250	128	77	179	2	0	5	24678	13351	36006
1988	28826	5975	51678	526	301	751	393	155	630	8946	3366	14526	68636	43844	93429
1989	258741	205163	312318	718	412	1024	175	120	230	4113	1407	6819	16016	7667	24364
1990	36041	24438	47643	6616	3550	9682	1139	838	1440	4541	0	9493	92985	50944	135025
1991	55879	25342	86417	11082	7997	14166	3961	2966	4956	79417	41631	117203	38620	0	78044
1992	116	0	248	45546	24813	66278	1678	1200	2155	39073	22509	55636	13810	0	36539
1993	257	72	442	26917	14421	39414	1217	824	1611	68077	4138	132016	5717	0	13927
1994	9237	905	17569	26762	13870	39654	1940	1025	2854	18918	0	40609	53599	0	123179
1995	614	0	1412	89604	45220	133988	540	275	805	1700	611	2790	16516	3373	29660
1996	47055	24214	69896	70783	46761	94804	1066	796	1336	59120	29516	88724	27	8	47
1997	57585	24634	90535	68060	50188	85932	626	432	819	46833	21013	72652	147	0	296
1998	35881	23090	48671	6798	4310	9287	5993	3739	8247	79577	44037	115118	746	9	1483
1999	88855	48623	129088	1364	151	2577	1154	378	1931	16525	2116	30934	41	15	66
2000	39380	590	78170	26112	13948	38276	2945	1883	4008	49710	3342	96078	7539	0	16907
2001	5212	639	9786	981	188	1775	2016	1293	2739	852	152	1553	6	1	11
2002	20722	11632	29811	19128	11086	27170	1848	1274	2421	23494	12217	34772	132	22	243
2003	130672	68070	193273	19098	11174	27021	8643	4481	12805	31400	17390	45410	192	0	412
2004	20737	5641	35834	22420	16392	28448	20081	13354	26808	138995	98698	179291	1024	0	2105
2005	47256	16240	78272	21427	14610	28245	33785	24796	42774	26361	1151	51571	12370	665	24074
2006	186348	113329	259367	8023	3752	12294	11538	7609	15467	71464	27236	115693	26038	11608	40468
Mean	66315			18504			3617			30153			56082		

End of Table 2.2.2

Year	Saithe Index	Confidence limit		Gr. halibut Index	Confidence limit		Long rough dab Index	Confidence limit		Polar cod East Index	Confidence limit		Polar cod West Index	Confidence limit	
1980	3	0	5	57	17	97	1183	869	1497	0	0	0	14767	0	35894
1981	0	0	0	69	42	95	517	253	780	302	140	464	5398	2108	8689
1982	137	0	364	40	11	70	861	577	1146	0	0	1	308	0	680
1983	244	83	404	39	20	57	433	263	603	1406	0	3256	6180	0	13218
1984	760	221	1299	31	18	45	45	31	59	123	0	313	3236	788	5684
1985	14	0	28	45	28	63	282	120	445	20346	5399	35292	839	0	1692
1986	1	0	2	115	62	167	7218	5149	9288	8490	2873	14107	2113	129	4096
1987	1	0	1	37	24	50	837	436	1238	7791	0	18096	77	33	122
1988	17	4	29	8	3	13	198	111	285	403	8	798	4722	0	10104
1989	1	0	3	2	1	3	175	95	254	228	0	489	17293	2350	32236
1990	10	1	20	3	0	5	54	25	83	384	97	671	32403	0	72485
1991	4	2	5	3	0	7	83	49	118	62589	28607	96572	40526	0	116372
1992	162	88	237	9	0	18	130	20	239	7153	0	14371	10083	1542	18624
1993	372	0	927	4	2	7	51	22	80	13235	3458	23012	8380	1385	15376
1994	3	0	5	39	0	93	1823	1155	2490	189989	100120	279857	5485	0	12090
1995	172	75	269	19	5	32	261	43	478	0	0	0	28	2	53
1996	146	63	228	6	3	9	43	2	84	74321	46479	102162	4925	0	12253
1997	81	38	124	5	3	7	97	44	150	32700	17919	47481	7711	623	14799
1998	78	33	123	8	3	12	27	13	42	12442	7336	17549	10307	0	23356
1999	134	66	202	16	10	23	107	1	212	131108	83614	178601	3134	502	5766
2000	209	114	304	39	14	65	216	105	327	112525	64870	160179	24526	15767	33286
2001	21	0	46	52	11	93	78	0	165	0	0	0	16492	0	36246
2002	322	186	457	61	0	142	755	352	1158	97154	57155	137153	30117	5580	54654
2003	348	0	824	14	0	30	122	66	178	10821	5700	15943	2739	197	5281
2004	1426	859	1993	81	23	140	37	19	55	33277	14843	51710	317	88	546
2005	54	36	73	9	4	13	189	95	238	5823	2526	9119	3367	1269	
2006	143	59	226	18	2	35	805	503	1107	24058	8713	39403	2568	625	4512
Mean	180			31			616			31358			9557		

Table 2.2.3 0-group abundance indices (in millions) with 95% confidence limits, corrected for capture efficiency

	Capelin			Cod			Haddock			Herring			Saithe			Polar cod East			Polar cod West		
Year	Index	Confidence limit		Index	Confidence limit		Index	Confidence limit		Index	Confidence limit		Index	Confidence limit		Index	Confidence limit		Index	Confidence limit	
1980	809193	553831	1064555	316	167	465	309	190	427	93	25	161	21	0	47	0	0	0	126699	0	307667
1981	428316	228724	627909	277	195	358	71	31	111	38	0	86	0	0	0	2479	1147	3810	48351	19163	77538
1982	611698	152679	1070717	2581	1893	3269	2296	1690	2902	798	219	1378	266	0	665	3	0	6	2751	0	6070
1983	332287	173699	490875	15863	7716	24011	4453	3220	5686	121992	28954	215030	420	130	709	1406	0	3256	55760	0	120841
1984	168660	103049	234270	20342	5689	34995	3753	2572	4934	18193	1301	35084	1006	332	1680	123	0	313	26718	6475	46962
1985	73436	726	146146	63561	31160	95962	2463	1535	3392	30140	6135	54146	34	4	64	84185	23055	145316	6907	0	14133
1986	56472	4969	107976	9675	6654	12695	2071	1228	2915	112	31	193	4	0	9	64160	21966	106355	18414	0	37224
1987	2302	471	4133	1036	497	1574	749	459	1039	50	0	112	4	0	10	64879	0	148667	652	273	1032
1988	92075	16757	167392	2668	1547	3789	1687	616	2758	62354	21253	103455	31	11	50	2721	56	5386	41910	0	91010
1989	881764	702020	1061507	2781	1659	3903	665	461	868	17640	8202	27078	11	0	23	1593	0	3393	156778	17601	295955
1990	115198	77600	152796	23609	13304	33915	3081	2278	3885	7925	621	15228	28		53	2774	668	4880	250497	0	558091
1991	164819	73881	255757	41545	30446	52644	14216	10877	17556	270770	103481	438060	9	4	14	580649	262623	898675	293904	0	841007
1992	349	0	743	169569	92199	246939	4889	3343	6435	88619	51003	126236	332	161	504	47171	0	94701	81776	12754	150797
1993	776	161	1391	96425	52852	139998	3107	2141	4072	328180	2398	653963	1050	0	2551	97783	24623	170943	71105	12557	129653
1994	20987	1942	40032	86942	45935	127950	5191	2922	7459	131190	0	273976	6	0	13	1212620	548275	1876966	49512	0	109966
1995	2067	0	4743	279395	134482	424308	1366	694	2038	14320	5680	22960	473	210	735	0	0	0	217	12	423
1996	143826	73868	213783	278201	185042	371361	2618	1980	3257	568532	269319	867745	471	197	745	611412	383278	839546	46883	0	116490
1997	196013	84792	307235	298365	221488	375242	2058	1412	2704	468285	173000	763571	350	166	534	289215	155738	422691	63047	6053	120041
1998	88035	48283	127788	24066	15780	32352	14160	9429	18891	474513	274346	674681	164	80	249	17195	8796	25595	95558	0	220902
1999	294999	150183	439814	4406	987	7826	2782	1041	4523	36959	13919	59999	272	136	408	1164168	734544	1593792	26605	4450	48760
2000	140131	5619	274643	108728	58115	159341	11003	6913	15092	470181	23065	917297	863	456	1270	889767	509481	1270052	205736	141129	270343
2001	19895	3266	36523	4552	934	8171	5431	3719	7142	10243	1839	18646	48	0	107	0	0	0	144870	0	315443
2002	21887	12610	31164	33939	21774	46104	4380	2944	5816	93210	13660	172759	517	300	734	97154	57155	137153	234204	47674	420734
2003	458890	235602	682178	89964	52287	127641	33050	17840	48260	192343	69648	315038	2705	0	7090	82300	42482	122118	14595	1032	28157
2004	69251	22963	115539	77737	56183	99291	41646	28141	55152	799415	546550	1052281	4869	2786	6952	259201	113764	404638	2437	667	4206
2005	154692	54006	255378	71955	50378	93532	92889	68915	116862	125719	19941	231496	173	112	234	39715	18247	61183	27431	9833	45028
2006	568153	354393	781913	25725	11914	39536	29280	19368	39191	307703	114440	500966	283	116	450	170828	65293	276363	19717	4571	34862
Mean	219117			67935			10729			171834			533			214204			78260		

Table 2.2.4. Length distributions (%) of 0-group fish in the Barents Sea and adjacent waters, August-October 2006

Length, cm	Cod	Haddock	Capelin	Herring	Saithe	Redfish	Polarcod	Grhalibut	LRD	Sandeel
1.5-1.9						0.0				
2.0-2.4			0.0			0.1			0.3	0.0
2.5-2.9			0.0			0.3	0.0		6.8	0.1
3.0-3.4			0.1			10.0	0.3		15.7	0.2
3.5-3.9	0.0	0.1	0.6	0.0		13.6	2.3		27.2	5.6
4.0-4.4	0.0	0.1	2.0			22.3	9.4		32.3	25.3
4.5-4.9	0.4	0.5	12.7	0.1		17.0	24.8		15.4	37.8
5.0-5.4	0.8	0.4	24.5	0.2		20.4	19.8	1.0	2.2	16.1
5.5-5.9	1.0	1.3	25.7	1.2		13.0	29.5	4.2		6.2
6.0-6.4	1.3	1.2	17.7	3.8	0.2	3.2	13.7	6.2		1.8
6.5-6.9	3.3	1.3	11.1	9.4		0.2		4.0		0.5
7.0-7.4	4.0	1.7	5.0	16.1	0.7			7.1		0.1
7.5-7.9	7.2	3.2	0.5	11.4	0.9			10.6		0.1
8.0-8.4	10.6	2.7	0.1	12.2	0.1			16.4		0.1
8.5-8.9	9.6	3.9	0.0	13.4	1.1			50.5		0.2
9.0-9.4	11.1	5.2		10.1	2.3					0.2
9.5-9.9	13.8	9.0		10.1	3.4					0.4
10.0-10.4	12.8	8.4		5.8	5.5					0.1
10.5-10.9	8.3	11.2		3.8	10.8					0.0
11.0-11.4	5.8	8.1		1.5	7.6					0.0
11.5-11.9	5.3	12.2		0.7	17.6					0.0
12.0-12.4	2.7	9.5		0.1	22.5					
12.5-12.9	1.2	9.0			6.0					0.0
13.0-13.4	0.8	4.9			7.3					
13.5-13.9	0.2	3.3			4.5					
14.0-14.4	0.0	1.7			4.0					
14.5-14.9	0.0	0.7			2.3					0.8
Mean length (cm)	8.86	10.22	5.11	7.77	11.36	4.07	4.55	7.39	3.25	4.57

Table 2.3.1. Acoustic estimate of Barents Sea capelin, August-September 2006

Length (cm)	Age/Yearclass					Sum (10^9)	Biomass (10^3 t)	Mean weight (g)
	1	2	3	4	5+			
	2005	2004	2003	2002	2001			
6.5 - 7.0	280					280	0.3	1.0
7.0 - 7.5	1461					1461	1.7	1.2
7.5 - 8.0	2056					2056	4.1	2.0
8.0 - 8.5	5035					5035	10.1	2.0
8.5 - 9.0	3519					3519	8.8	2.5
9.0 - 9.5	4022					4022	11.7	2.9
9.5 - 10.0	4297					4297	15.3	3.6
10.0 - 10.5	6648	164				6812	29.2	4.3
10.5 - 11.0	9452					9453	46.9	5.0
11.0 - 11.5	6497	214				6711	38.1	5.7
11.5 - 12.0	8455	271				8727	56.0	6.4
12.0 - 12.5	3371	70				3441	26.7	7.8
12.5 - 13.0	3486	1170				4656	38.8	8.3
13.0 - 13.5	1143	1444	107			2693	26.6	9.9
13.5 - 14.0	351	2654	55			3060	35.1	11.5
14.0 - 14.5	19	3802	234			4055	53.9	13.3
14.5 - 15.0		2773	325	2		3100	48.4	15.6
15.0 - 15.5	2	2668	437	23		3130	55.0	17.6
15.5 - 16.0		2618	475	1		3094	61.2	19.8
16.0 - 16.5		1961	778	10		2749	62.4	22.7
16.5 - 17.0		1155	986	33		2175	54.9	25.2
17.0 - 17.5		460	668	3		1131	32.8	29.0
17.5 - 18.0		155	979	86		1220	38.9	31.9
18.0 - 18.5		85	361	163		608	21.2	34.9
18.5 - 19.0		10	158	16	1	184	6.8	36.8
19.0 - 19.5		12	12	7		31	1.4	46.6
TSN (10^6)	60094	21686	5575	344	1	87700		
TSB (10^3 t)	290.0	347.2	139.1	10.9	0.0		787.1	
Mean length (cm)	10.5	14.7	16.6	17.7	18.8	11.9		
Mean weight (g)	4.8	16.1	24.8	30.6	36.5			9.0
SSN (10^6)	21	15699	5413	344	1	21477		
SSB (10^3 t)	0.3	288.4	137.4	10.9	0.0		437.0	
	Based on TS value: 19.1 log L - 74.0, corresponding to $\sigma = 5.0 \cdot 10^{-7} \cdot L^{1.91}$							

Table 2.3.2. Acoustic estimates of the Barents Sea capelin stock by age in autumn 1973-2006. Biomass (B) in 10^6 tonnes, average weight (AW) in grams. All estimates based on TS = 19.1Log L -74.0 dB

Age	1		2		3		4		5		Sum 1+
Year	B	AW	B	AW	B	AW	B	AW	B	AW	B
1973	1.69	3.2	2.32	6.2	0.73	18.3	0.41	23.8	0.01	30.1	5.14
1974	1.06	3.5	3.06	5.6	1.53	8.9	0.07	20.8	+	25.0	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	6.72
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]	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[2]	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	0.16	4.2	1.01	13.6	0.27	26.9	0.09	29.3			2.78
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
Average	0.64	3.6	1.30	10.6	0.82	18.7	0.25	24.44	0.07	28.0	2.95

[1] Computed values based on the estimates in 1981 and 1983.
[2] Combined estimates from multispecies survey and succeeding survey with "Eldjarn".

Table 2.3.3. Survey mortalities for capelin from age 1 to age 2

Year	Year class	Age 1 (10^9)	Age 2 (10^9)	Total mort. %	Total mort. Z
1984-1985	1983	154.8	48.3	69	1.16
1985-1986	1984	38.7	4.7	88	2.11
1986-1987	1985	6.0	1.7	72	1.26
1987-1988	1986	37.6	28.7	24	0.27
1988-1989	1987	21.0	17.7	16	0.17
1989-1990	1988	189.2	177.6	6	0.06
1990-1991	1989	700.4	580.2	17	0.19
1991-1992	1990	402.1	196.3	51	0.72
1992-1993	1991	351.3	53.4	85	1.88
1993-1994	1992	2.2	3.4	-	-
1994-1995	1993	19.8	8.1	59	0.89
1995-1996	1994	7.1	11.5	-	-
1996-1997	1995	81.9	39.1	52	0.74
1997-1998	1996	98.9	72.6	27	0.31
1998-1999	1997	179.0	101.5	43	0.57
1999-2000	1998	155.9	110.6	29	0.34
2000-2001	1999	449.2	218.7	51	0.72
2001-2002	2000	113.6	90.8	20	0.22
2002-2003	2001	59.7	9.6	84	1.83
2003-2004	2002	82.4	24.8	70	1.20
2004-2005	2003	51.2	13.0	75	1.39
2005-2006	2004	26.9	21.7	19.3	0.21

Table 2.3.4 Acoustic estimate of polar cod in August-September 2005

Length (cm)	Age/Yearclass 1	2	3	4	5	Sum (10^6)	Biomass (10^3 t)	Mean weigt (g)
	2005	2004	2003	2002	2001			
7.0 - 7.5	5					5	0.0	2.7
7.5 - 8.0	50					50	0.2	3.8
8.0 - 8.5	178					178	0.7	4.0
8.5 - 9.0	393					393	1.8	4.5
9.0 - 9.5	721					721	4.0	5.5
9.5 - 10.0	1151					1151	7.0	6.1
10.0 - 10.5	1954	8				1962	14.9	7.6
10.5 - 11.0	2142	84				2226	19.0	8.6
11.0 - 11.5	2320	69				2389	24.0	10.0
11.5 - 12.0	1824	362	1			2187	25.9	11.9
12.0 - 12.5	1496	424	50			1971	26.4	13.4
12.5 - 13.0	1482	460	85			2027	30.6	15.1
13.0 - 13.5	1083	1423	8			2515	43.0	17.1
13.5 - 14.0	910	2429	48			3390	68.4	20.2
14.0 - 14.5	325	2584	1002			3912	83.5	21.3
14.5 - 15.0	121	4686	718			5526	126.4	22.9
15.0 - 15.5	35	6298	637			6971	179.4	25.7
15.5 - 16.0		5621	968			6589	182.2	27.6
16.0 - 16.5		5645	769	9		6423	190.9	29.7
16.5 - 17.0		6066	431	7		6505	211.9	32.6
17.0 - 17.5		4023	1211	213		5446	191.3	35.1
17.5 - 18.0		2311	1238	2		3551	133.6	37.6
18.0 - 18.5		1410	1487	86		2983	125.0	41.9
18.5 - 19.0		809	949	1	57	1815	78.6	43.3
19.0 - 19.5		270	861	79		1210	55.6	45.9
19.5 - 20.0		46	636	4		686	36.0	52.5
20.0 - 20.5		10	478	11		499	27.9	56.0
20.5 - 21.0			247	31		279	16.8	60.3
21.0 - 21.5		24	145	71		240	16.7	69.7
21.5 - 22.0			59	15		74	5.0	67.0
22.0 - 22.5			41	25		66	5.0	76.0
22.5 - 23.0			1	25	1	27	2.2	79.7
23.0 - 23.5			11			11	0.8	73.9
23.5 - 24.0			2	2		4	0.4	94.4
24.0 - 24.5				4		4	0.3	82.0
24.5 - 25.0				21	3	24	2.5	106.0
25.0 - 25.5								
25.5 - 26.0					6	6	0.7	112.0
26.0 - 26.5					3	3	0.4	155.0
26.5 - 27.0					9	9	1.0	111.0
27.0 - 27.5					3	3	0.4	146.0
27.5 - 28.0								
28.0 - 28.5				7		7	0.8	121.4
TSN(10^6)	16190	45063	12083	617	81	74033		
TSB(10^3 t)	180.8	1277.4	445.9	31.8	5.4		1941.2	
Mean length (cm)	11.4	15.8	17.3	19.3	21	15.1		
Mean weight (g)	11.2	28.3	36.9	51.6	66			26.2
	Based on TS value: 21.8 log L - 72.7, corresponding to $\sigma = 6.7 \cdot 10^{-7} \cdot L^{2.18}$							

Table 2.3.5. Acoustic estimates of polar cod by age in August-September 1986-2006. TSN and TSB is total stock numbers (106) and total stock biomass (103 tonnes) respectively. Numbers based on TS = 21.8 Log L - 72.7 dB

Year	Age 1		Age 2		Age 3		Age 4+		Total	
	TSN	TSB	TSN	TSB	TSN	TSB	TSN	TSB	TSN	TSB
1986	24038	169.6	6263	104.3	1058	31.5	82	3.4	31441	308.8
1987	15041	125.1	10142	184.2	3111	72.2	39	1.2	28333	382.8
1988	4314	37.1	1469	27.1	727	20.1	52	1.7	6562	86.0
1989	13540	154.9	1777	41.7	236	8.6	60	2.6	15613	207.8
1990	3834	39.3	2221	56.8	650	25.3	94	6.9	6799	127.3
1991	23670	214.2	4159	93.8	1922	67.0	152	6.4	29903	381.5
1992	22902	194.4	13992	376.5	832	20.9	64	2.9	37790	594.9
1993	16269	131.6	18919	367.1	2965	103.3	147	7.7	38300	609.7
1994	27466	189.7	9297	161.0	5044	154.0	790	35.8	42597	540.5
1995	30697	249.6	6493	127.8	1610	41.0	175	7.9	38975	426.2
1996	19438	144.9	10056	230.6	3287	103.1	212	8.0	33012	487.4
1997	15848	136.7	7755	124.5	3139	86.4	992	39.3	28012	400.7
1998	89947	505.5	7634	174.5	3965	119.3	598	23.0	102435	839.5
1999	59434	399.6	22760	426.0	8803	286.8	435	25.9	91463	1141.9
2000	33825	269.4	19999	432.4	14598	597.6	840	48.4	69262	1347.8
2001	77144	709.0	15694	434.5	12499	589.3	2271	132.1	107713	1869.6
2002	8431	56.8	34824	875.9	6350	282.2	2322	143.2	52218	1377.2
2003	15434	114.1	2057	37.9	2038	63.9	1545	64.4	21074	280.2
2004	99404	627.1	22777	404.9	2627	82.2	510	32.7	125319	1143.8
2005	71675	626.6	57053	1028.2	3703	120.2	407	28.3	132859	1803.3
2006	16190	180.8	45063	1277.4	12083	445.9	698	37.2	74033	1941.2
Average	32788	251.3	15257	332.7	4345	158.2	595	31.4	53034	776.2

Table 2.3.6. Survey mortalities for polar cod from age 1 to age 2, and from age 2 to age 3

Year	Year class	Age 1 (10^9)	Age 2 (10^9)	Total mort. %	Total mort Z
1986-1987	1985	24.0	10.1	58	0.86
1987-1988	1986	15.0	1.5	90	2.30
1988-1989	1987	4.3	1.8	58	0.87
1989-1990	1988	13.5	2.2	84	1.81
1990-1991	1989	3.8	4.2	-	-
1991-1992	1990	23.7	14.0	41	0.53
1992-1993	1991	22.9	18.9	17	0.19
1993-1994	1992	16.3	9.3	43	0.56
1994-1995	1993	27.5	6.5	76	1.44
1995-1996	1994	30.7	10.1	67	1.11
1996-1997	1995	19.4	7.8	59	0.91
1997-1998	1996	15.8	7.6	52	0.73
1998-1999	1997	89.9	22.8	75	1.37
1999-2000	1998	59.4	20.0	66	1.09
2000-2001	1999	33.8	15.7	54	0.77
2001-2002	2000	77.1	34.8	55	0.80
2002-2003	2001	8.4	2.1	75	1.38
2003-2004	2002	15.4	22.7	-	-
2004-2005	2003	99.4	57.1	43	0.56
2005-2006	2004	71.7	45.1	37	0.48

Year	Year class	Age 2 (10^9)	Age 3 (10^9)	Total mort. %	Total mort Z
1986-1987	1984	6.3	3.1	51	0.71
1987-1988	1985	10.1	0.7	93	2.67
1988-1989	1986	1.5	0.2	87	2.01
1989-1990	1987	1.8	0.7	61	2.57
1990-1991	1988	2.2	1.9	14	0.15
1991-1992	1989	4.2	0.8	81	1.66
1992-1993	1990	14.0	3.0	78	1.54
1993-1994	1991	18.9	5.0	74	1.33
1994-1995	1992	9.3	1.6	83	1.76
1995-1996	1993	6.5	3.3	51	0.68
1996-1997	1994	10.1	3.1	69	1.18
1997-1998	1995	7.8	4.0	49	0.67
1998-1999	1996	7.6	8.8	-	-
1999-2000	1997	22.8	14.6	36	0.44
2000-2001	1998	20.0	12.5	38	0.47
2001-2002	1999	15.7	6.4	59	0.90
2002-2003	2000	34.8	2.0	94	2.86
2003-2004	2001	2.1	2.6	-	-
2004-2005	2002	22.8	3.7	84	1.83
2005-2006	2003	51.7	12.1	77	1.50

Table 2.3.7. Acoustic estimate of young herring in the Barents Sea August-September 2006

Length (cm)	Age/Yearclass 1	2	3+	Sum (106)	Biomass (103 t)	Mean weigt(g)
	2005	2004	2003			
11.5 - 12.0	48			48	0.5	9.6
12.0 - 12.5	55			55	0.6	11.7
12.5 - 13.0	99			99	1.3	13.6
13.0 - 13.5	109			109	1.7	15.3
13.5 - 14.0	208			208	3.5	16.9
14.0 - 14.5	257			257	4.9	19.0
14.5 - 15.0	188			188	4.1	21.6
15.0 - 15.5	207			207	5.0	24.2
15.5 - 16.0	226			226	5.7	25.1
16.0 - 16.5	102	16		118	3.2	27.4
16.5 - 17.0	63	11		74	2.2	29.8
17.0 - 17.5	42	10		51	1.9	37.4
17.5 - 18.0	4	40		44	1.8	39.9
18.0 - 18.5		7		7	0.3	42.6
18.5 - 19.0	11	63		74	4.0	53.7
19.0 - 19.5		285		285	15.0	52.7
19.5 - 20.0		369		369	20.6	56.0
20.0 - 20.5		483		483	27.0	55.9
20.5 - 21.0		356		356	22.3	62.7
21.0 - 21.5		729		729	50.3	69.0
21.5 - 22.0		818	2	820	59.5	72.6
22.0 - 22.5		999	8	1007	79.1	78.6
22.5 - 23.0		592	1	593	49.6	83.6
23.0 - 23.5		525	36	562	48.9	87.0
23.5 - 24.0		82	149	230	22.0	95.7
24.0 - 24.5		80	93	173	17.5	101.2
24.5 - 25.0		64	176	240	25.6	106.7
25.0 - 25.5			173	173	20.8	120.8
25.5 - 26.0			221	220	27.8	126.0
26.0 - 26.5		7	202	209	28.5	136.4
26.5 - 27.0			150	151	22.1	146.4
27.0 - 27.5			199	200	30.5	152.6
27.5 - 28.0			73	73	11.2	152.7
28.0 - 28.5			77	77	12.7	165.0
28.5 - 29.0			47	47	9.0	190.9
29.0 - 29.5			11	11	2.1	191.6
29.5 - 30.0						
30.0 - 30.5			1	1	0.3	234.0
TSN(10^6)	1618	5535	1620	8773		
TSB(10^3 t)	34.2	398.4	210.5		643.0	
Mean length (cm)	14.6	21.6	25.9	21.1		
Mean weight (g)	21.1	72	129.9			73.3
	Based on TS=20.0* lg(L) - 71.9					

Table 2.3.8. Acoustic estimate of blue whiting in the Barents Sea August-September 2006

Length (cm)	Age/Yearclass									Sum (10^6)	Biomass (10^3 t)	Mean weight (g)
	1	2	3	4	5	6	7	8	9+			
	2005	2004	2003	2002	2001	2000	1999	1998	1997			
19.0 - 19.5	7									7	0.2	32.2
19.5 - 20.0		1								1	0.0	39.0
20.0 - 20.5	17	2								19	0.8	40.5
20.5 - 21.0	44	24								68	3.0	44.1
21.0 - 21.5		82	1							82	4.1	50.3
21.5 - 22.0	94	21								115	6.0	52.6
22.0 - 22.5		221	199							420	24.1	57.3
22.5 - 23.0	54	206	47							307	18.7	61.0
23.0 - 23.5	155	374	116							644	42.2	65.6
23.5 - 24.0		381	232	13						626	44.4	70.9
24.0 - 24.5		310	162							472	35.7	75.5
24.5 - 25.0		330	350	1						681	55.9	82.0
25.0 - 25.5		160	291	9						460	41.0	89.2
25.5 - 26.0		116	530	128						773	73.6	95.1
26.0 - 26.5			244	152						397	40.6	102.2
26.5 - 27.0			183	296	76	4				559	60.2	107.8
27.0 - 27.5			151	208	15	6				380	44.7	117.6
27.5 - 28.0			113	229	26	15				383	46.5	121.5
28.0 - 28.5			25	285	20	5				335	42.8	127.7
28.5 - 29.0			2	148	20	46				216	29.8	138.2
29.0 - 29.5			19	95	76	6				196	28.2	144.0
29.5 - 30.0				9	72	32	14			127	19.6	154.3
30.0 - 30.5				39	37	18	28			122	19.6	161.2
30.5 - 31.0				11	81	20	1	1		114	18.4	160.9
31.0 - 31.5				1	34	25	1		1	61	10.7	174.9
31.5 - 32.0					4	20	7			31	6.2	197.7
32.0 - 32.5				7	21	10		6		43	8.4	195.9
32.5 - 33.0					12	25	9	6		52	9.6	185.8
33.0 - 33.5					2	12	5			20	4.2	214.1
33.5 - 34.0						7	5	3		15	3.2	219.5
34.0 - 34.5							5	5	3	13	2.8	213.6
34.5 - 35.0						5				5	1.3	243.4
35.0 - 35.5							1			2	0.4	239.2
35.5 - 36.0									2	2	0.4	273.8
36.0 - 36.5						1		2		3	0.6	248.3
36.5 - 37.0									1	1	0.5	282.9
37.0 - 37.5												
37.5 - 38.0									1	1	0.1	274.3
TSN(10^6)	371	2227	2665	1630	496	255	78	24	8	7754		
TSB(10^3 t)	21.2	158.8	238.1	195.0	73.0	42.0	13.9	4.9	1.8		748.8	
Mean length (cm)	22.3	23.7	25.2	27.5	29.4	30.5	31.4	33.3	34.7	25.7		
Mean weight (g)	57.3	71.3	89.3	119.6	147.1	164.7	178.8	204.3	234.1			96.6
	Based on TS=21.8* lg(L) - 72.7											

Table 2.7.1. Number of marine mammal individuals observed from the research vessels Johan Hjort, G.O. Sars, Jan Mayen, Smolensk and F. Nansen during the ecosystem survey 2006

Class / suborder	Name of species (english)	Johan Hjort	G.O. Sars	Jan Mayen	Smolensk	F. Nansen	Total	%
Cetacea / baleen whales	Minke whale	37	16	3	11	19	**86**	**4.86**
	Sei whale					1	**1**	**0.06**
	Fin whale	14	36	106	3	5	**164**	**9.27**
	Blue whale			4			**4**	**0.23**
	Humpback whale	24	50	21	1	37	**133**	**7.51**
	Bowhead Whale				1		**1**	**0.06**
	Unidentified whale				3	19	**22**	**1.24**
	Unidentified large whale	7	1	4			**12**	**0.68**
Cetacea / toothed whales	Sperm whale	6					**6**	**0.34**
	Killer whale					4	**4**	**0.23**
	White-beaked dolphin	401	218	79	91	148	**937**	**52.94**
	White-sided dolphin				16	8	**24**	**1.36**
	Common dolphin				3		**3**	**0.17**
	Striped dolphin				6		**6**	**0.34**
	Unid. dolphin	11		13	3	13	**40**	**2.26**
	White whale				38		**38**	**2.15**
	Harbour porpoise				14	20	**34**	**1.92**
Pinni-pedia	Harp seal			178	3		**181**	**10.23**
	Bearded seal			3		1	**4**	**0.23**
	Grey seal				2		**2**	**0.11**
	Walrus			60			**60**	**3.39**
	Unidentified seal	2		2			**4**	**0.23**
Other	Polar bear				3		**3**	**0.17**
	Basking shark	1					**1**	**0.06**
Total sum		**503**	**321**	**473**	**198**	**275**	**1770**	**100.00**

Table 2.7.2. Number of sea bird individuals observed from the Norwegian research vessels Johan Hjort, G.O.Sars and Jan Mayen during the ecosystem surveys 2006, and from the Russian vessel F. Nansen

Species (latin)	Species (english)	G.O. Sars	Johan Hjort	Jan Mayen	F. Nansen	Total	Prop. of total
Alle alle	Little auk	728	1	277	92	**1098**	**4.2**
Cepphus grylle	Black guillemot	2	1	7	0	**10**	**0.04**
Fratercula arctica	Puffin	320	308	43	20	**691**	**2.7**
Uria aalge	Common guillemot	30	50	0	64	**144**	**0.55**
Uria lomvia	Brünnich's guillemot	3398	397	246	573	**4614**	**17.8**
Uria sp.	Guillemot	0	0	0	877	**877**	**3.4**
Alca torda	Razorbill	15	1	0	1	**17**	**0.07**
Alcidae sp.	Unident. alcids	362	153	0	0	**515**	**2.0**
Larus argentatus	Herring gull	5	98	0	8	**111**	**0.43**
Larus fuscus	Lesser black-backed gull	2	0	0	0	**2**	**0.01**
Larus hyperboreus	Glaucous gull	9	277	29	49	**364**	**1.4**
Larus marinus	Great black-backed gull	1	20	0	4	**25**	**0.1**
Pagophila eburnean	Ivory gull	2	0	0	1	**3**	**0.04**
Rissa tridactyla	Kittiwake	1334	843	10	730	**2917**	**11.2**
Stercorarius longicaudus	Long-tailed skua	4	2	15	0	**21**	**0.08**
Stercorarius parasiticus	Arctic skua	18	85	0	20	**123**	**0.5**
Stercorarius pomarinus	Pomarine skua	692	78	1	90	**861**	**3.3**
Stercorarius skua	Great skua	1	8	0	7	**16**	**0.06**
Stercorarius sp.	Unident. skua	100	67	0	0	**167**	**0.64**
Fulmarus glacialis	Northern fulmar	581	4224	1270	7174	**13249**	**51.0**
Puffinus griseus	Sooty shearwater	5	12	0	0	**17**	**0.07**
Sterna paradisaea	Arctic tern	10	24	3	30	**67**	**0.26**
Phalacrocorax aristotelis	European shag	1	0	0	0	**1**	**0.004**
Phalacrocorax carbo	Cormorant	8	0	0	3	**11**	**0.04**
Morus bassanus	Northern gannet	16	0	0	6	**22**	**0.08**
Calidris maritima	Purple sandpiper	1	0	0	0	**1**	**0.004**
Gavia arctica	Black-throated diver	1	0	0	1	**2**	**0.008**
Gavia immer	Great northern diver	1	0	0	0	**1**	**0.004**
Plectropenax nivalis	Snow bunting	3	0	0	0	**3**	**0.01**
Somateria mollissima	Eider	0	0	0	24	**24**	**0.09**
Total		**7650**	**6649**	**1901**	**9774**	**25974**	**100,0**

Table 2.8.1 Overview of benthos samples collected with different gear used onboard the five research vessels involved in the ecosystem survey. Number of replicates is given in parentheses

Equipment	Vessels				
	GO Sars	*Johan Hjort*	*Jan Mayen*	*Fritjof Nansen*	*Smolensk*
Grab (0.1 m^2)				44 (218)	37(222)
Grab (0.25 m^2)	12 (50)	7(35)			
RP sled	11				
Video rig	23				
Sigsby trawl				33	37
Beam trawl	18				

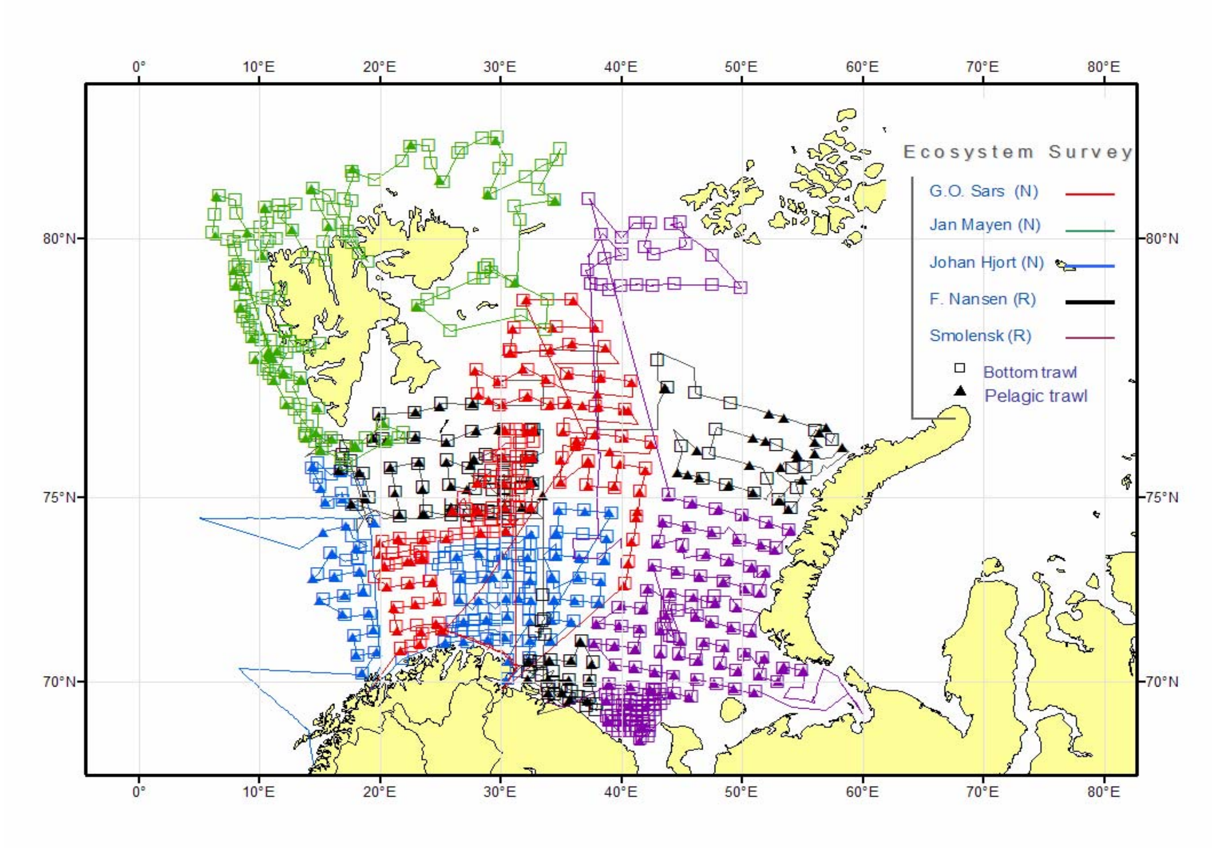

Figure 2.1 Trawl stations for "G.O. Sars" "Johan Hjort", "Jan Mayen", "Nansen" and "Smolensk" August-October 2006

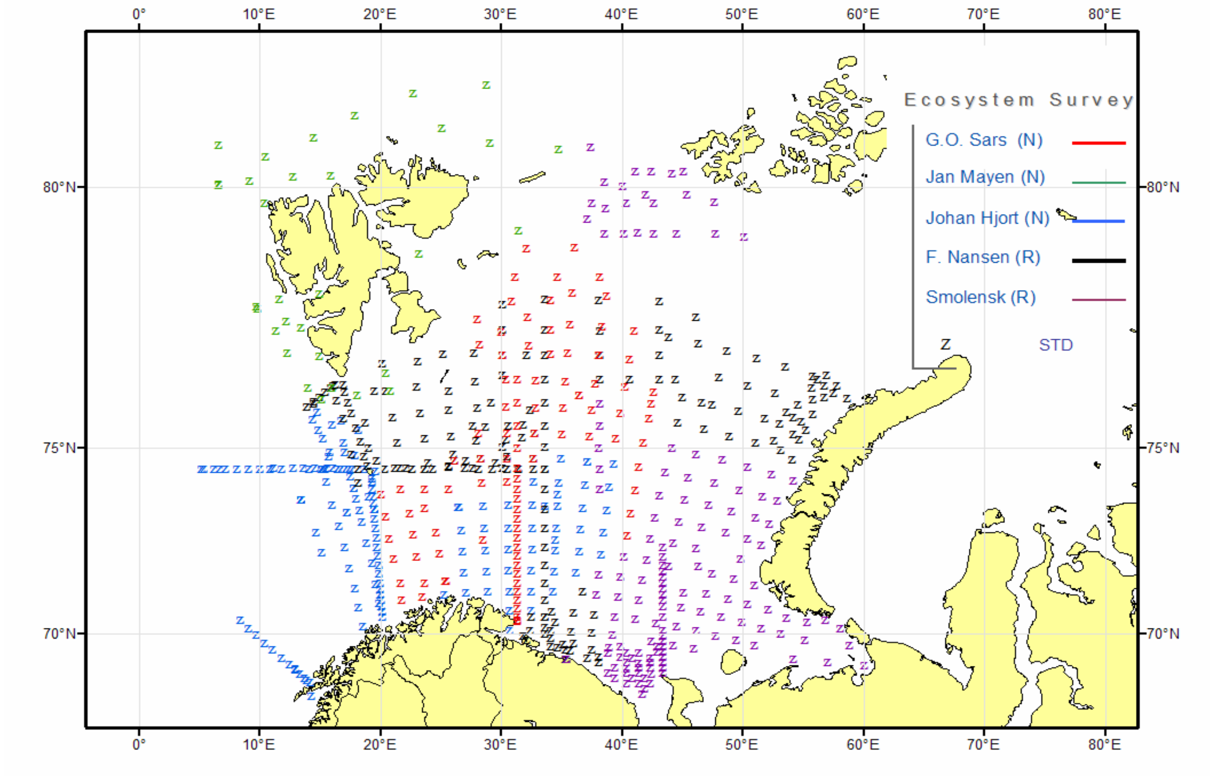

Figure 2.2 Hydrographic stations for "G.O. Sars" "Johan Hjort", "Jan Mayen", "Nansen" and "Smolensk" August-October 2006

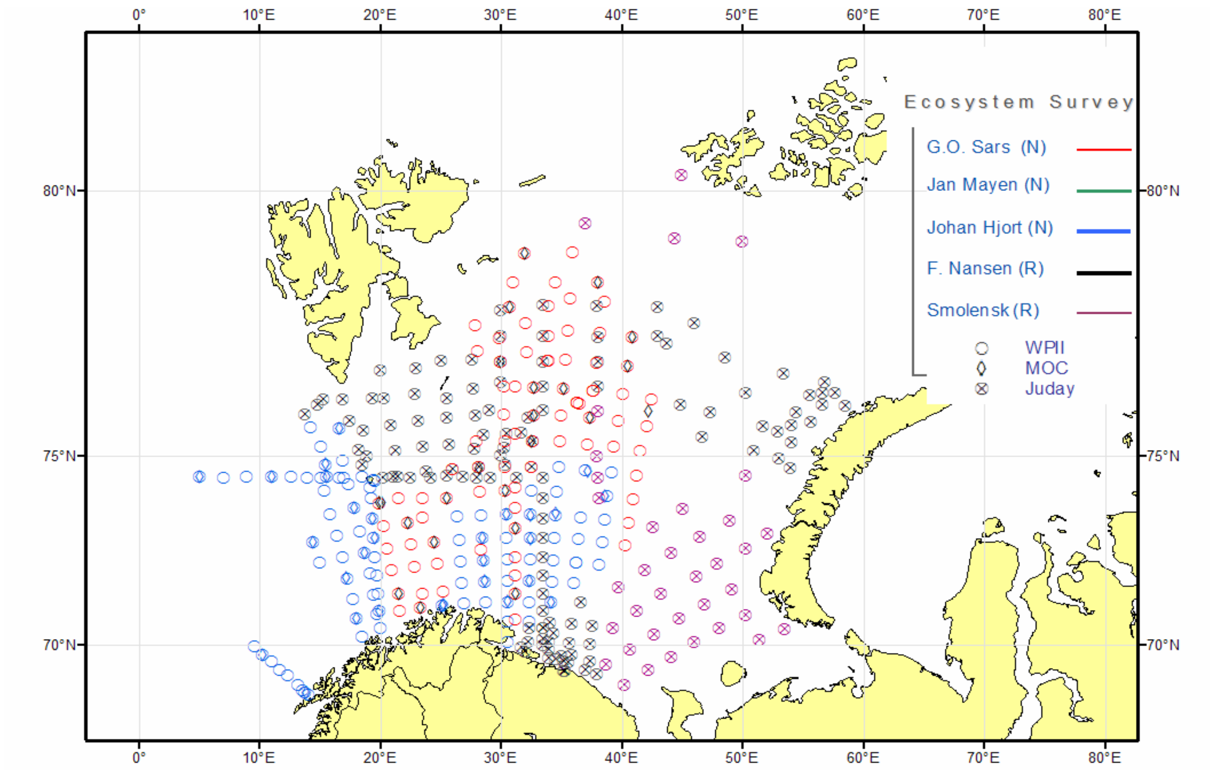

Figure 2.3 Plankton stations for "G.O. Sars" "Johan Hjort", "Jan Mayen", "Fr. Nansen" and "Smolensk" August-October 2006

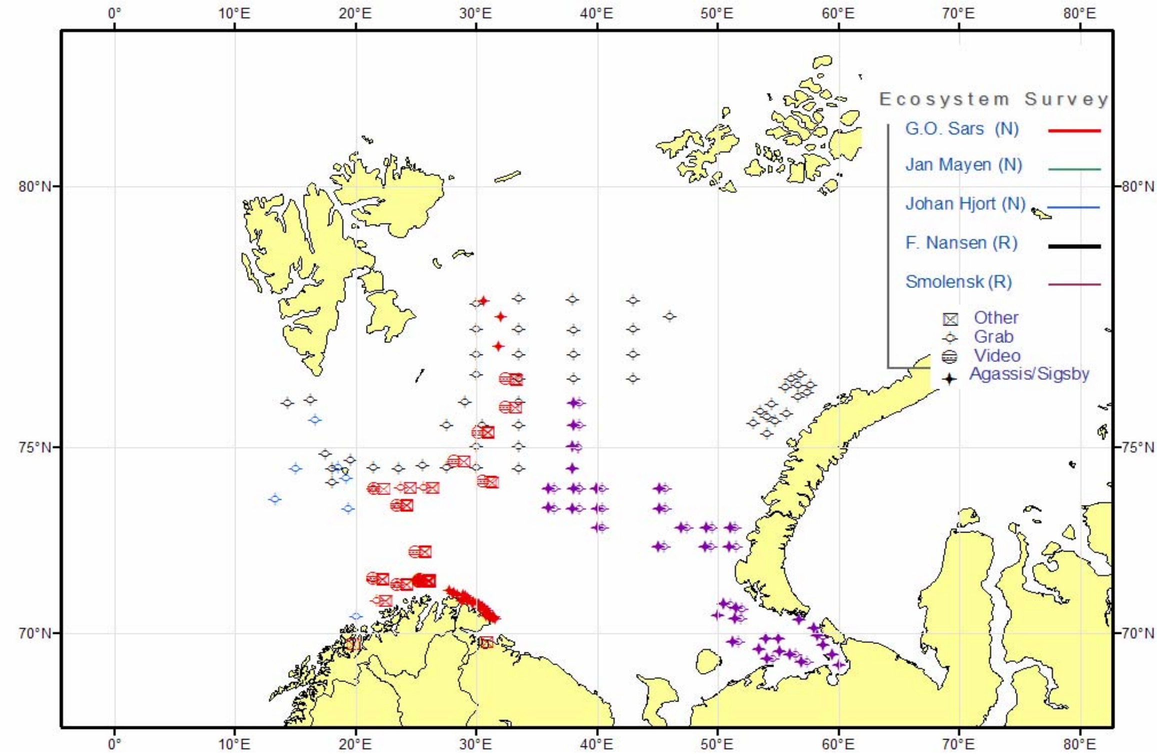

Figure 2.4 Benthos stations for "G.O. Sars" "Johan Hjort", "Jan Mayen", "Fr. Nansen" and "Smolensk" August-October 2006

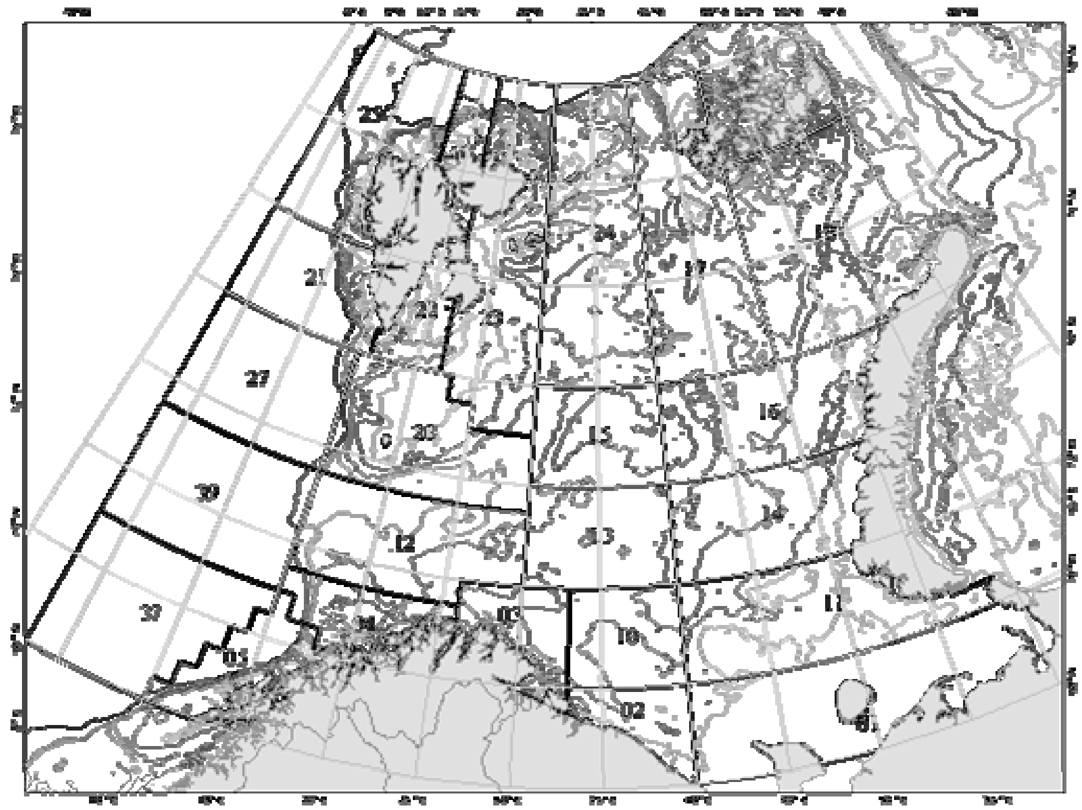

Figure 2.5 Strata-system used in 0-group stratified sample mean estimations

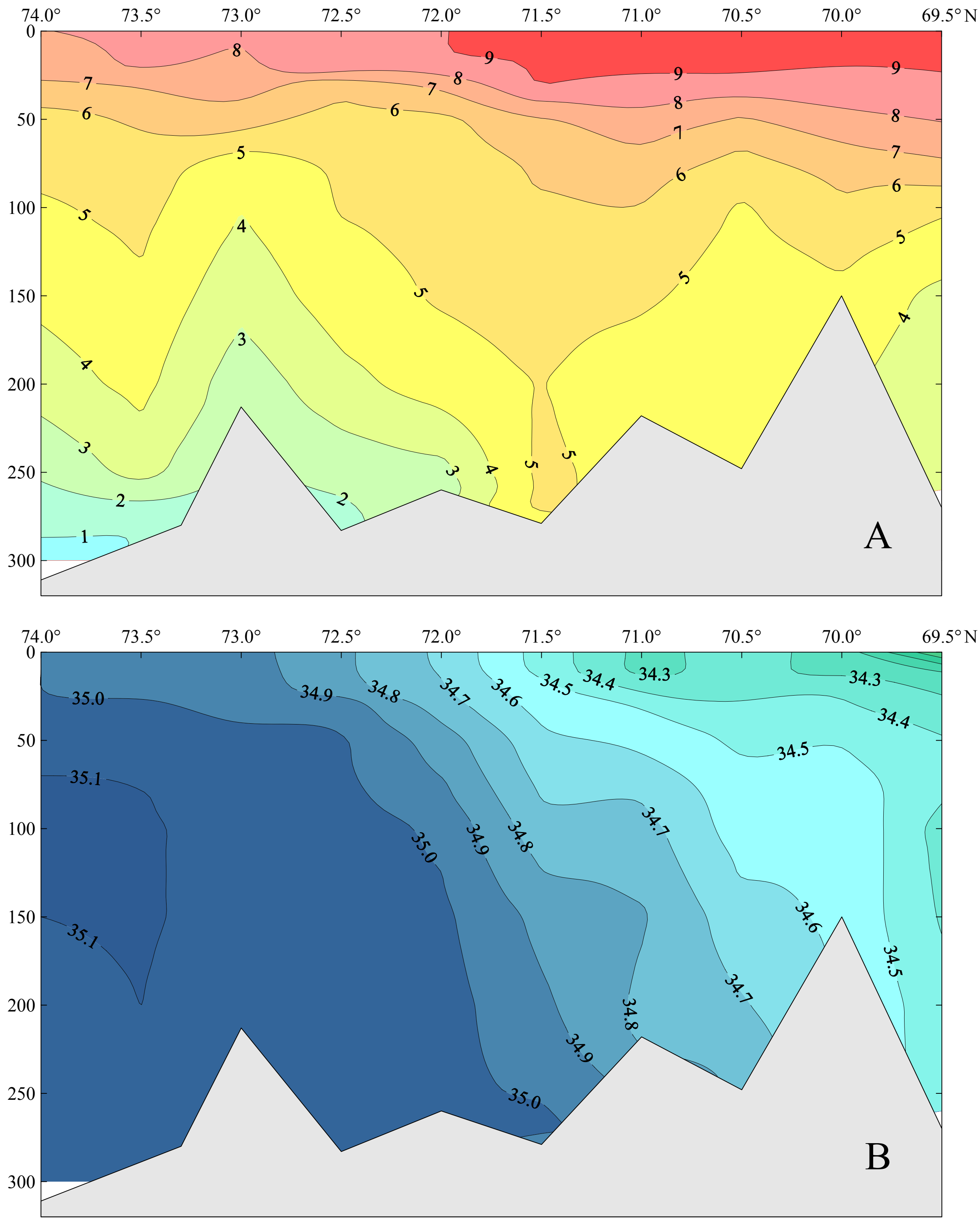

Figure 2.1.1 Temperature (A) and salinity (B) in the Kola Section

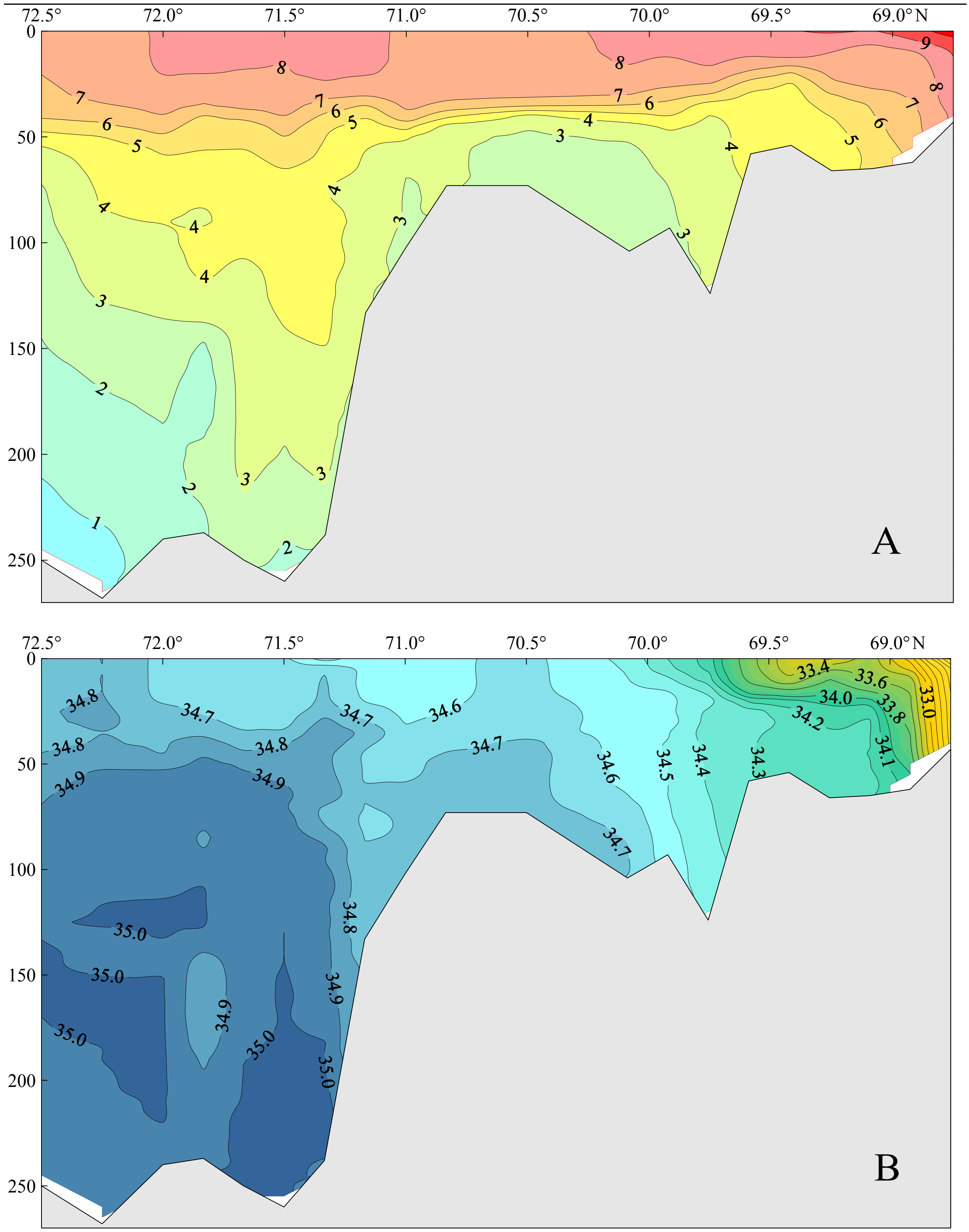

Figure 2.1.2 Temperature (A) and salinity (B) in the Kanin Section

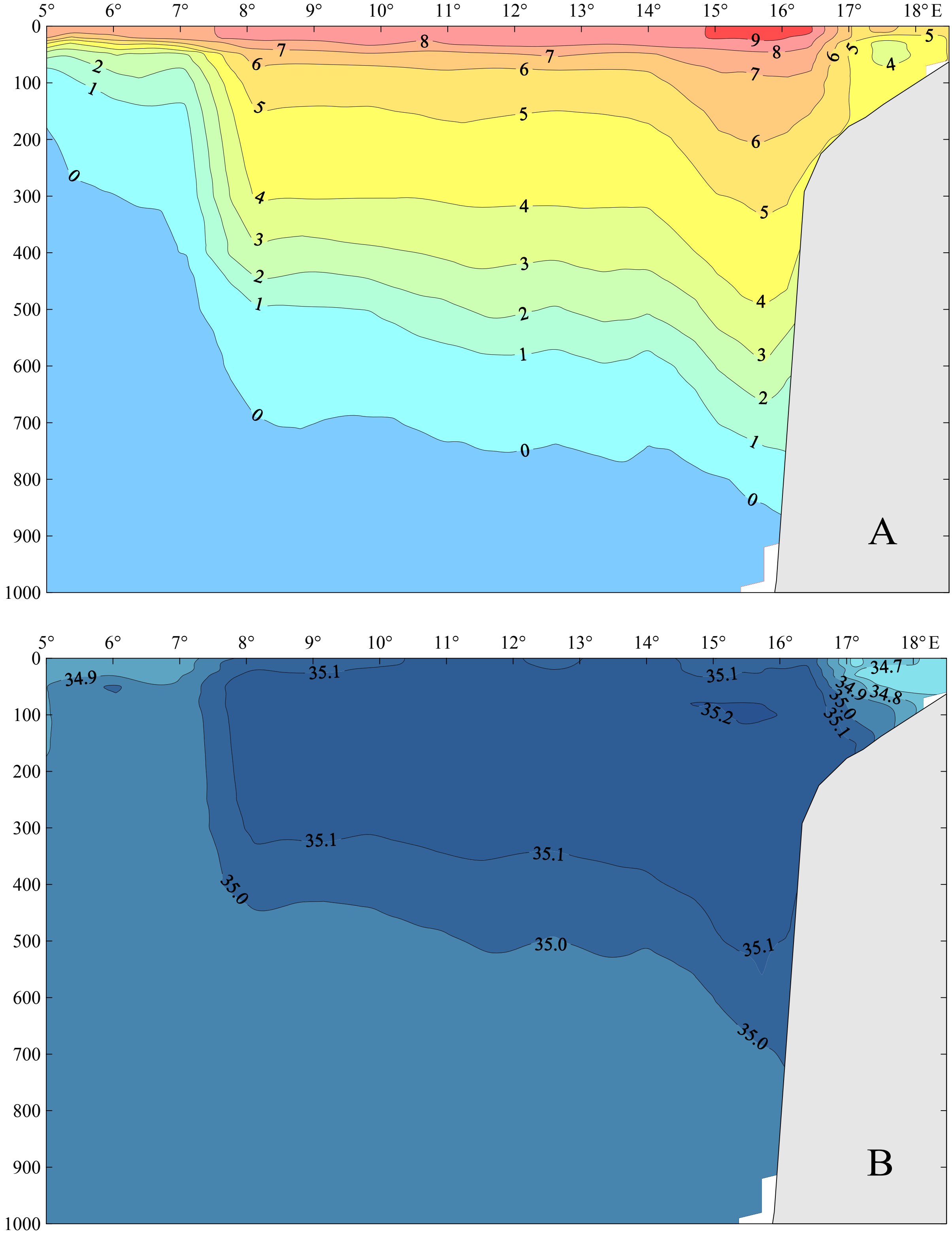

Figure 2.1.3 Temperature (A) and salinity (B) in the Bear Island - West Section

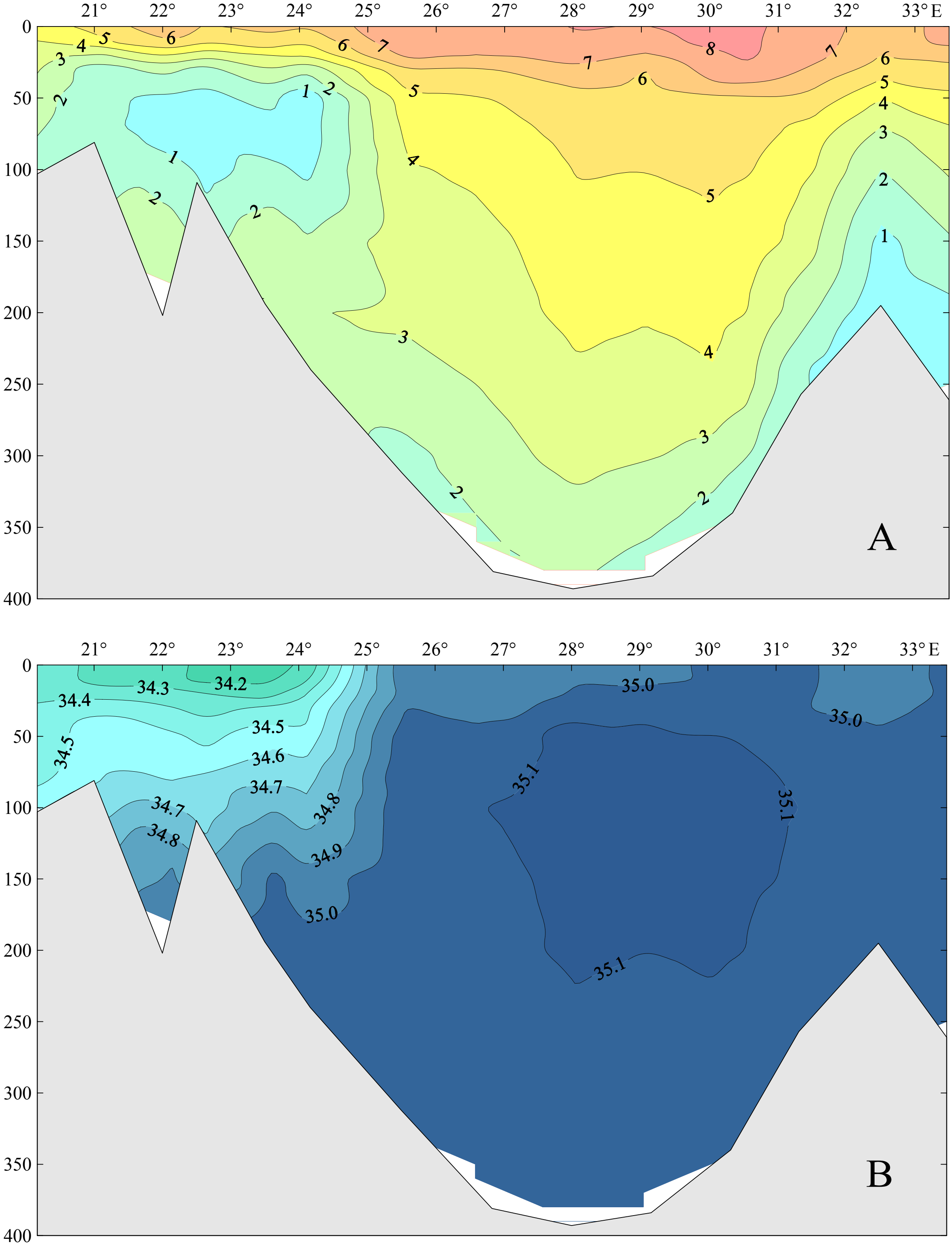

Figure 2.1.4 Temperature (A) and salinity (B) in the Bear Island - East Section

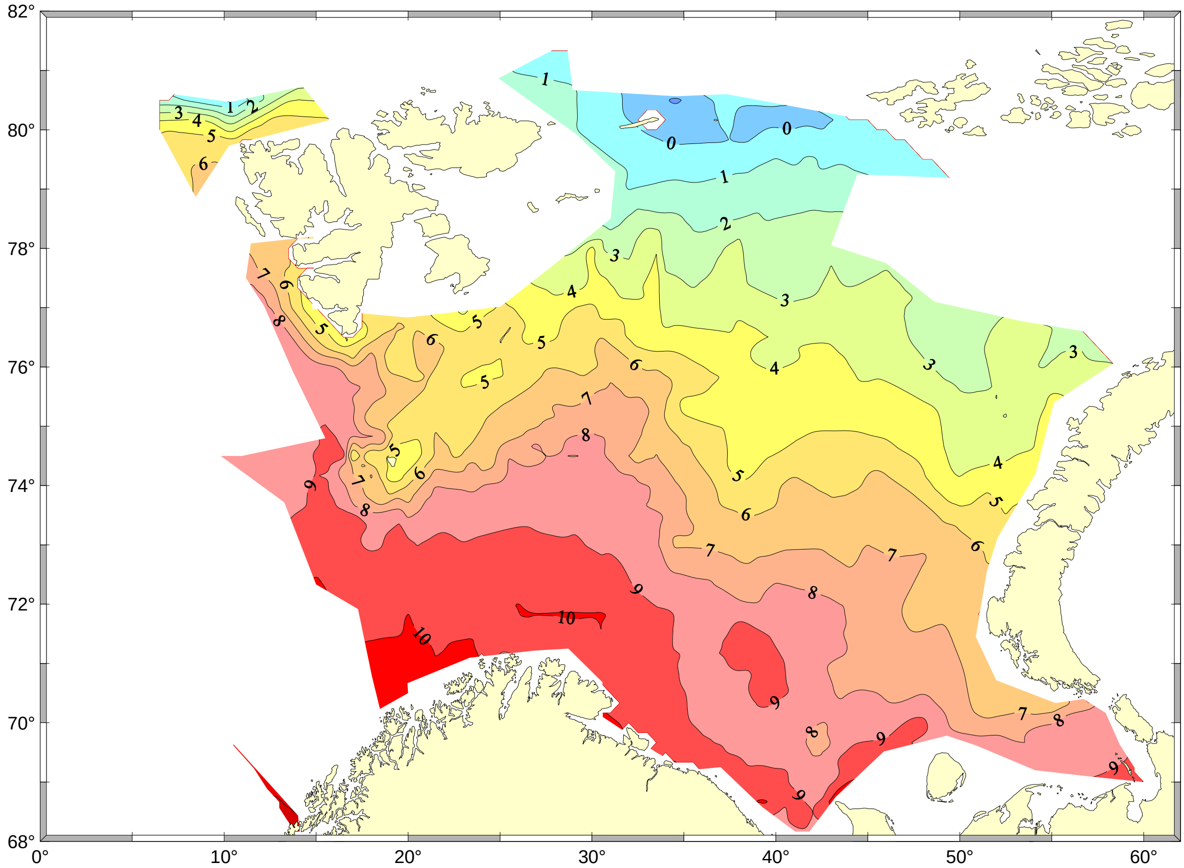

Figure 2.1.5 Distribution of surface temperature (°C), August-October 2006

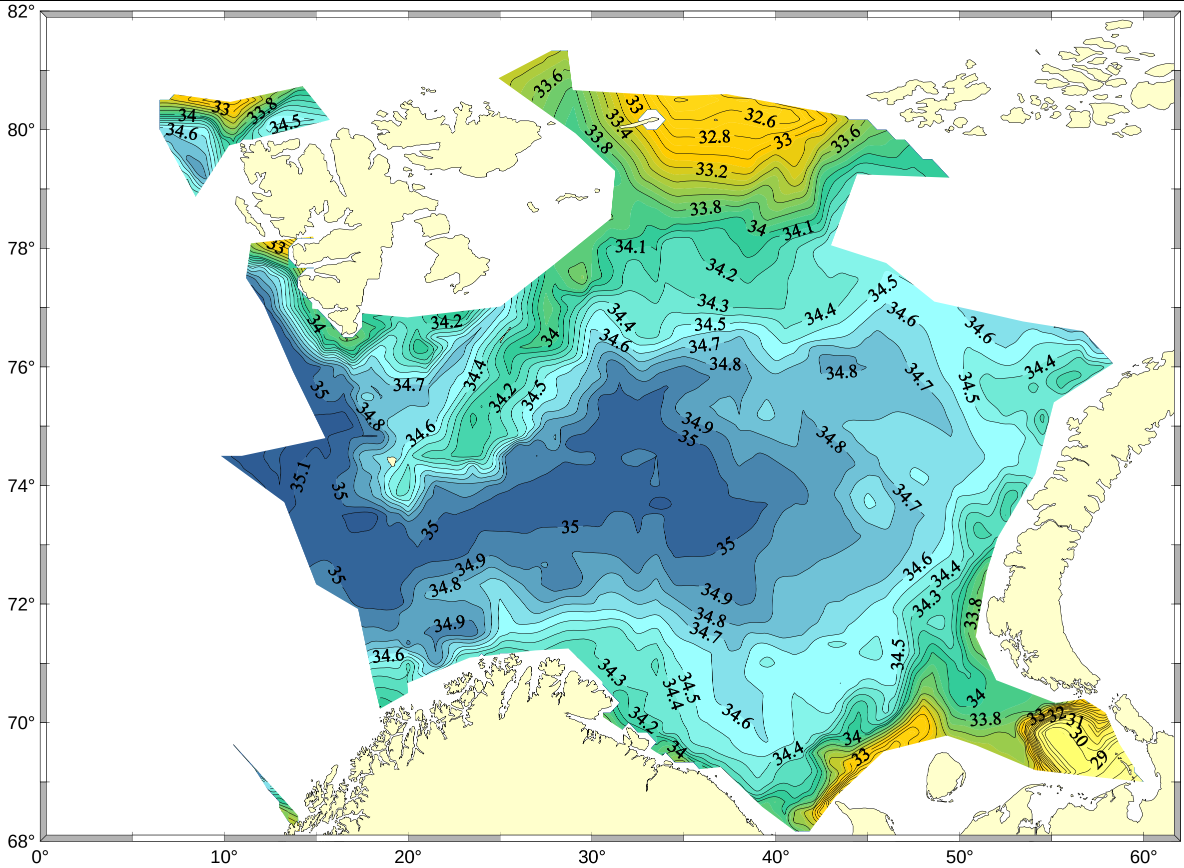

Figure 2.1.6 Distribution of surface salinity, August-October 2006

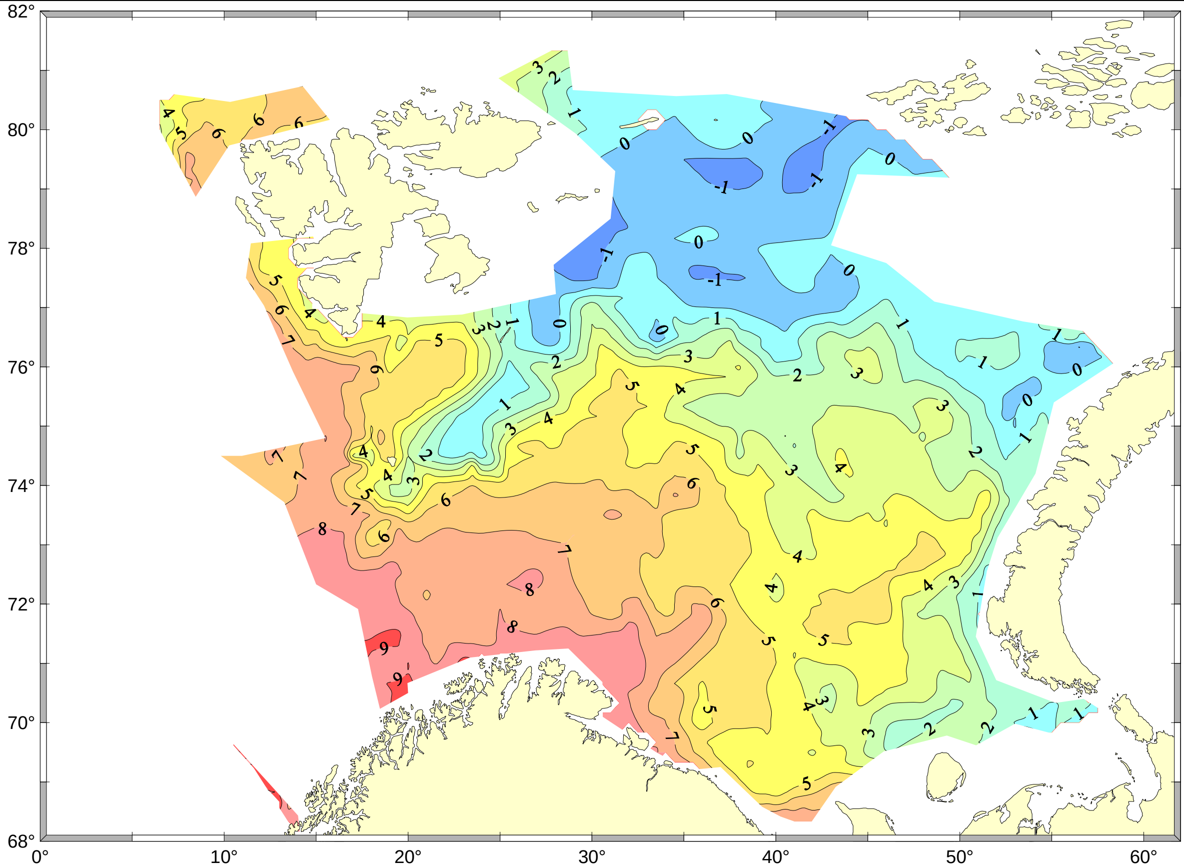

Figure 2.1.7 Distribution of temperature (°C) at the 50 m depth, August-October 2006

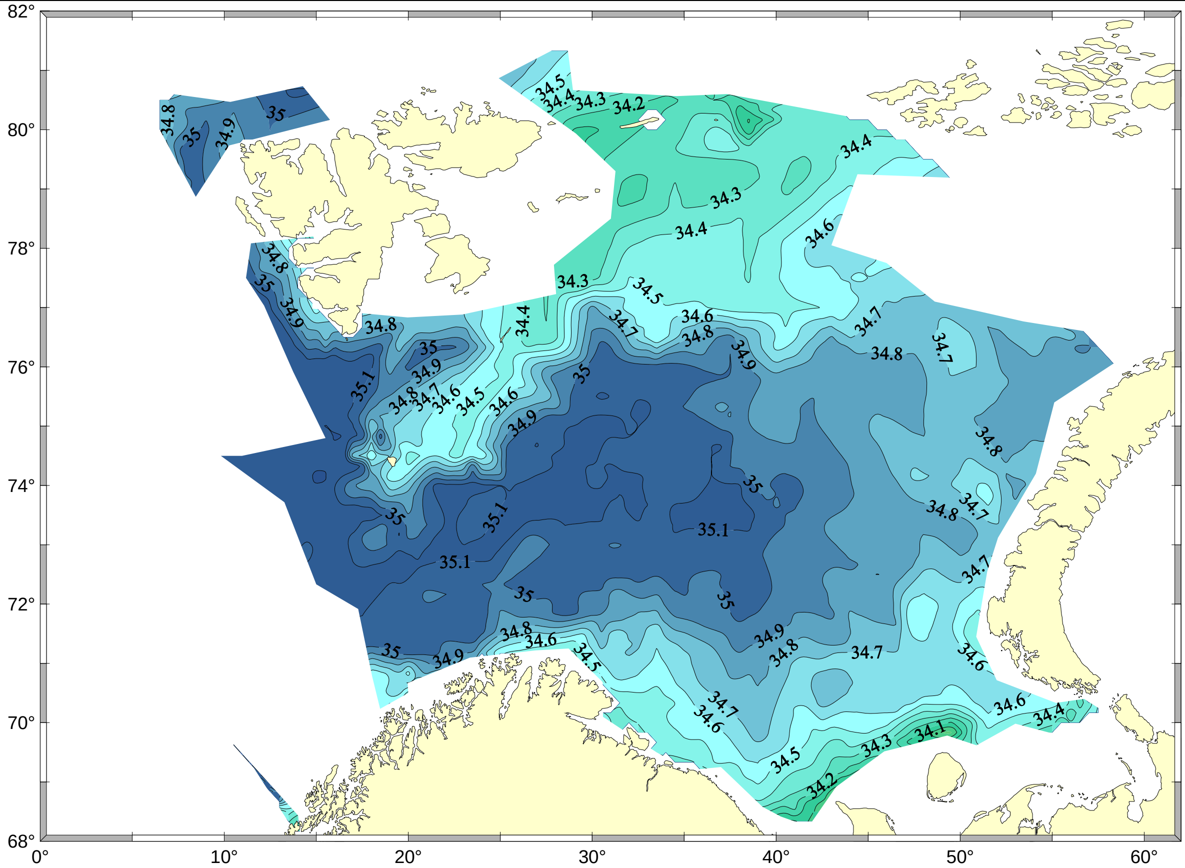

Figure 2.1.8 Distribution of salinity at the 50 m depth, August-October 2006

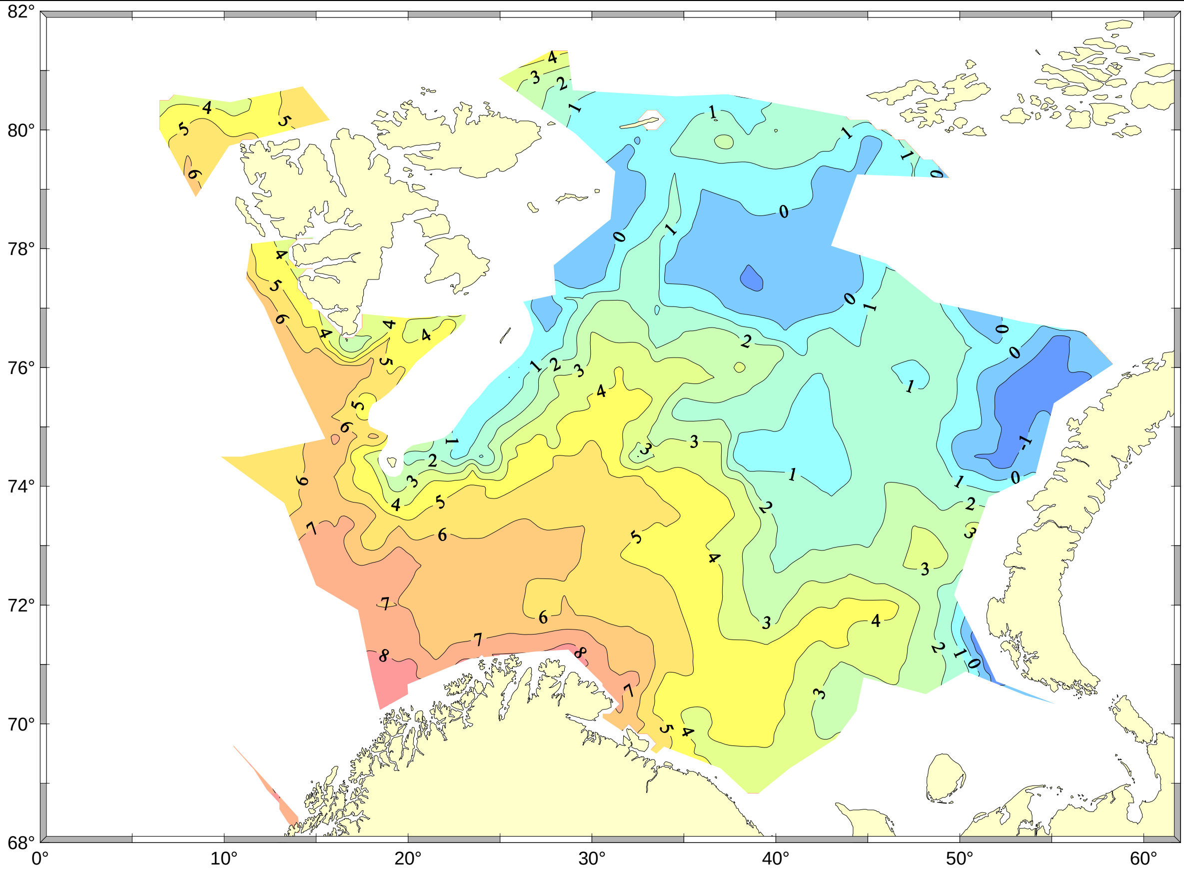

Figure 2.1.9 Distribution of temperature (°C) at the 100 m depth, August-October 2006

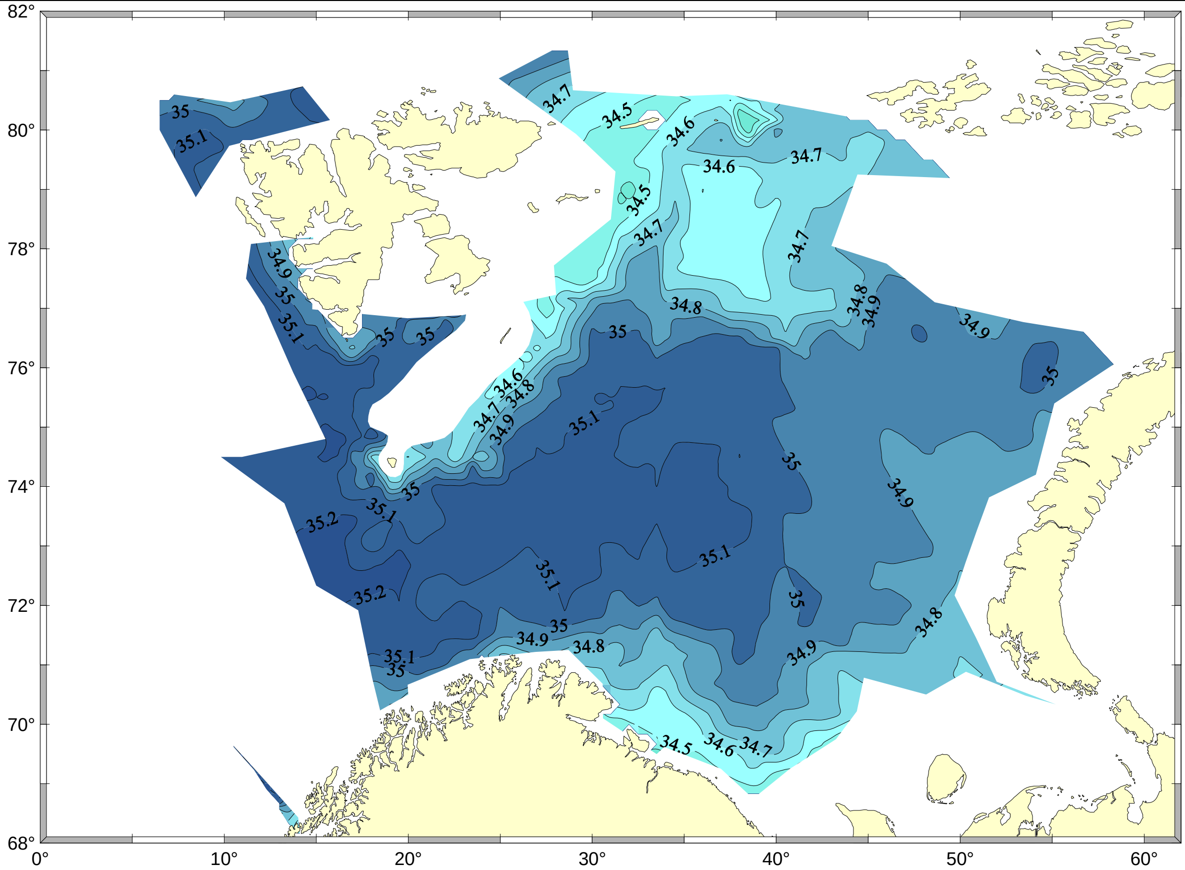

Figure 2.1.10 Distribution of salinity at the 100 m depth, August-October 2006

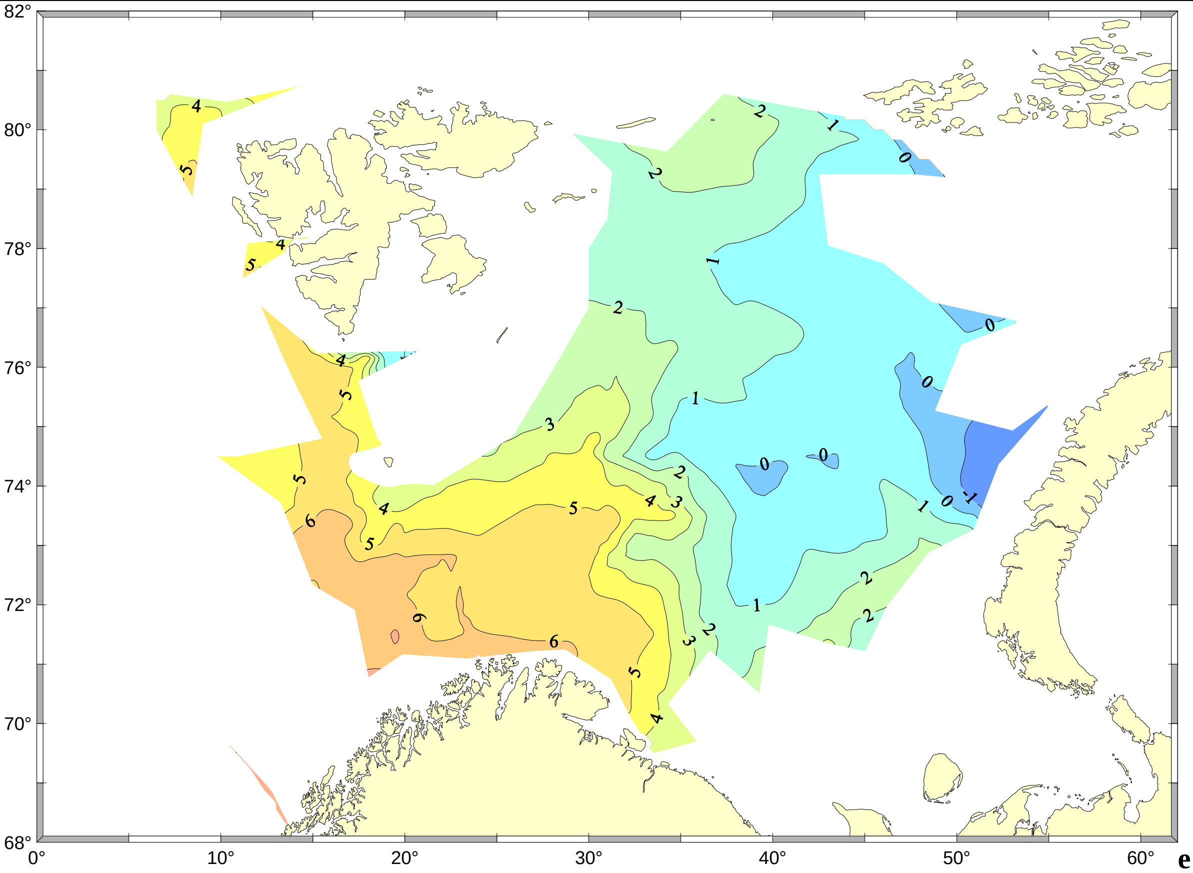

Figure 2.1.11 Distribution of temperature (°C) at the 200 m depth, August-October 2006

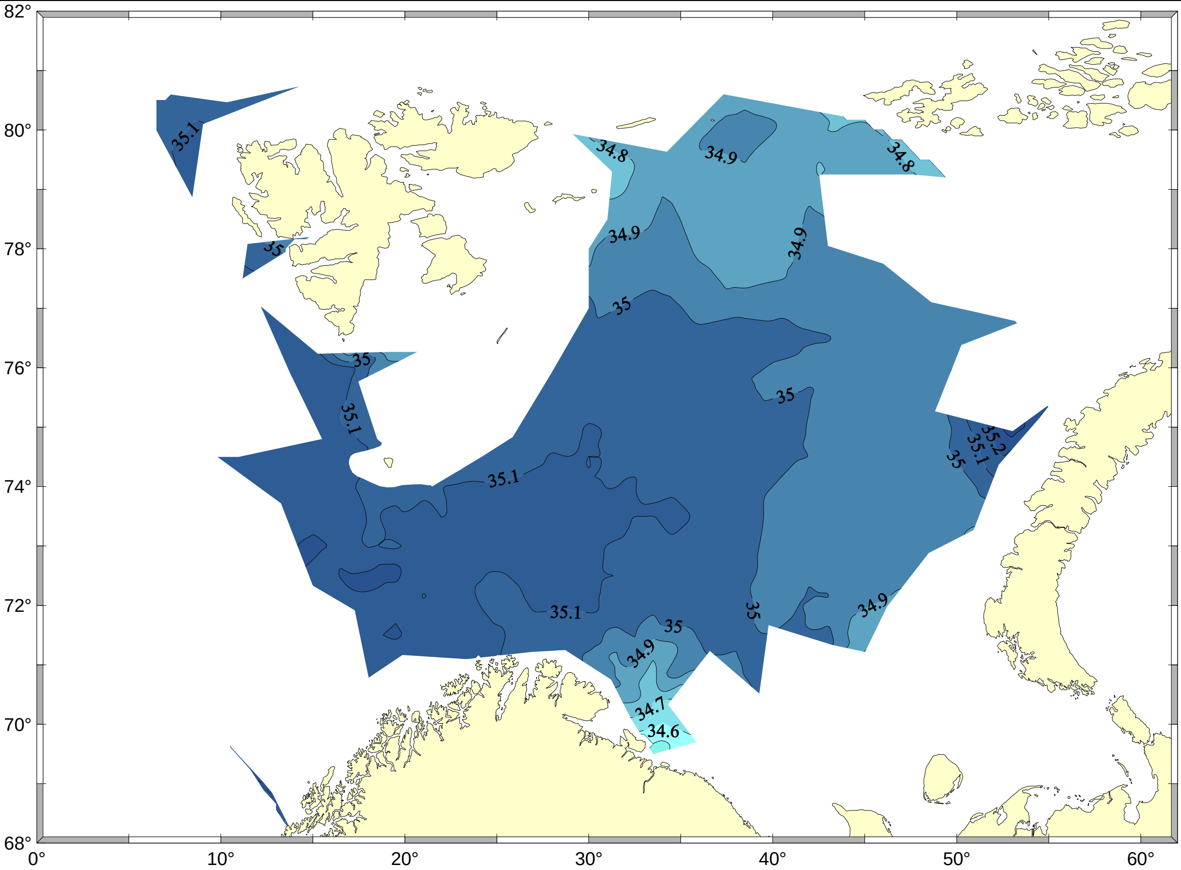

Figure 2.1.12 Distribution of salinity at the 200 m depth, August-October 2006

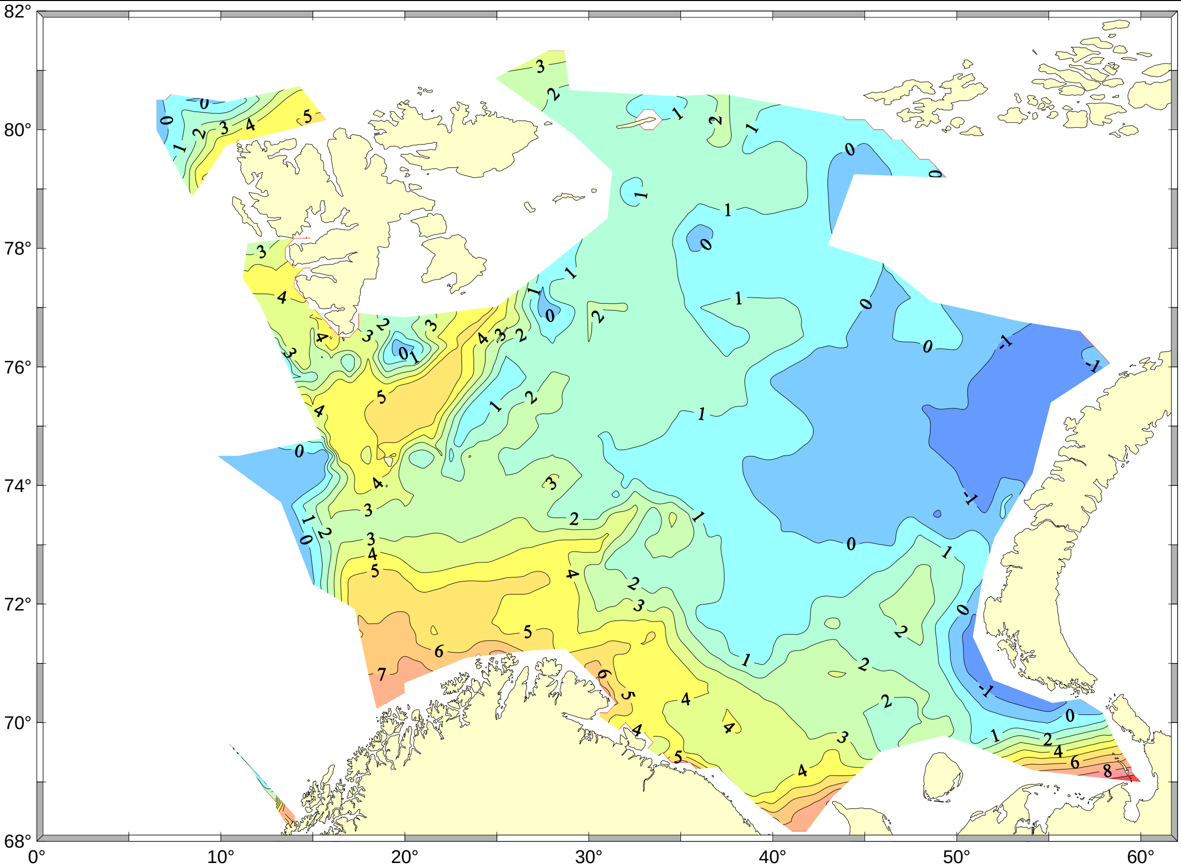

Figure 2.1.13 Distribution of temperature (°C) at the bottom, August-October 2006

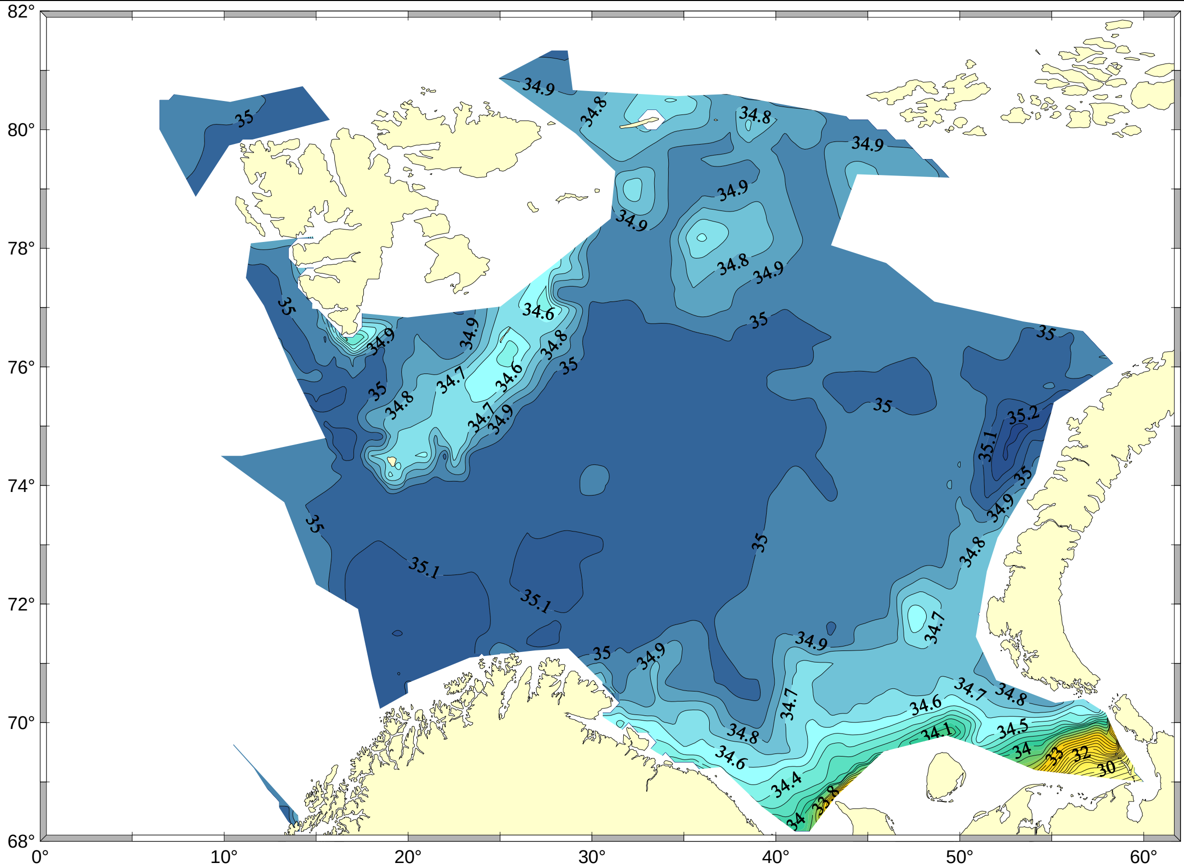

Figure 2.1.14 Distribution of salinity at the bottom, August-October 2006

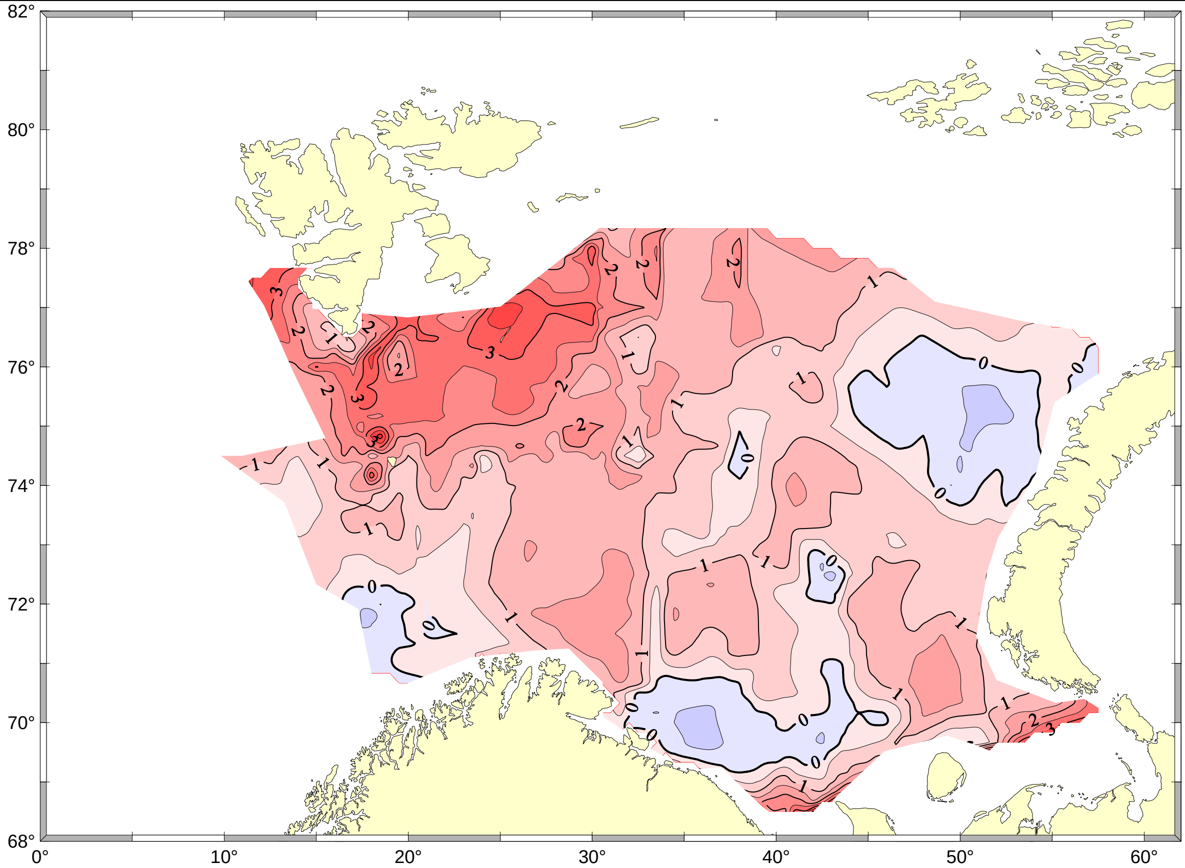

Figure 2.1.15 Surface temperature anomalies (°C), August-October 2006

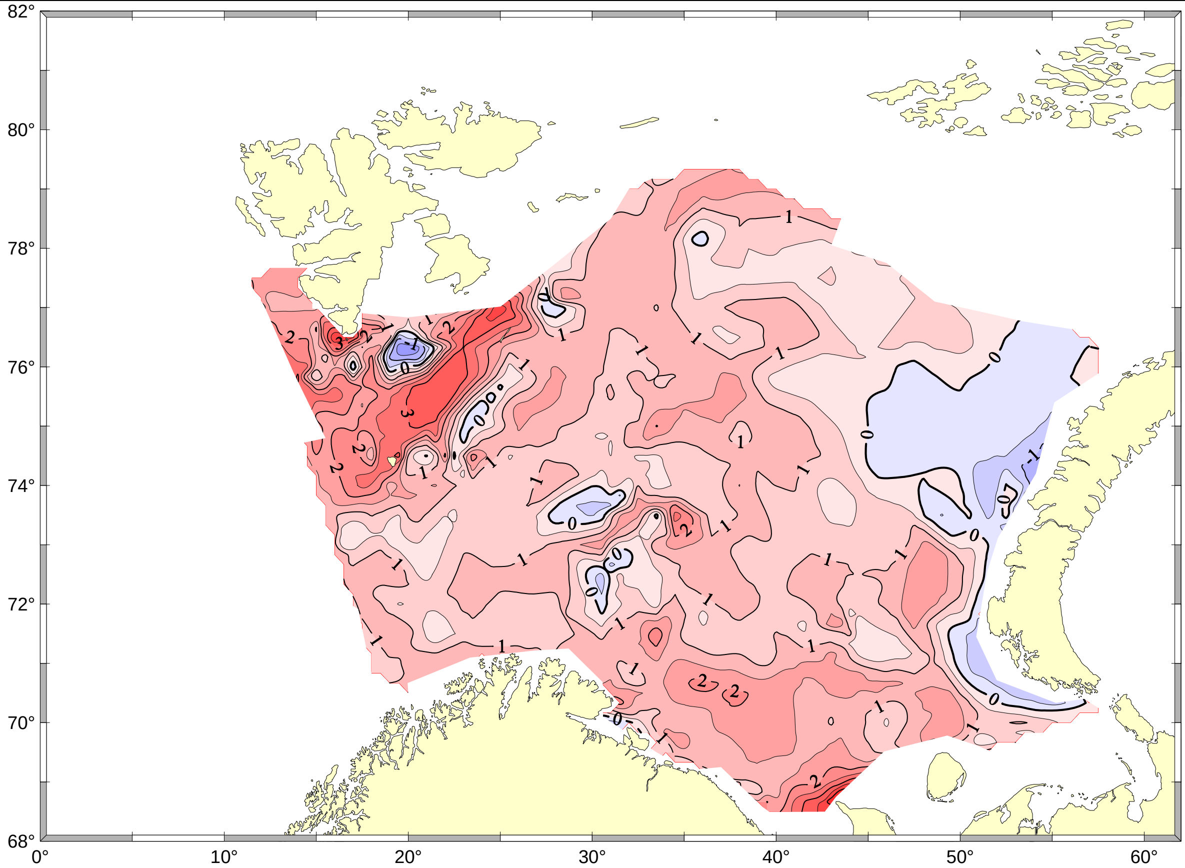

Figure 2.1.16 Temperature anomalies (°C) at the bottom, August-October 2006

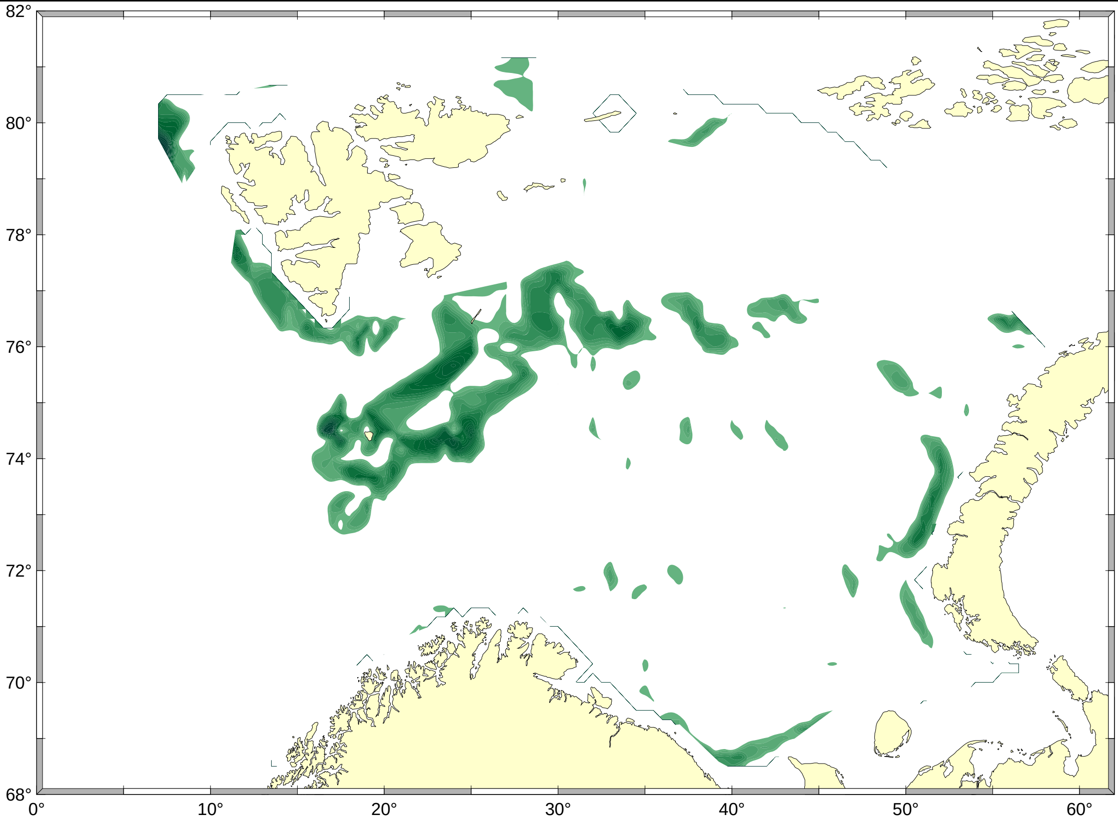

Figure 2.1.17 Temperature in frontal zones at 50 m depth (areas with temperature gradients more than 0.04°C/km), August-October 2006

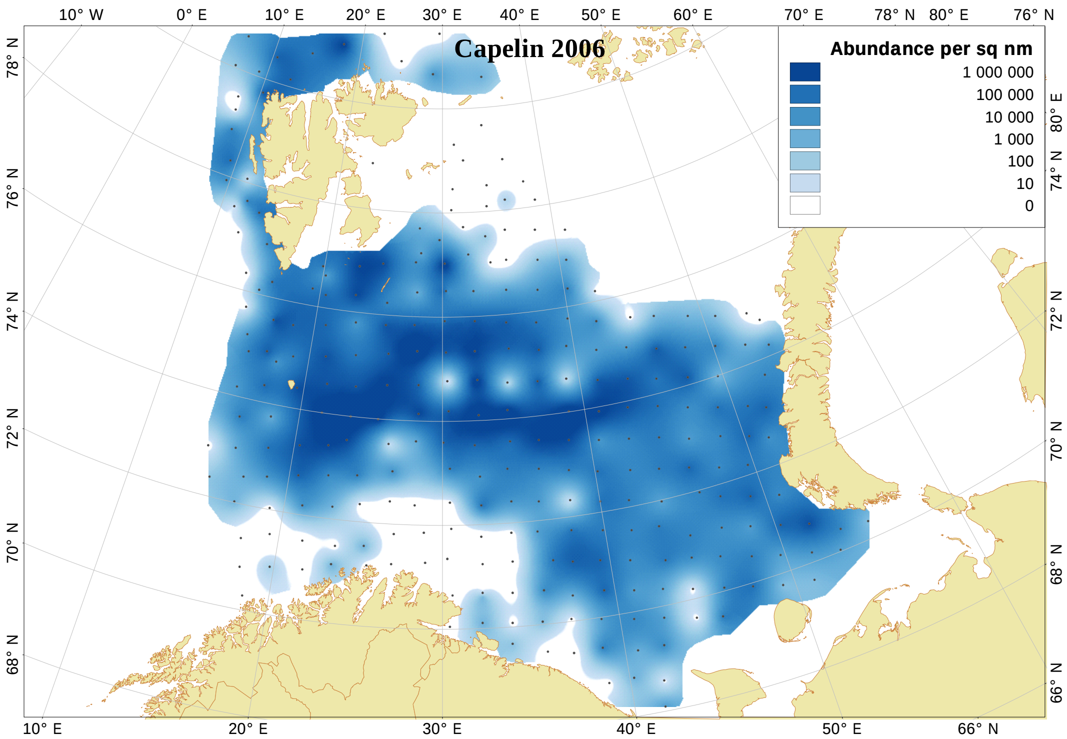

Figure 2.2.1 Distribution of 0-group capelin autumn 2006

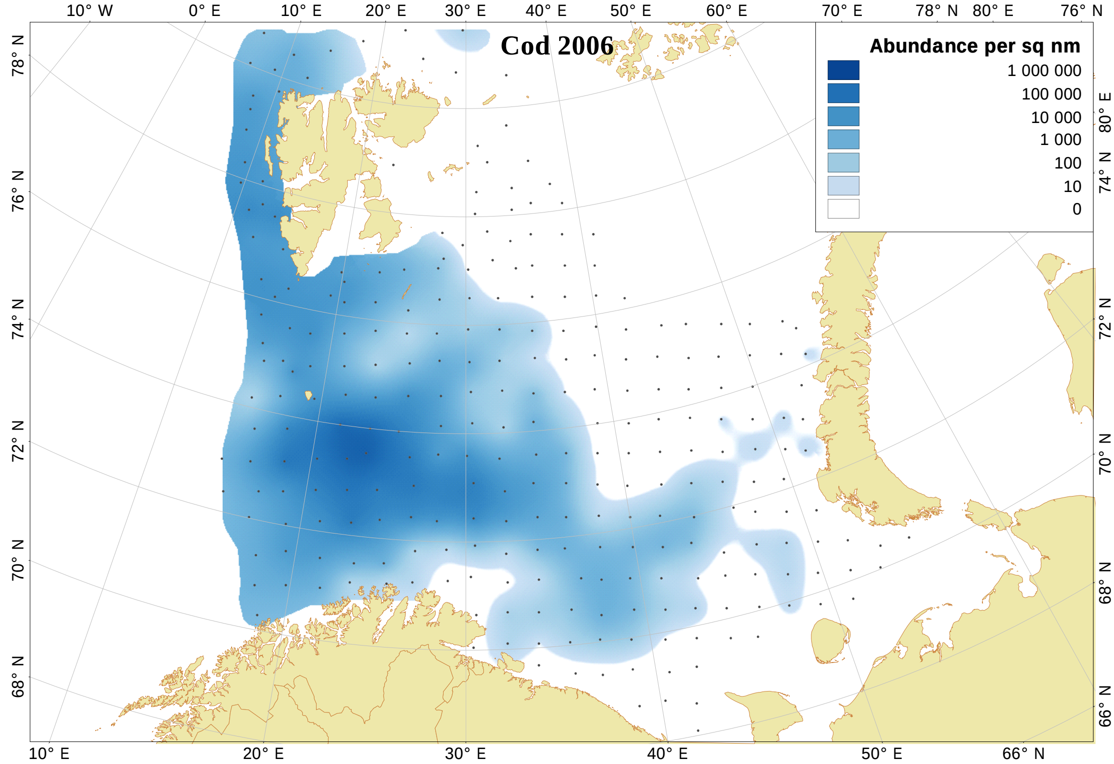

Figure 2.2.2 Distribution of 0-group cod autumn 2006

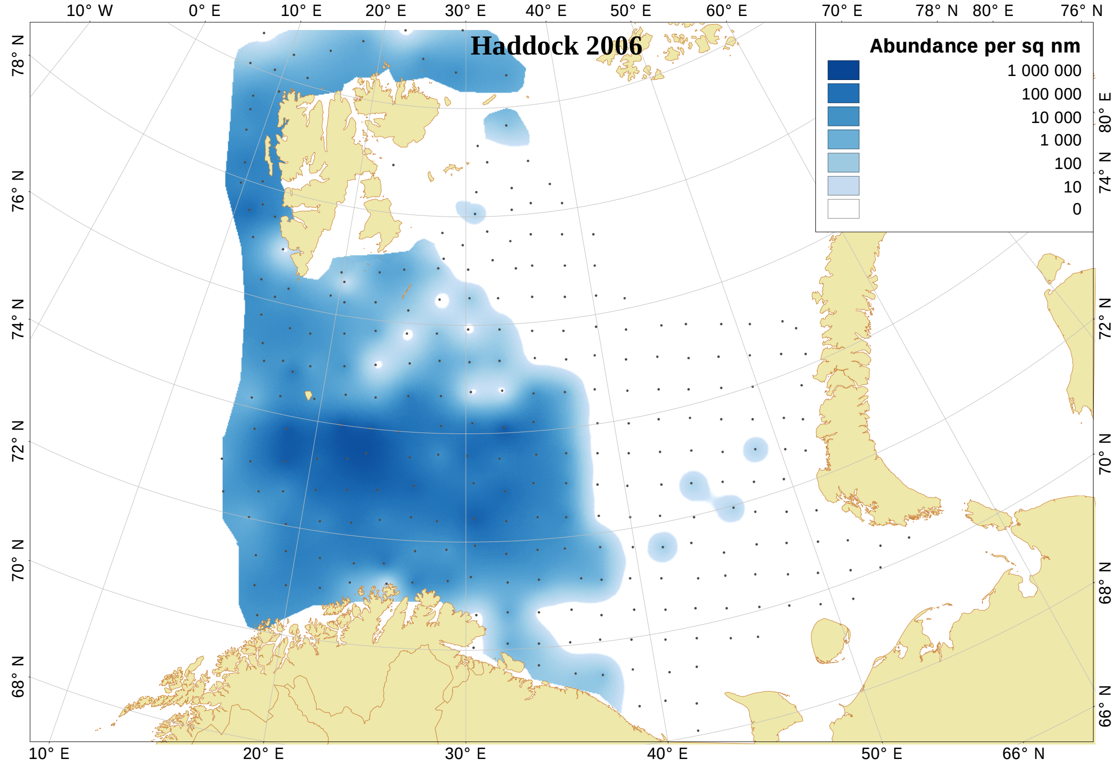

Figure 2.2.3 Distribution of 0-group haddock autumn 2006

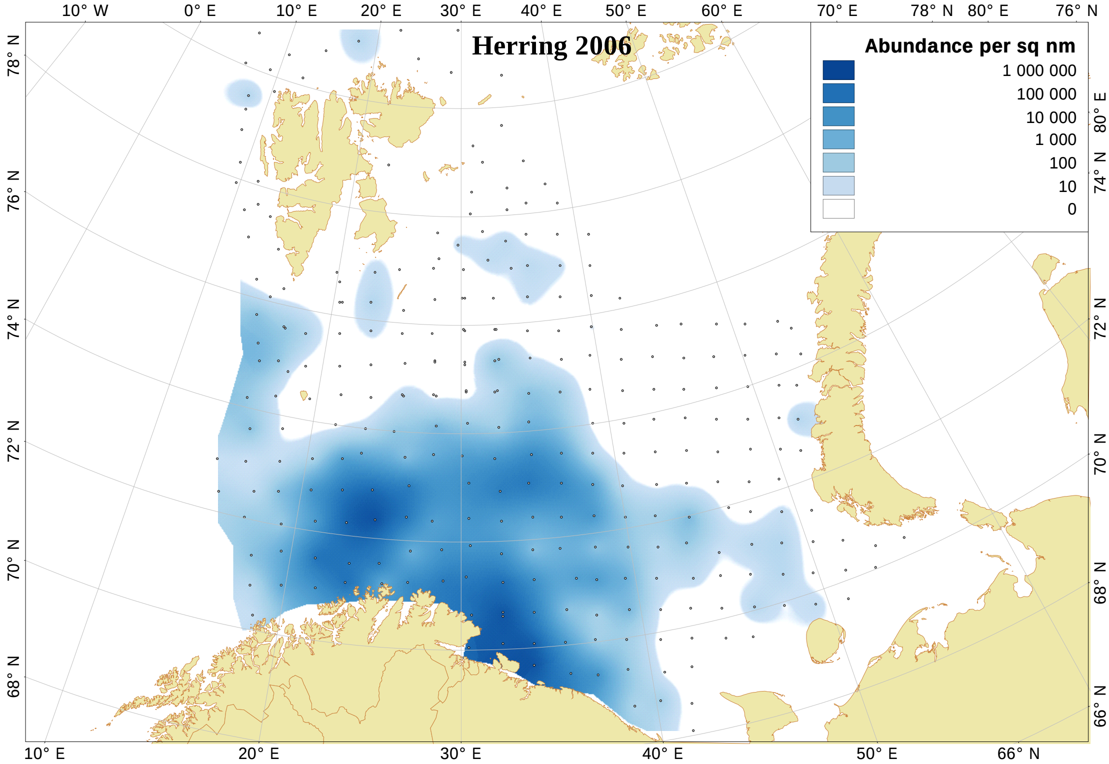

Figure 2.2.4 Distribution of 0-group herring autumn 2006

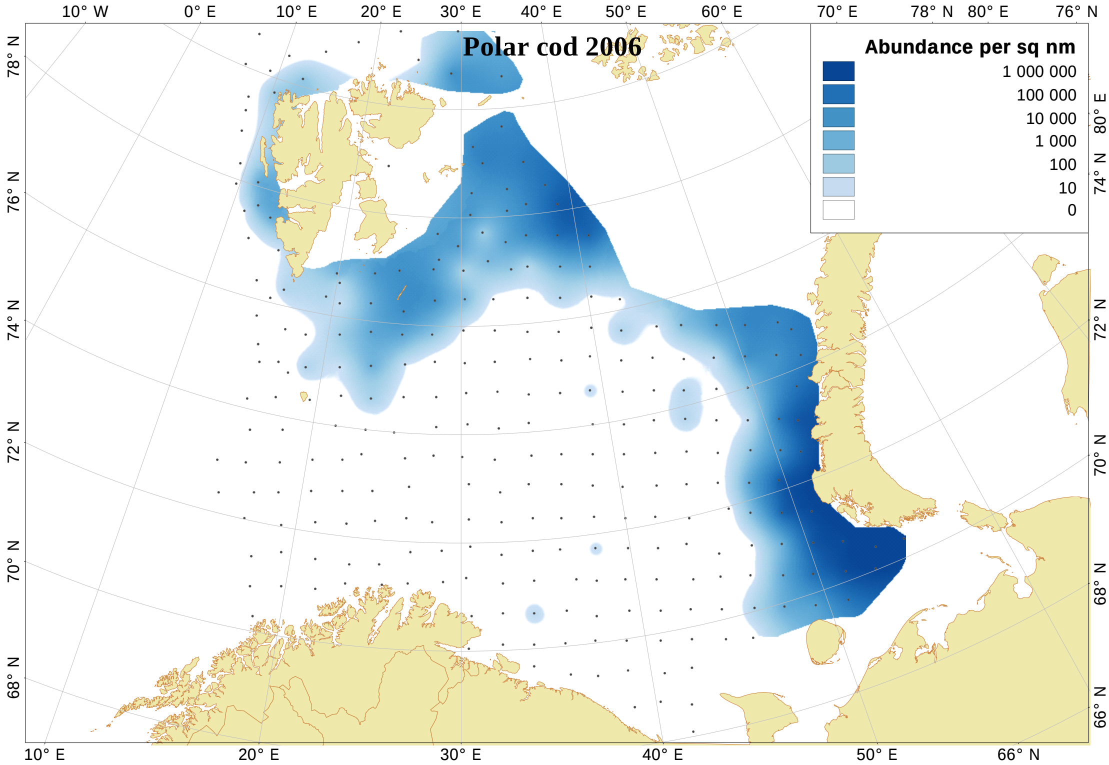

Figure 2.2.5 Distribution of 0-group polar cod autumn 2006

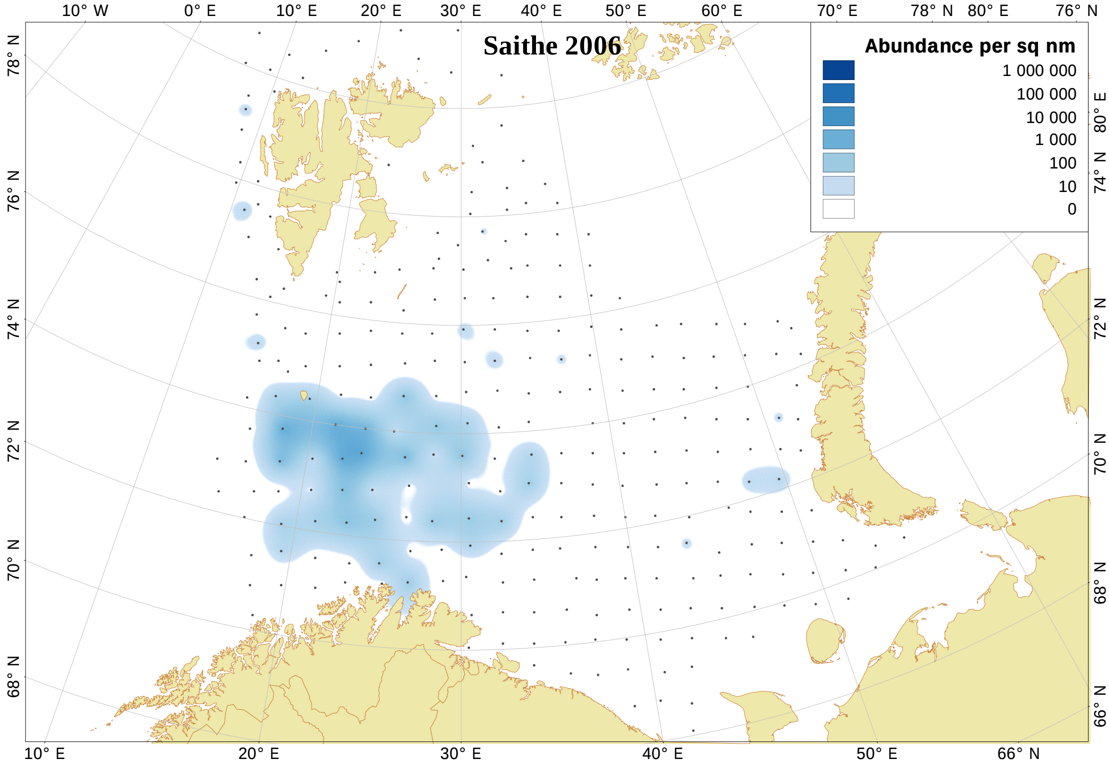

Figure 2.2.6 Distribution of 0-group saithe autumn 2006

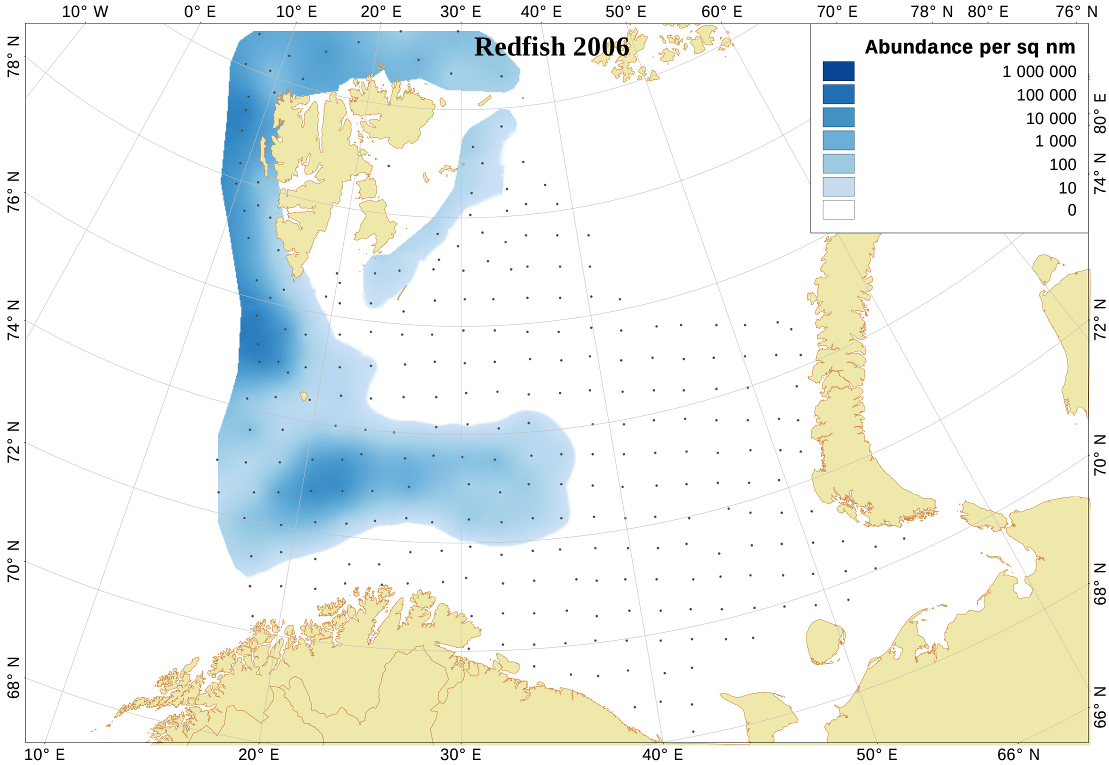

Figure 2.2.7 Distribution of 0-group redfish autumn 2006

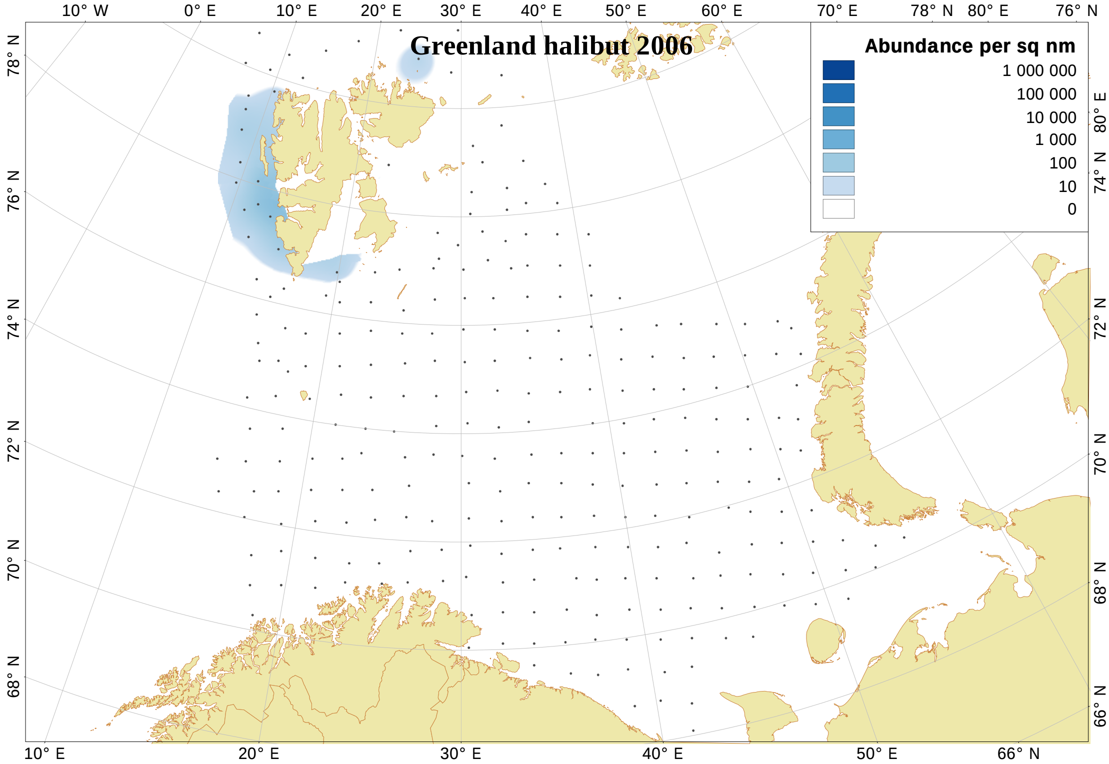

Figure 2.2.8 Distribution of 0-group Greenland halibut autumn 2006

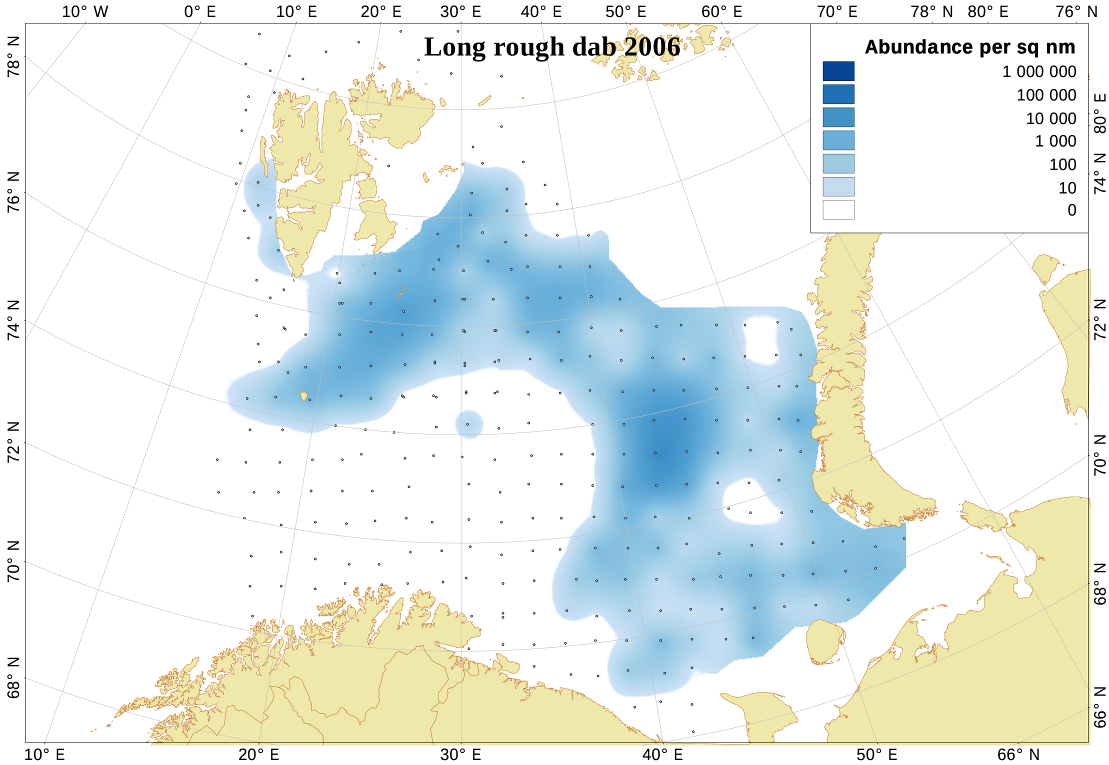

Figure 2.2.9 Distribution of 0-group long rough dab autumn 2006

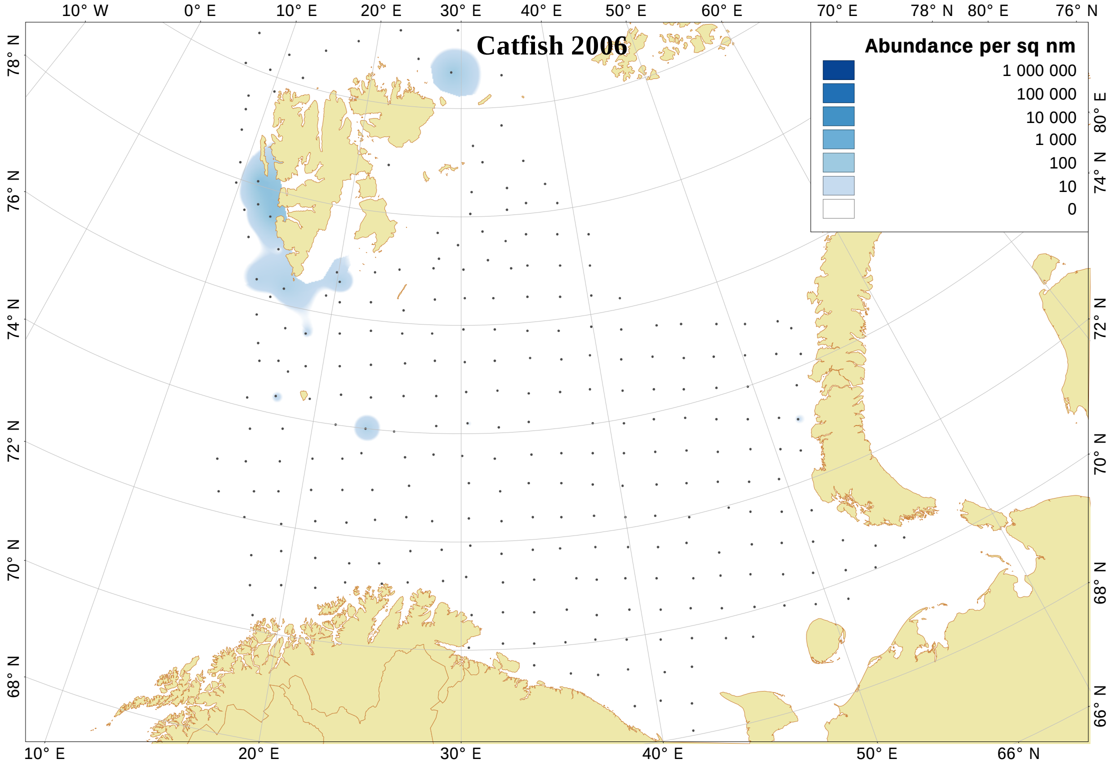

Figure 2.2.10 Distribution of 0-group catfish long rough dab autumn 2006

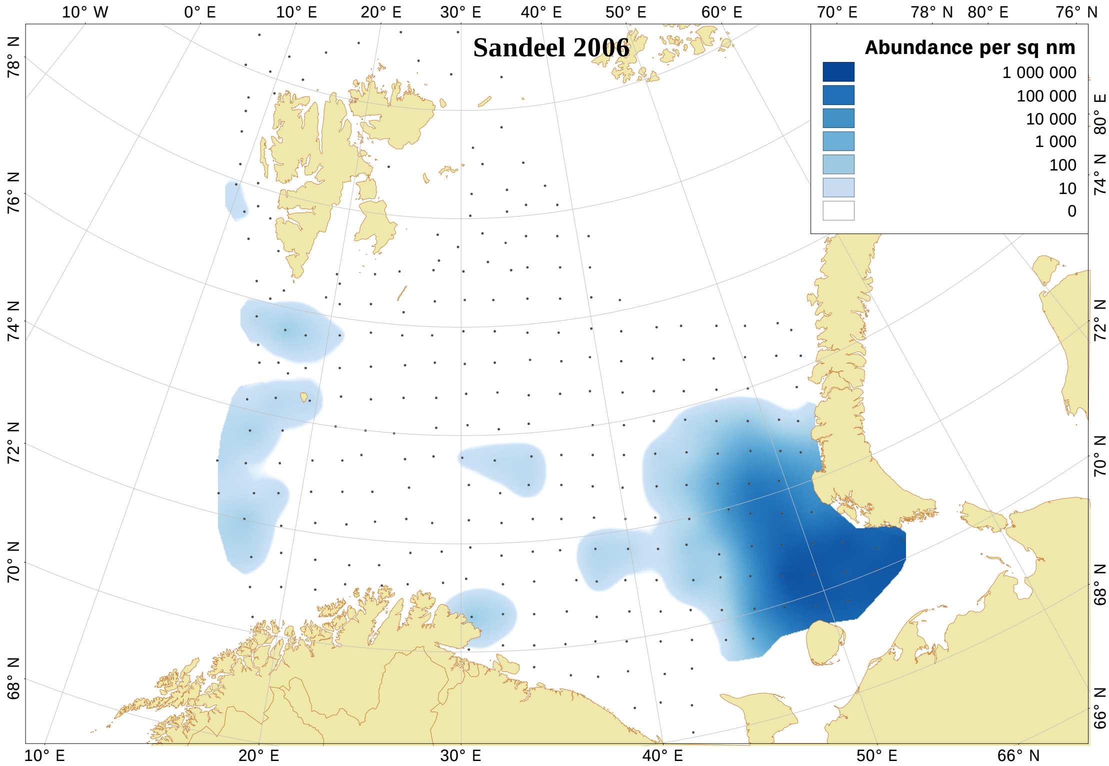

Figure 2.2.11 Distribution of 0-group sandeel autumn 2006

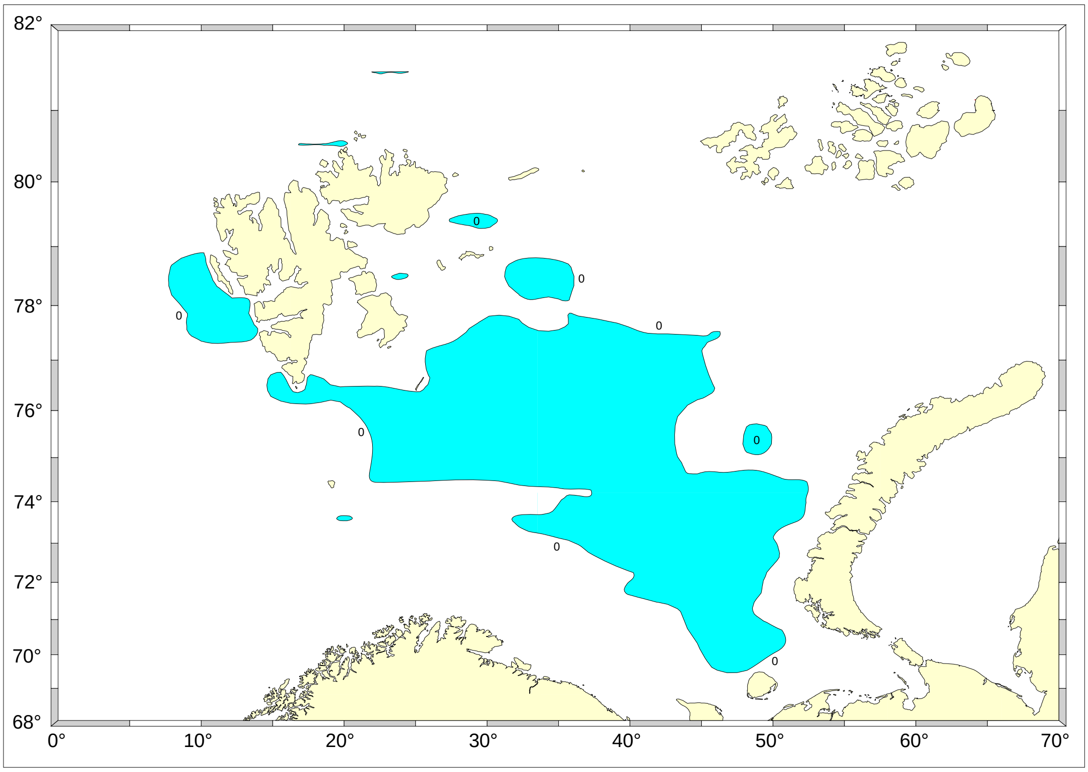

Figure 2.3.1 Estimated density distribution of one-year-old capelin (t/ nautical mile2) August-October 2006

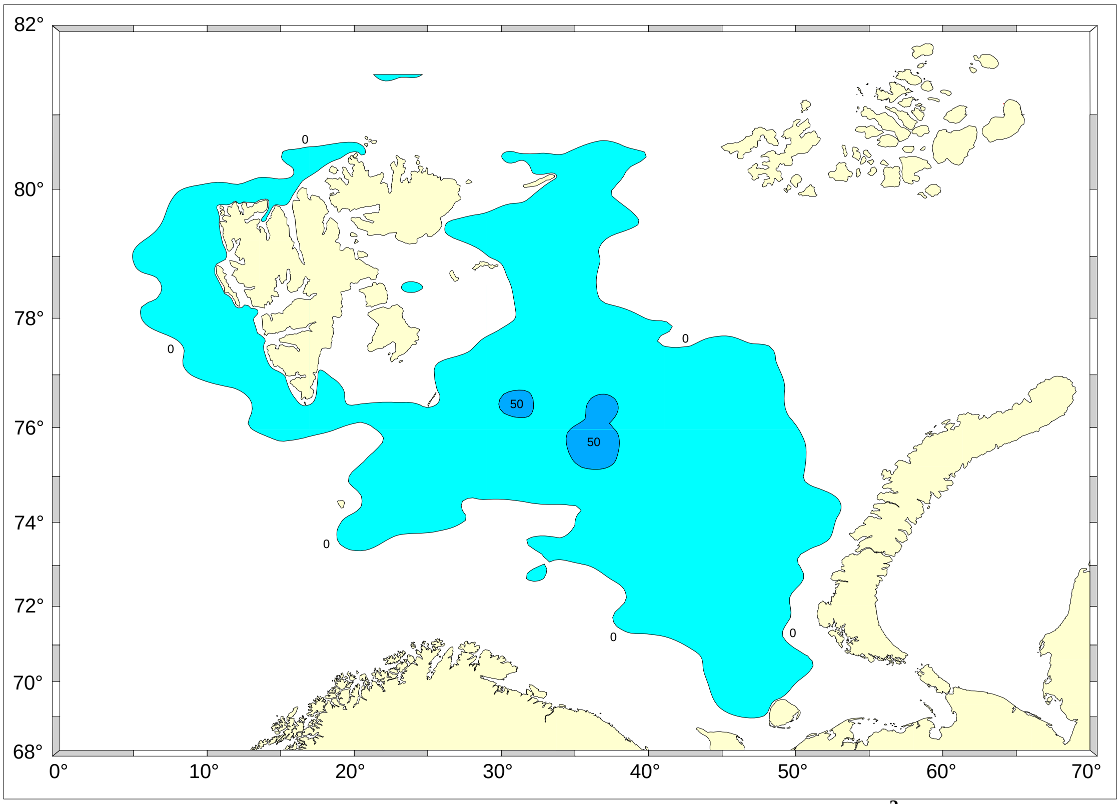

Figure 2.3.2 Estimated total density distribution of capelin (t/ nautical mile^2) August-October 2006

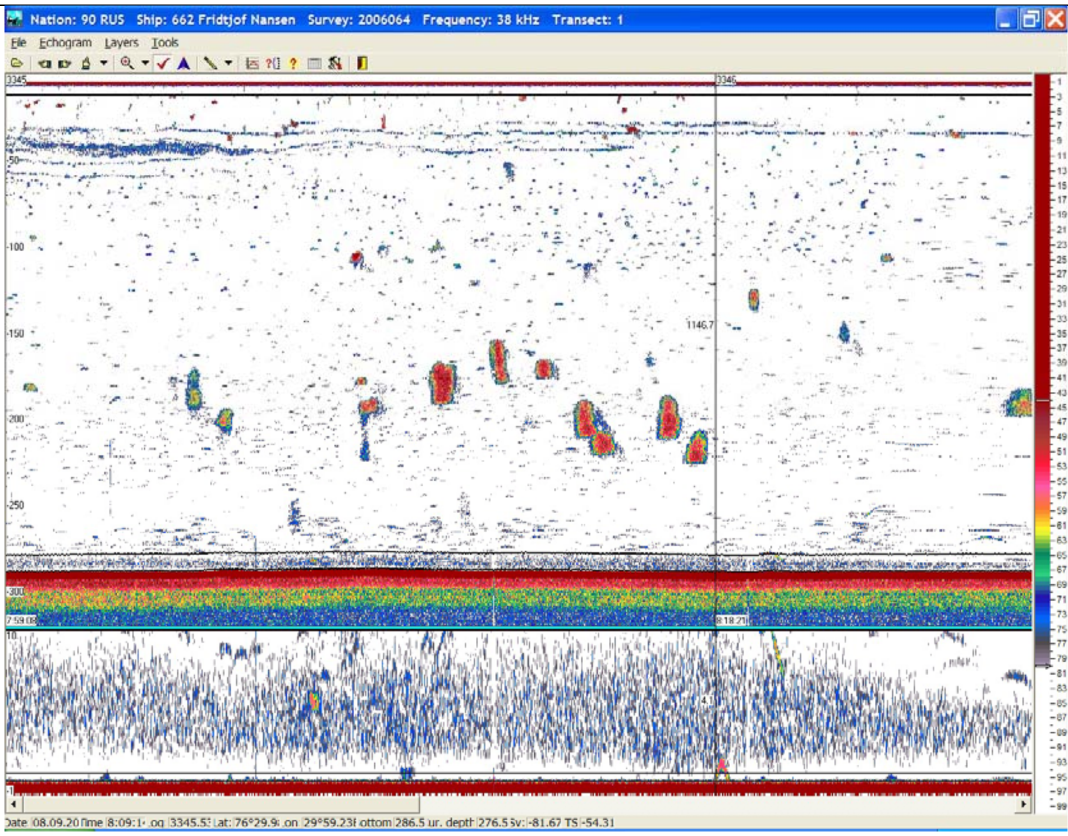

Figure 2.3.3 Echo-records of capelin in Hope Island area

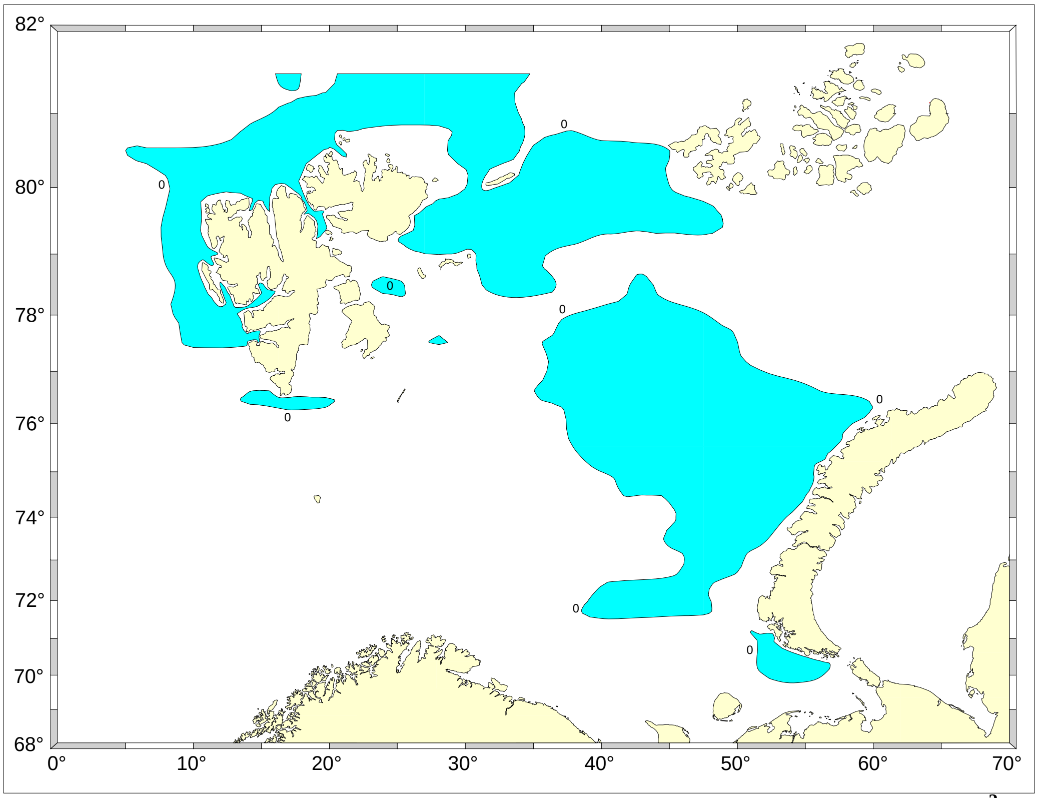

Figure 2.3.4 Estimated density distribution of one year old polar cod (t/ nautical mile^2) August - October 2006

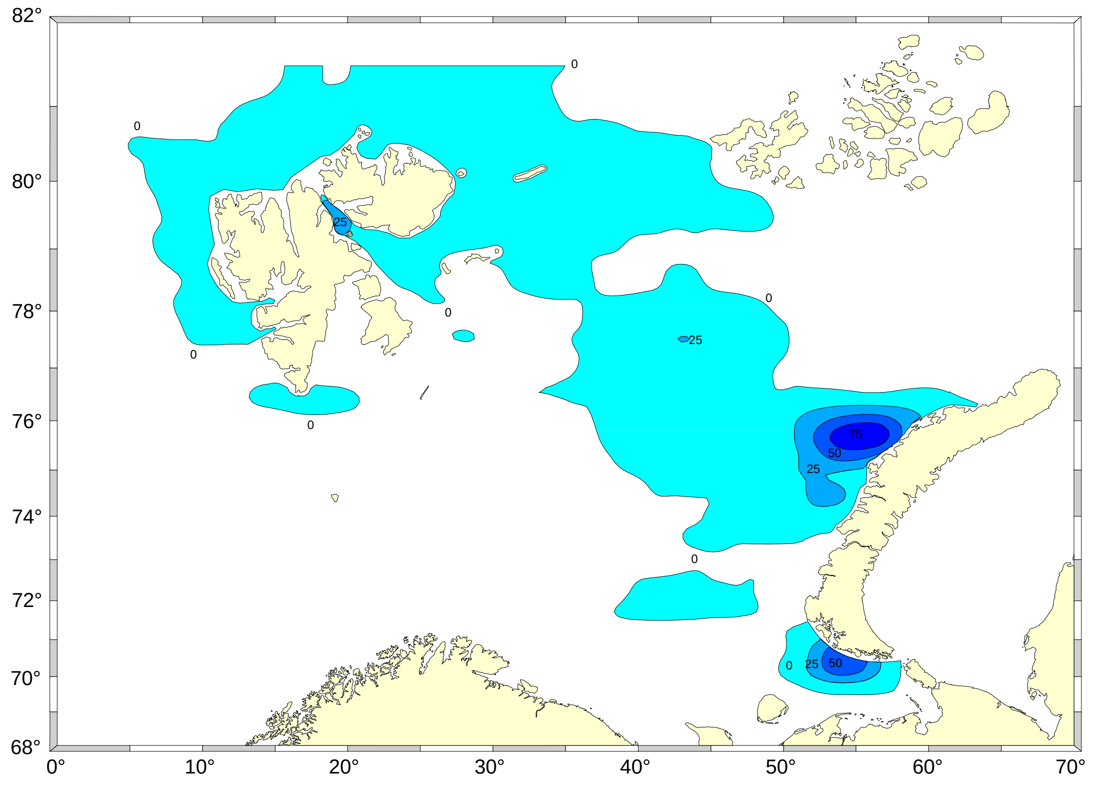

Figure 2.3.5 Estimated total density distribution of polar cod (t/ nautical mile²) August-October 2006

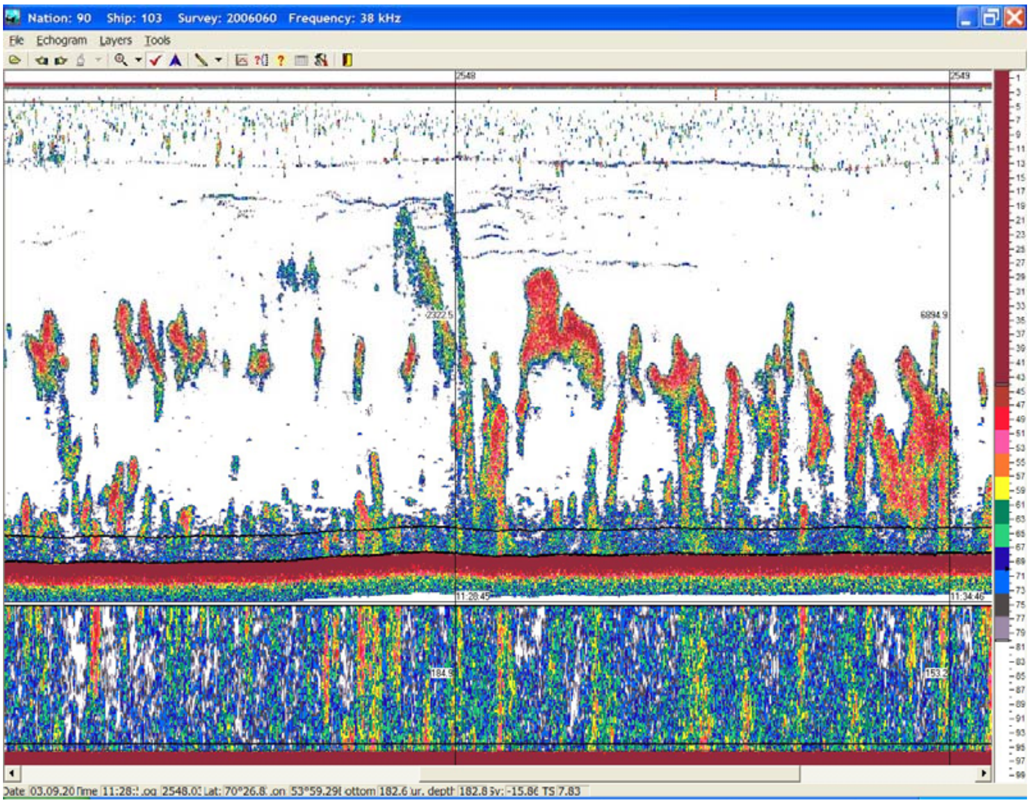

Figure 2.3.6 Typical echo-records of polar cod in east Barents Sea

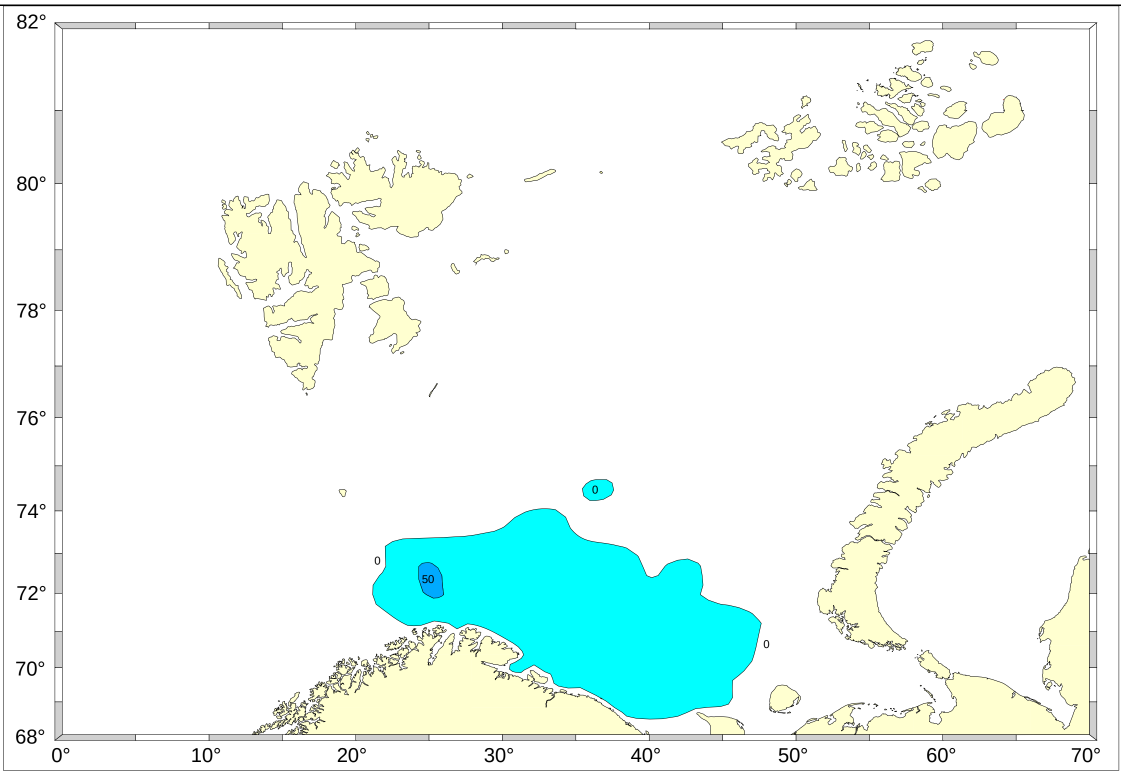

Figure 2.3.7 Estimated total density distribution of herring (t/ nautical mile^2) August-October 2006

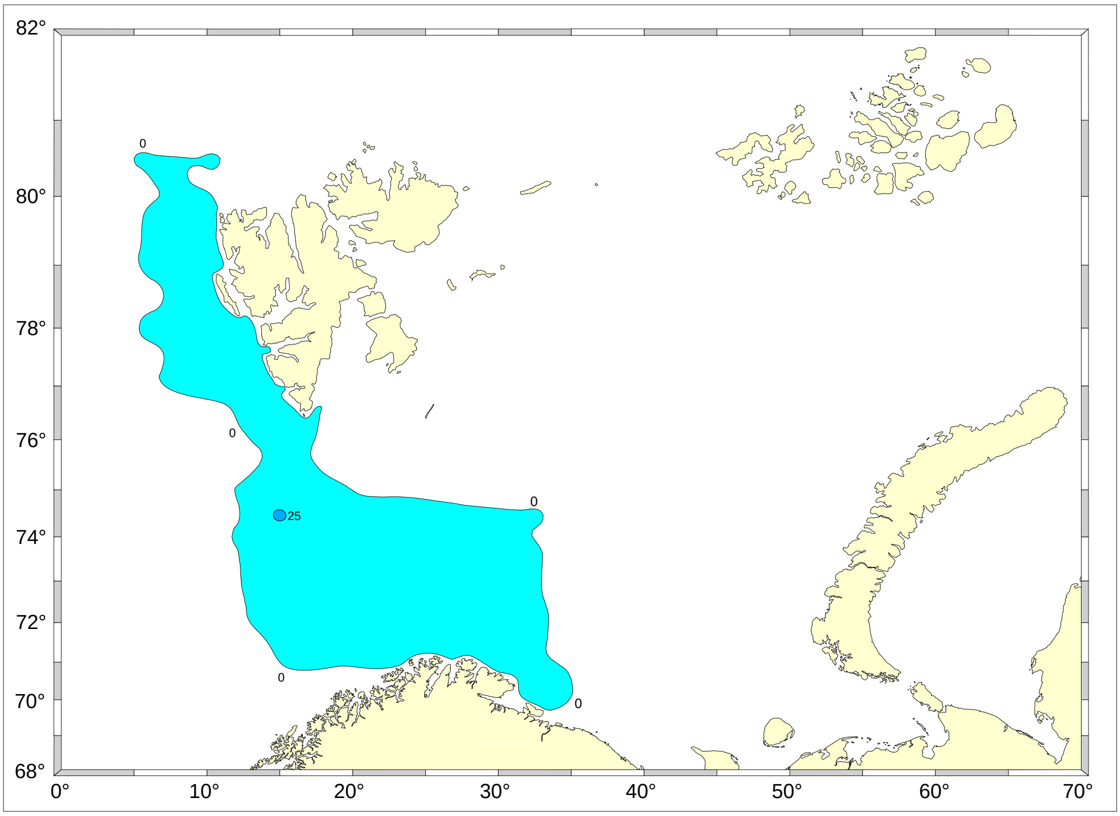

Figure 2.3.8 Estimated total density distribution of blue whiting (t/ nautical mile^2) August-October 2006

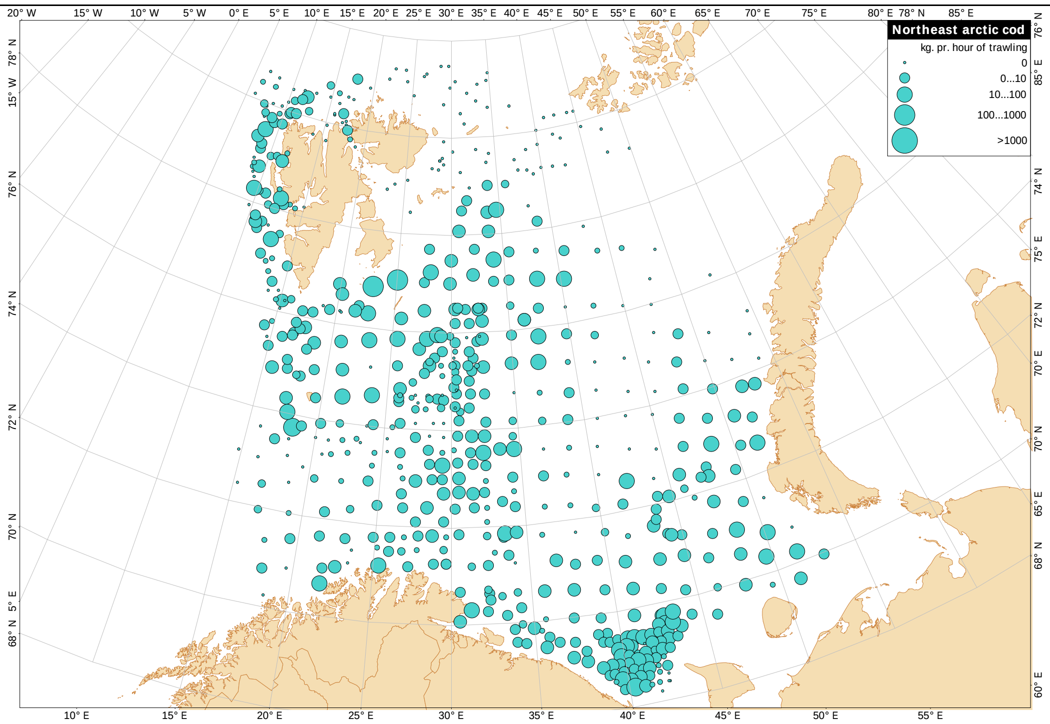

Figure 2.4.1 Distribution of cod

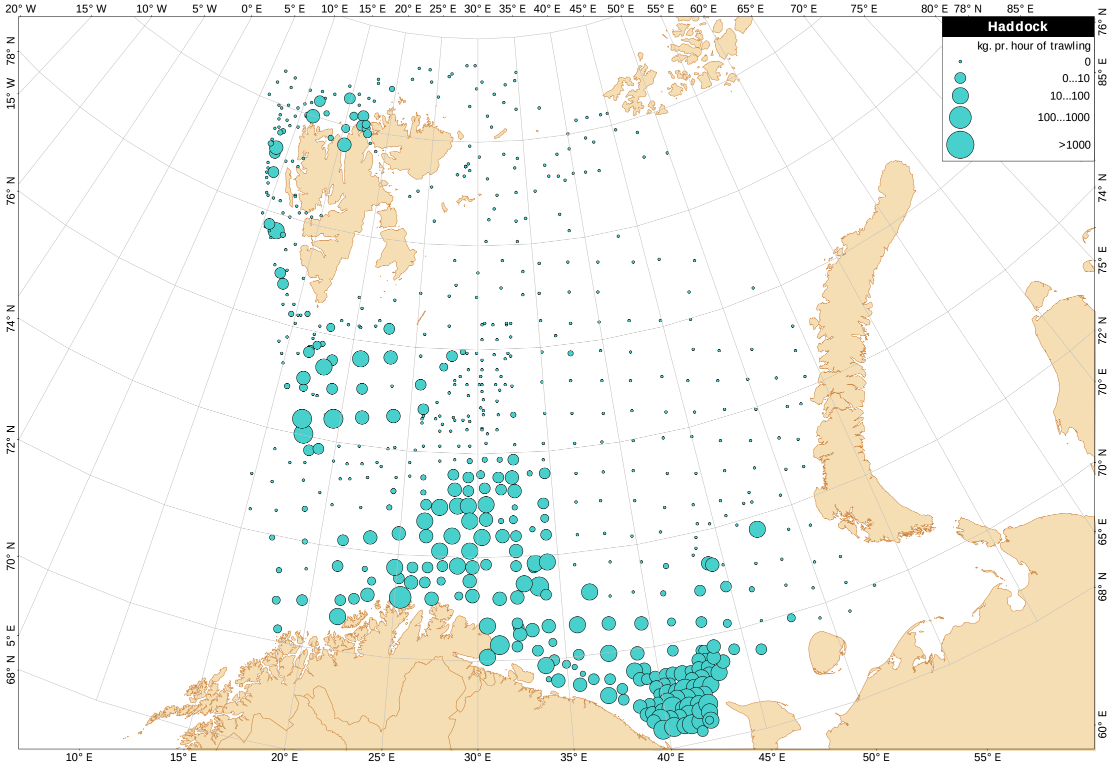

Figure 2.4.2 Distribution of haddock

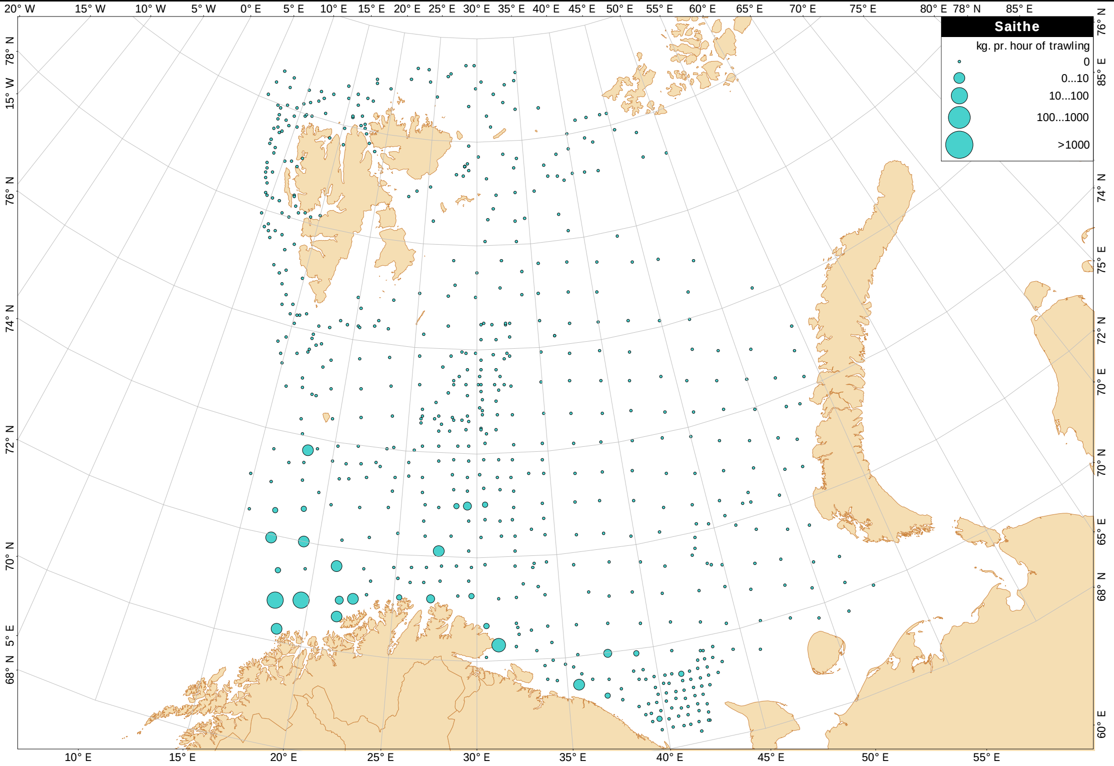

Figure 2.4.3 Distribution of saithe

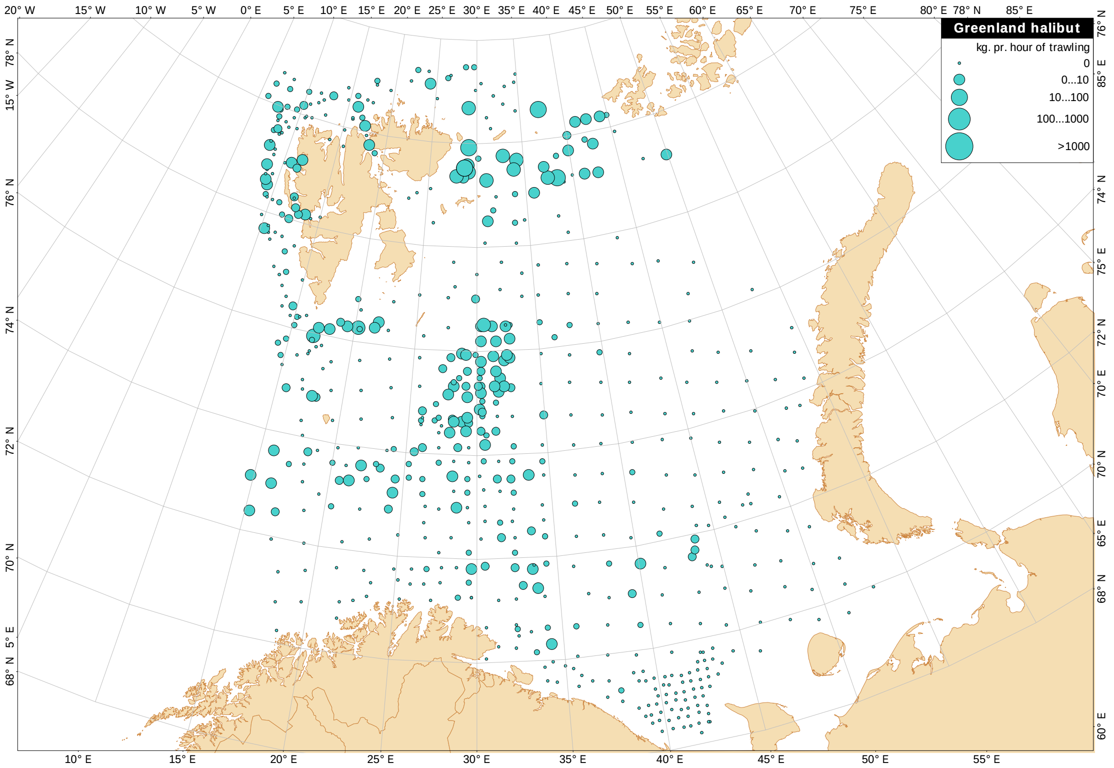

Figure 2.4.4 Distribution of Greenland halibut

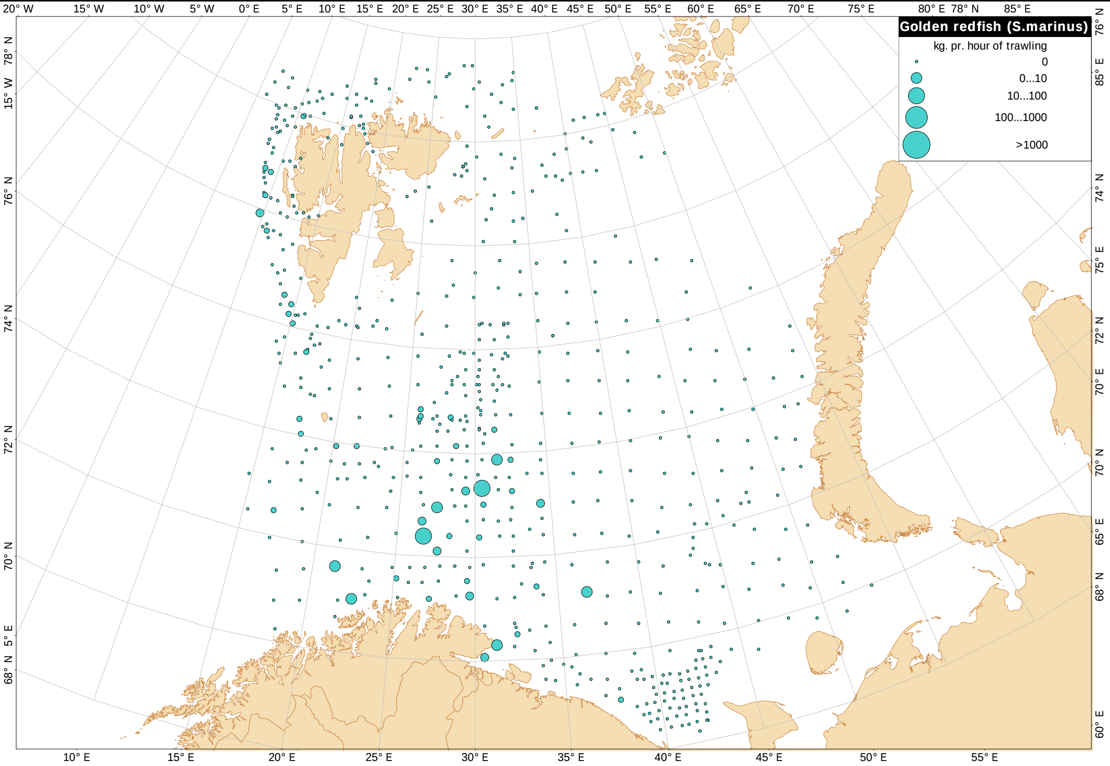

Figure 2.4.5 Distribution of *Sebastes marinus*

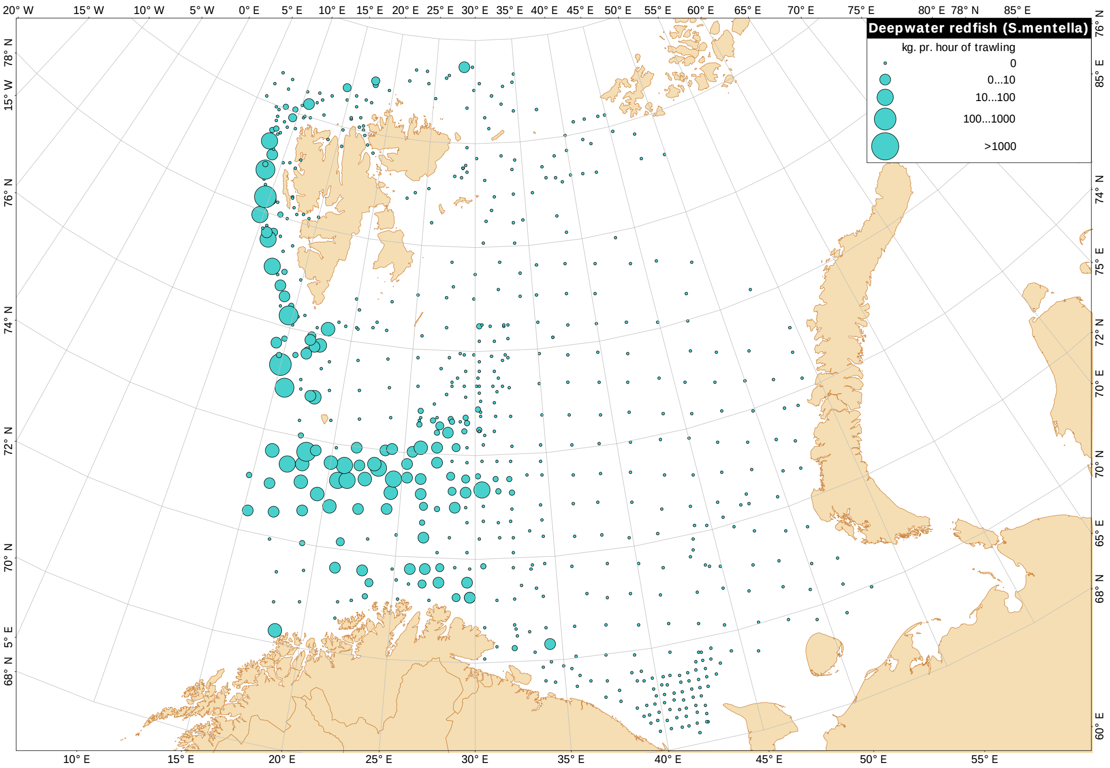

Figure 2.4.6 Distribution of *Sebastes mentella*

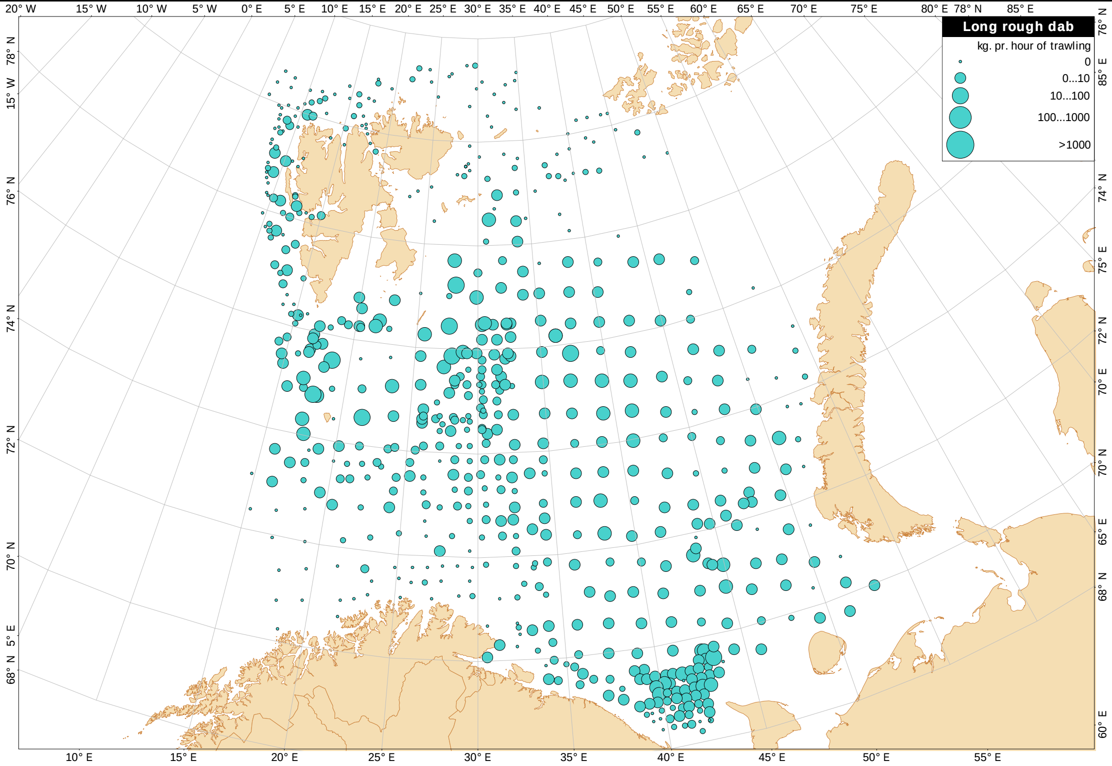

Figure 2.4.7 Distribution of long rough dab

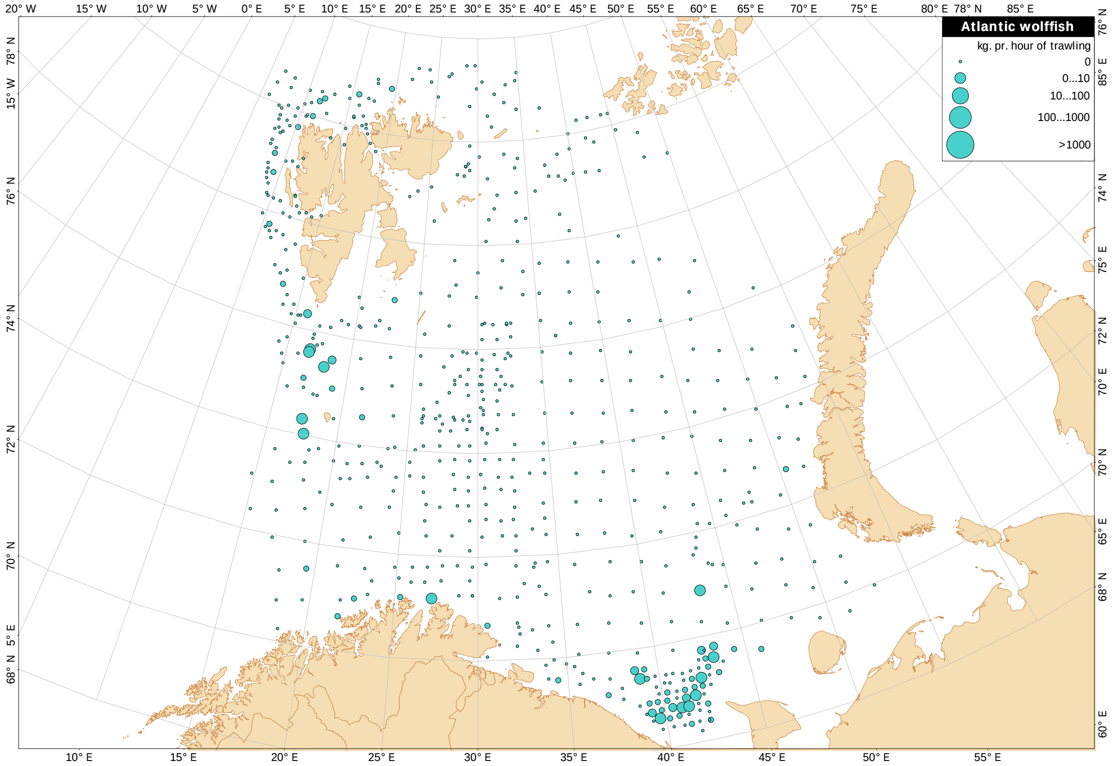

Figure 2.4.8 Distribution of Atlantic wolffish

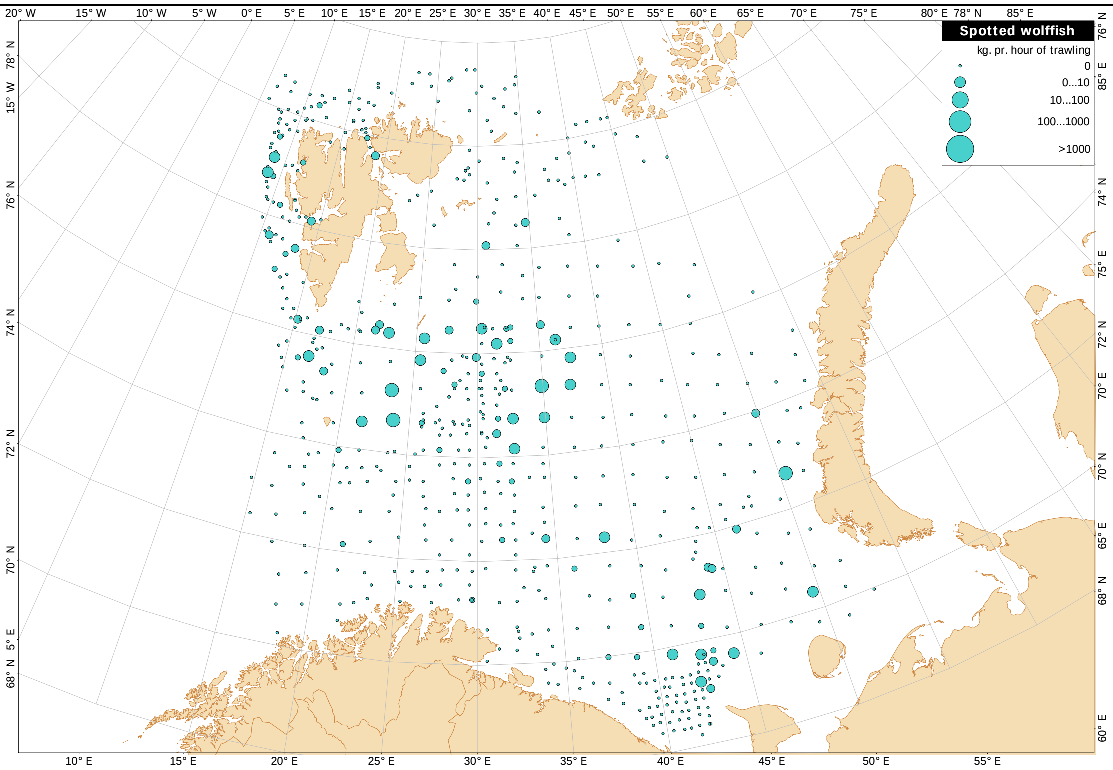

Figure 2.4.9 Distribution of spotted wolfish

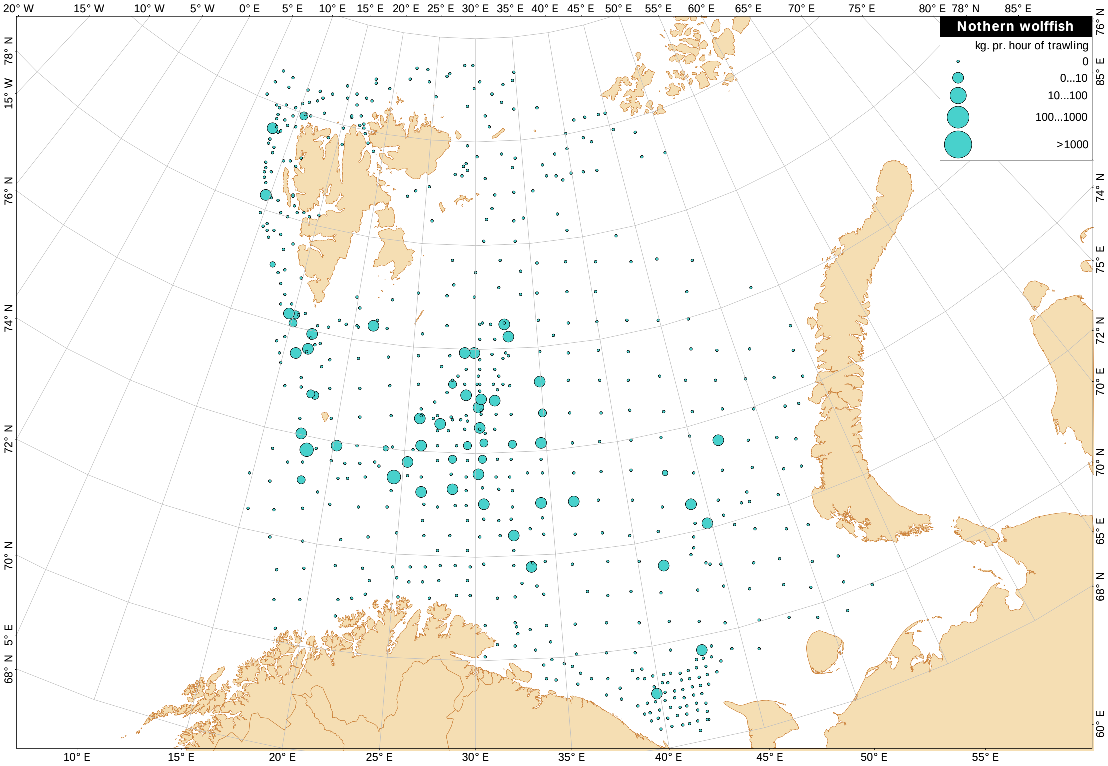

Figure 2.4.10 Distribution of northern wolfish

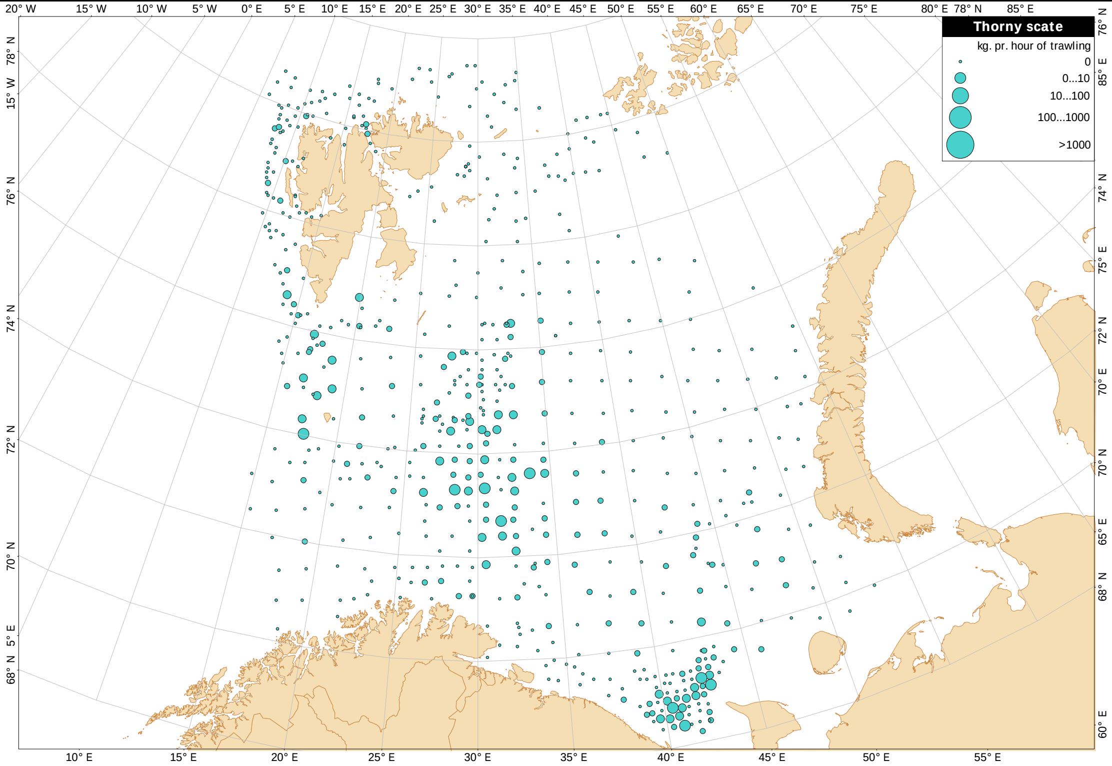

Figure 2.4.11 Distribution of thorny skate

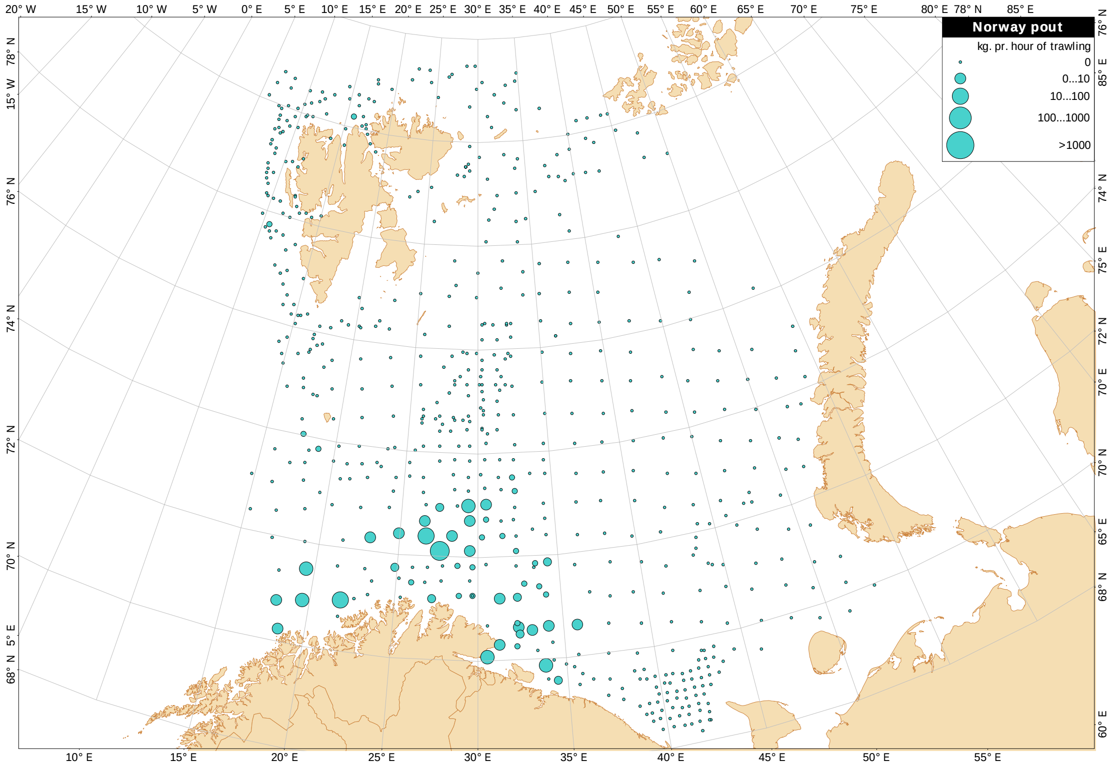

Figure 2.4.12 Distribution of Norway pout

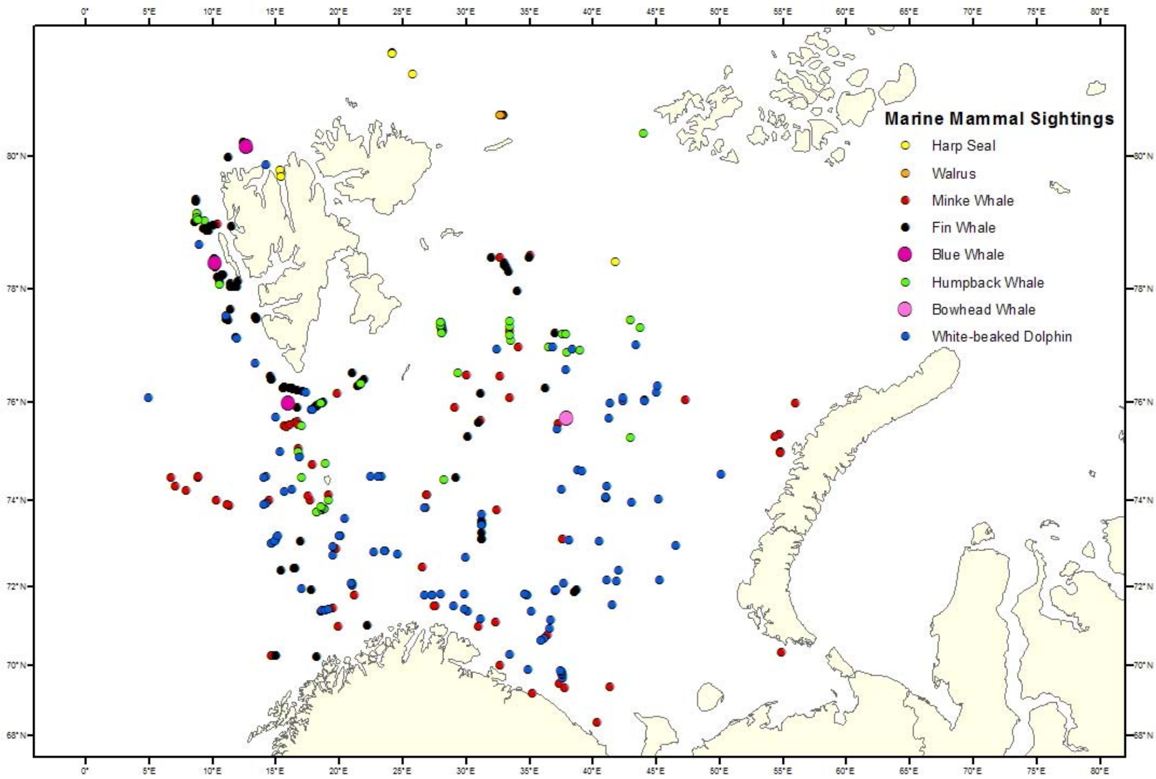

Figure 2.7.1 Distribution of a selection of marine mammal species sighted during the 2006 Norwegian-Russian joint ecosystem surveys

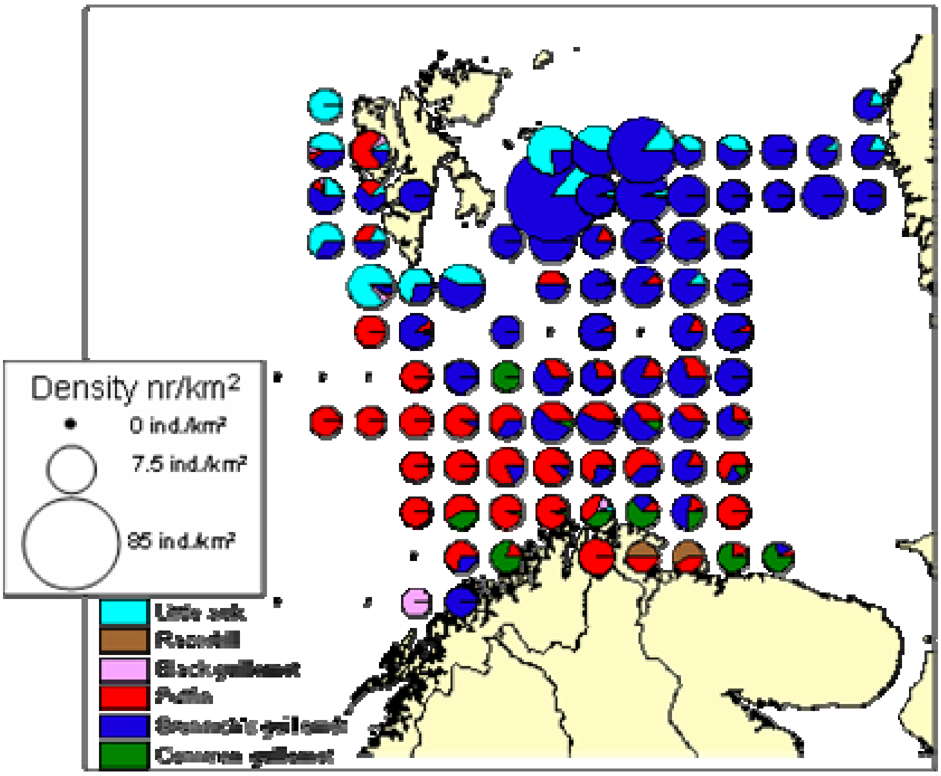

Figure 2.7.2. Distribution of auks observed from the research vessels F. Nansen, Jan Mayen, G.O. Sars and Johan Hjort. Pie size is total density of auks (individuals per km2). Data were aggregated on a 100x100 km2 grid

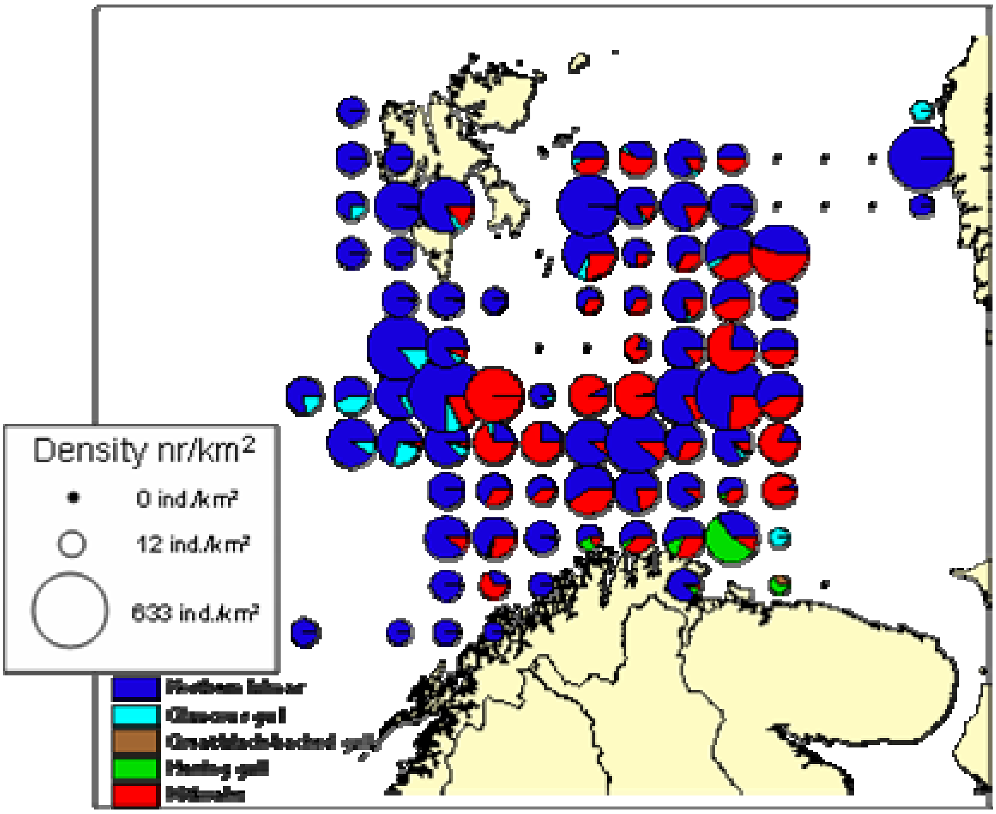

Figure 2.7.3. Distribution of gulls and northern fulmar observed from the research vessels F. Nansen, Jan Mayen, G.O. Sars and Johan Hjort. Pie size is total density of gulls and northern fulmars (individuals per km2). Data were aggregated on a 100x100 km2 grid

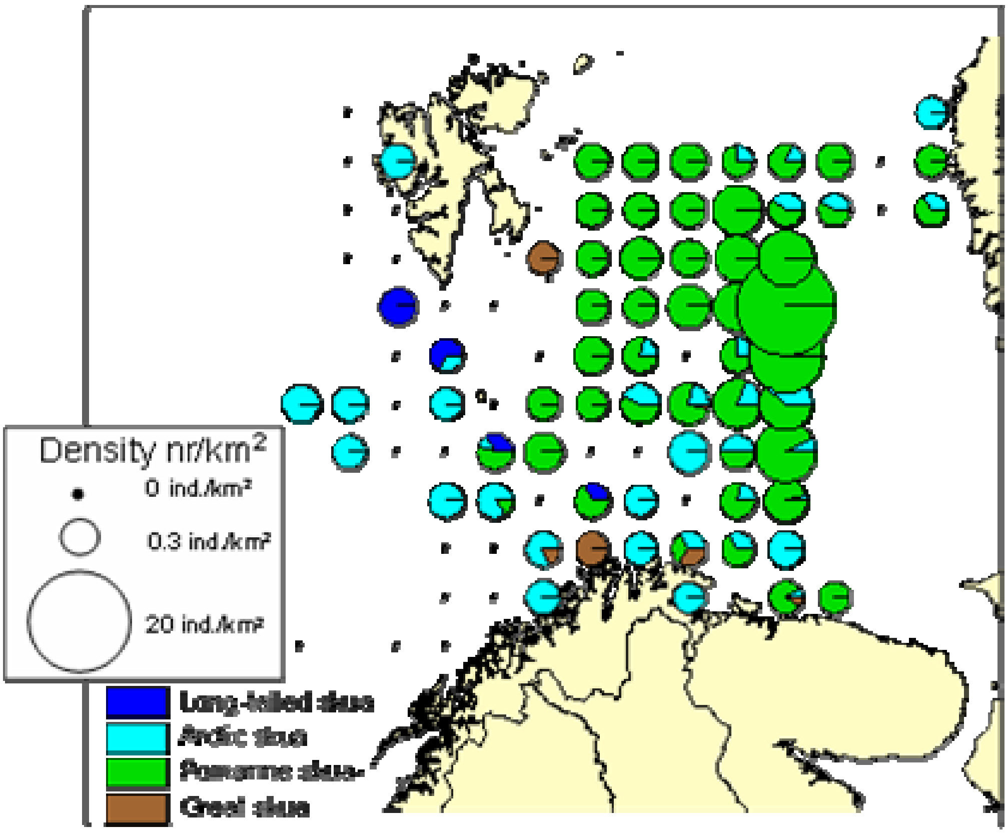

Figure 2.7.4. Distribution of skuas observed from the research vessels F. Nansen, Jan Mayen, G.O. Sars and Johan Hjort. Pie size is total density of skuas (individuals per km2). Data were aggregated on a 100x100 km2 grid

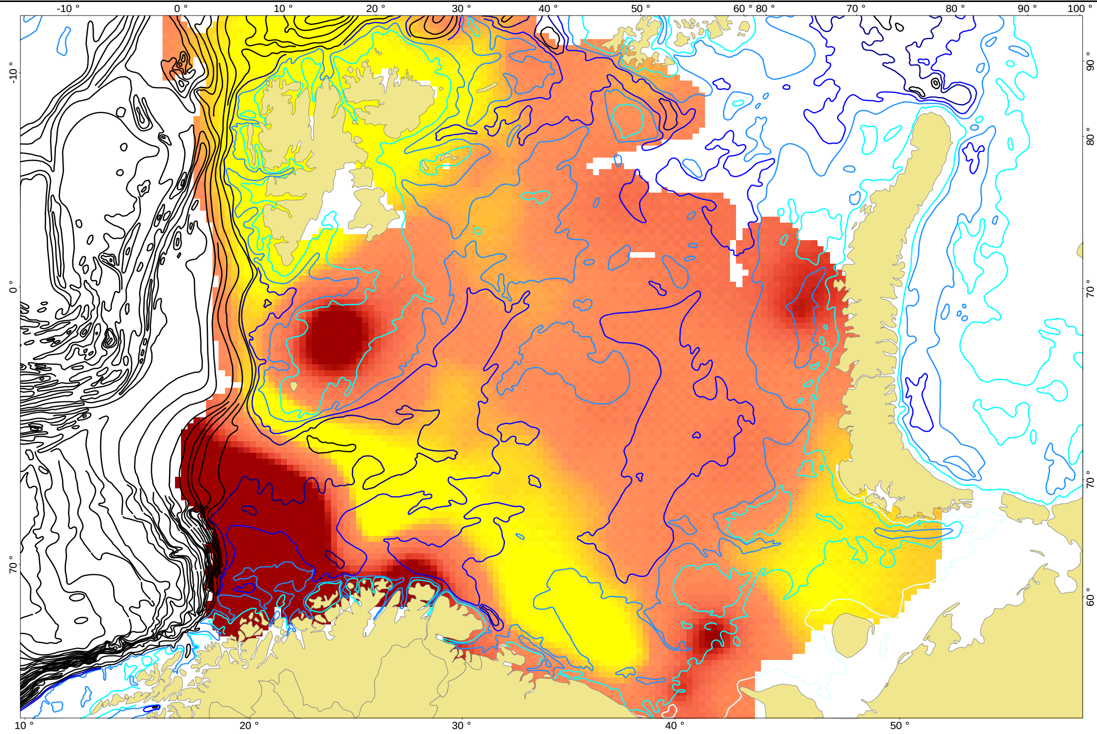

Figure 2.8.1 The extrapolated (649 stations) bentic animal biomass (exept Pandalus borealis, Paralithodes camtschatica and Chionoecetes opilio) catched by the demersal Campelen trawl per station. Dark red are highest, orange intermediate, while yellow lowest values

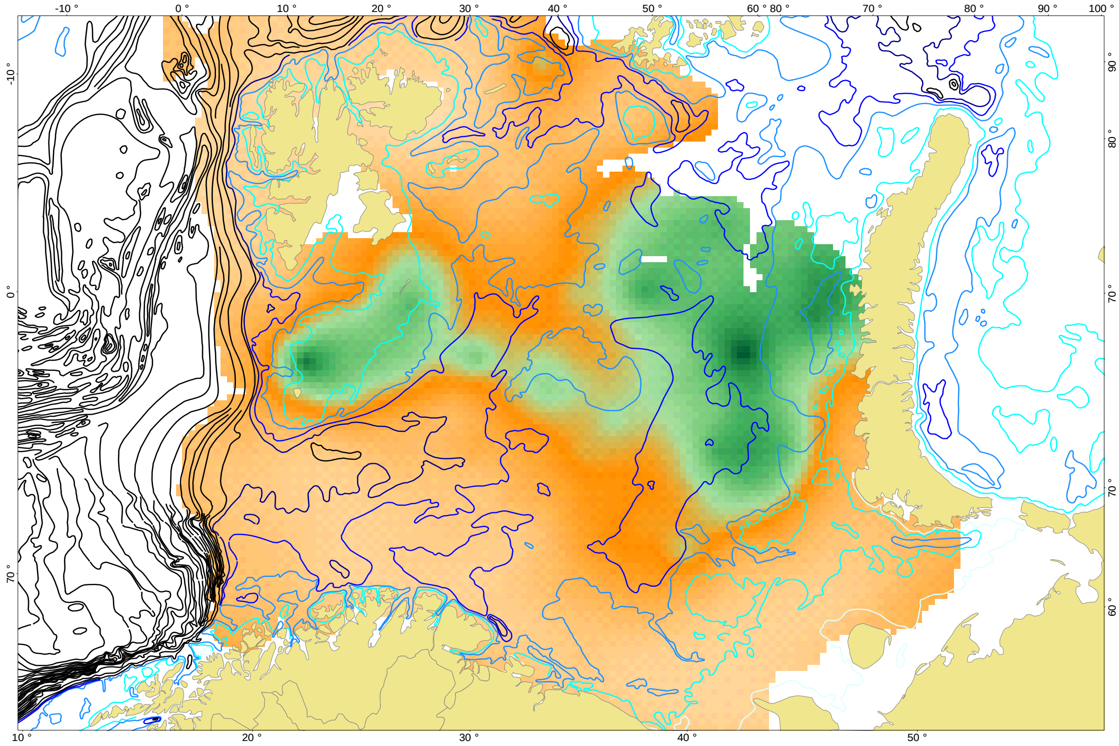

Figure 2.8.2 The extrapolated (649 stations) bentic animal abundances (exept Pandalus borealis, *Paralithodes camtschatica* and *Chionoecetes opilio*) catched by the demersal Campelen trawl per station. Dark green are highest, while light orange are lowest values. Colony forms are not included

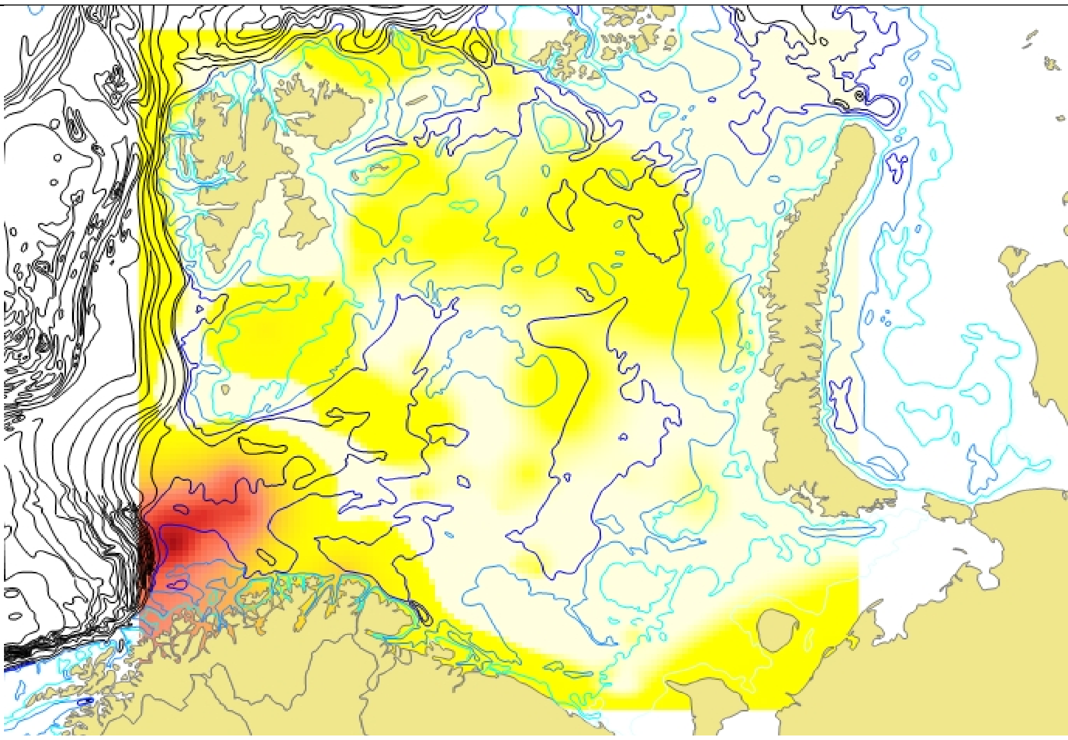

Figure 2.8.3 The extrapolated (649 stations) Porifera (sponges) biomass distribution in the Barents Sea. Red colour is highest while pale yellow are lowest values

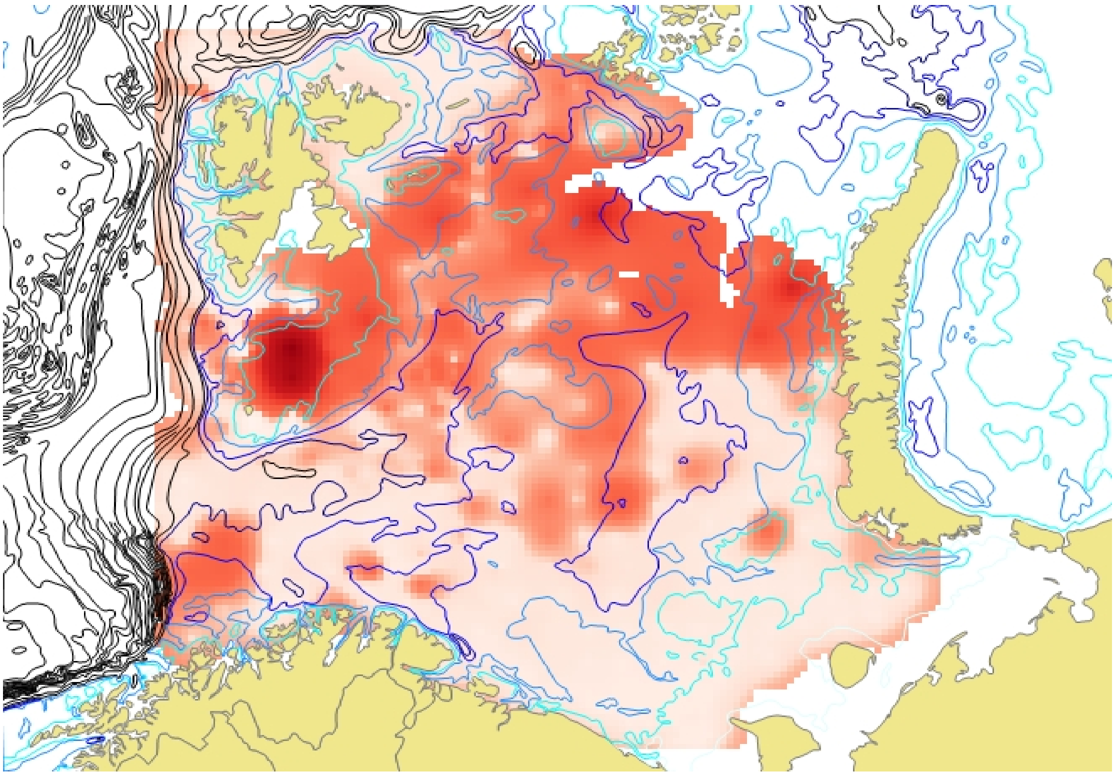

Figure 2.8.4 The extrapolated (649 stations) Echinodermata (sea stars, sea urchins, brittle stars, sea cucumber) biomass distribution in the Barents Sea. Dark red colour is highest while pale red are lowest values.

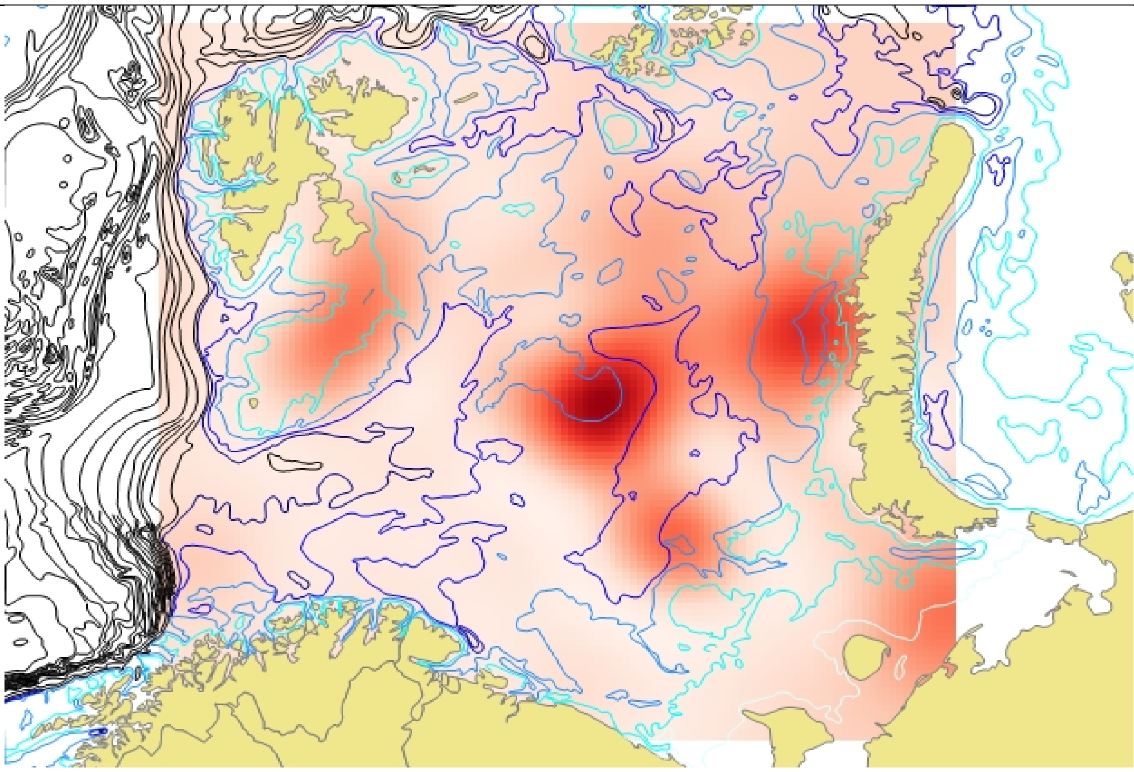

Figure 2.8.5 The extrapolated (649 stations) Crustacea (cirripedia, isopods, amphipods, prawns, crabs, and anomurans) biomass distribution in the Barents Sea. Pandalus borealis, king crab and snow crab are not included. Dark red colour is highest, while pale red lowest values.

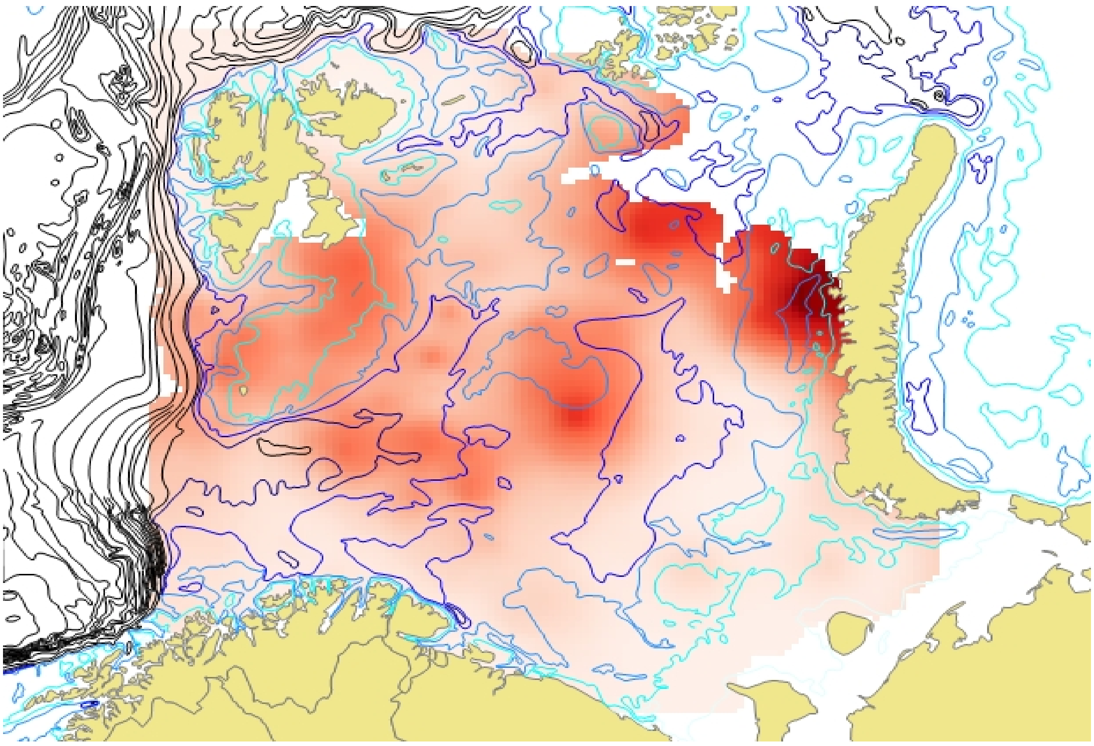

Figure 2.8.6 The extrapolated (649 stations) Mollusca (citons, bivalve and snails) biomass distribution in the Barents Sea. Dark red colour is highest, while pale red lowest values

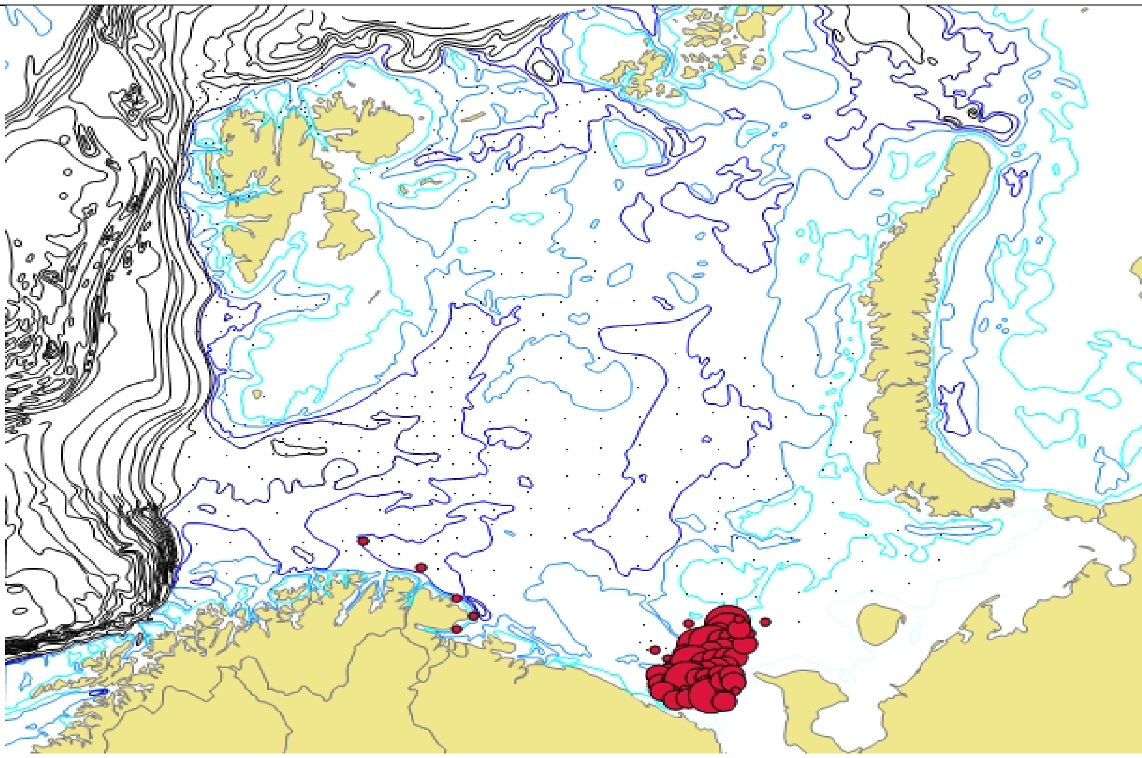

Figure 2.8.7 Distribution of king crab (*Paralithodes camtschaticus*) in Campelen bottom trawl. Standardized to kg/nm of trawling

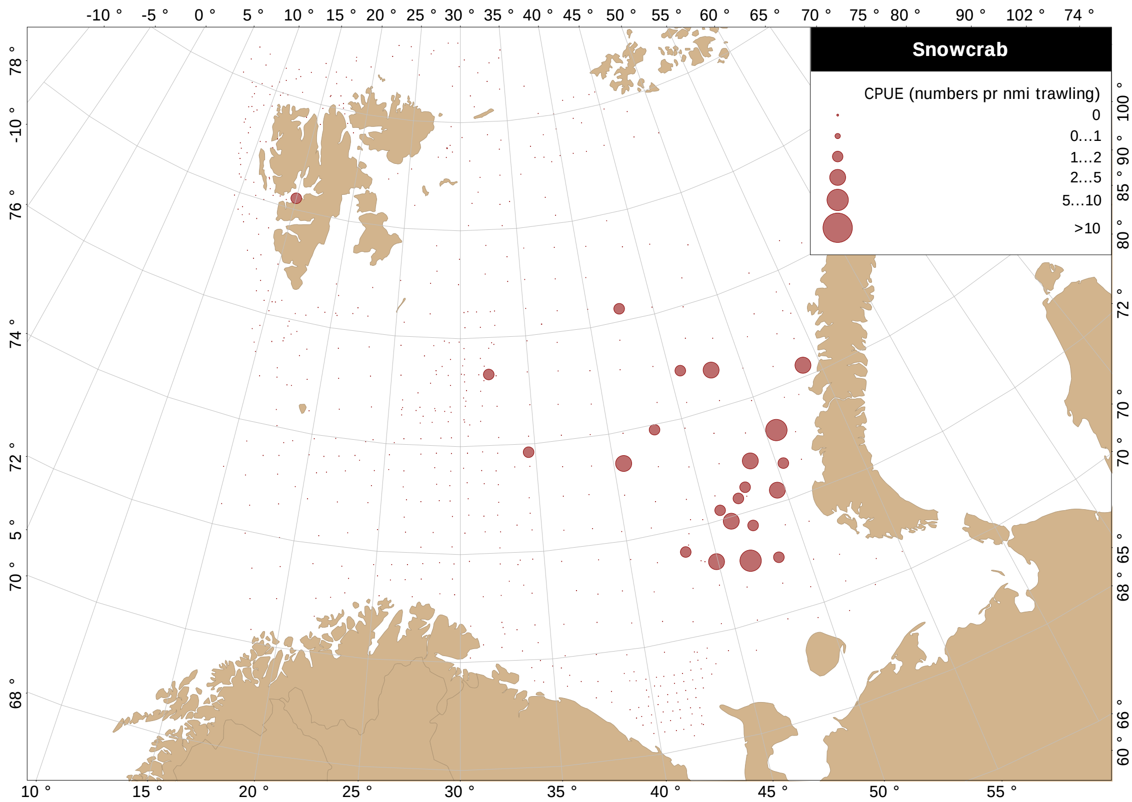

Figure 2.8.8 Distribution of snow crab (*Chionoecetes opilio*) in Campelen bottom trawl. Standardized to sp./nm of trawling

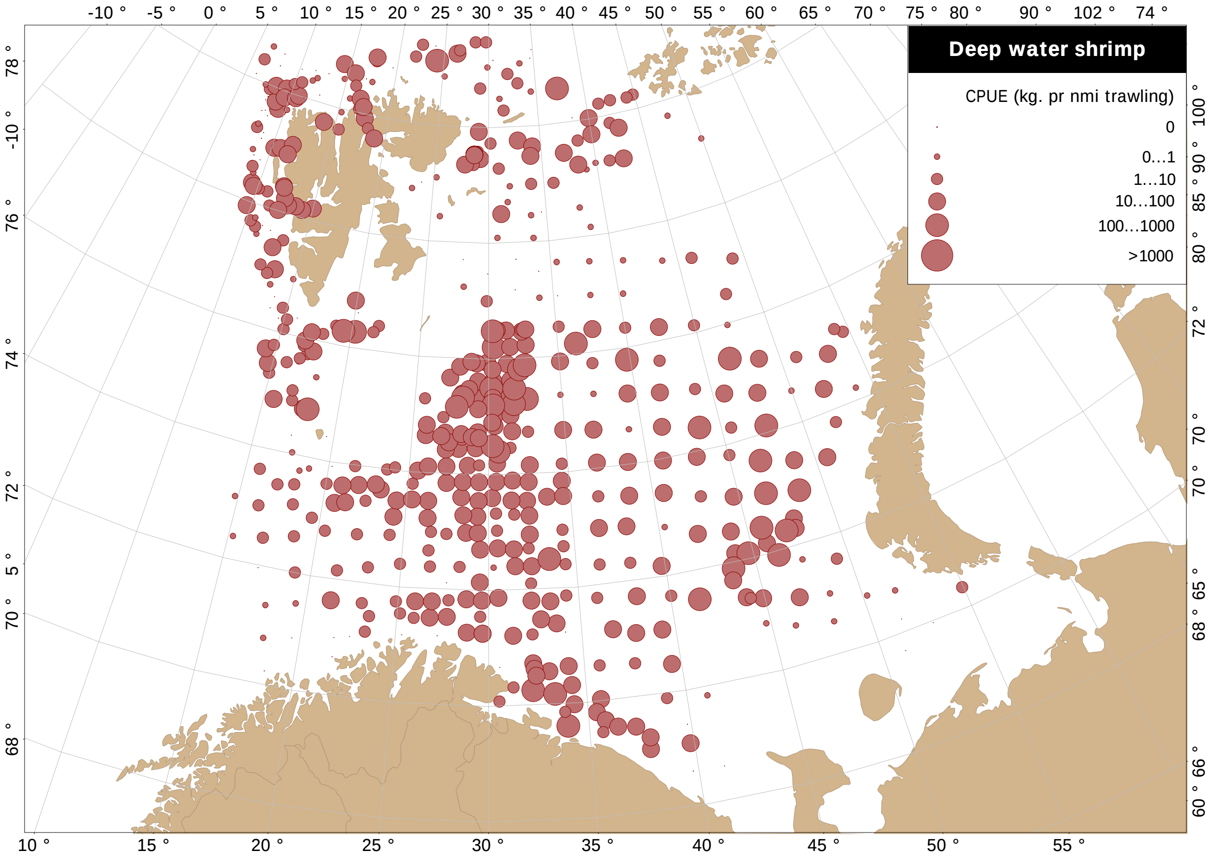

Figure 2.8.8 Distribution of shrimp ***(Pandalus borealis)*** **in Campelen bottom trawl. Standardized to kg/nm of trawling**

APPENDIX 1

Ecosystem survey 2006

Research vessel	Participants
“Smolensk” (16.08-29.09)	A. Astakhov, I. Golyak, V. Ivshin, V. Kapralov, A. Kluev, D. Prozorkevich (cruise leader), T. Prokhorova, S. Ratushnyy, M. Rybakov, A. Trofimov, I. Trofimov, G. Zuikov.
“F. Nansen” (11.08-05.10)	D. Aleksandrov, A. Amelkin, N. Anisimova, O. Dolgaja, I. Dolgolenko (cruise leader), N. Epifanova, T. Gavrilik, V. Guzenko, M. Kalashnikova, S. Kharlin, S. Lobodenko, N. Lukin, P. Lyubin, I. Manushin, N. Puodzhunas, I. Samsonova, V. Sergeev, T. Sergeeva, T. Yusupov.
”G.O. Sars” (18.08-28.09)	**Part 1 (18/08-04/09):** P. Abrahamsen, V. Anthonypillai, O.O. Amøy, I.M. Beck, S. Czudaj, K.B. Eriksen, L. Fonnes, E. Grønningsæter, H. Græsdal, T. Haugland, G.O. Johansen, R. Johansen, E. Johannesen, M. Johannessen, L.L. Jørgensen, T.Jåvold, B. Kvinge, E. Olsen (cruise leader), B. Røttingen, A. Samakupa, T. Sivertsen, Th. Sivertsen, N. Ushakov, C. Svellingen, D. White. **Part 2(05/09-10/09):** E. Olsen (cruise leader), I.M. Beck, S. Czudaj, E. Grønningsæter, T. Haugland, O. Isaksen (05-08.09), R. Johansen, R. Johannesen, L.L. Jørgensen, R. Palerud (05-08.09), N. Ushakov. **Part 3 (11/09-28/09):** J. Alvarez, J. Andersen, E. Bagøien, G. Bakke, S. Czudaj, M. Dahl, K.A. Fagerheim, T. Furset, H. Gjøsæter (cruise leader), M. Irgens, T. Knutsen, B. Røttingen, A. Steinsland, A. Storaker, N. Ushakov, K. Utne, T. de L. Wenneck.
“J. Hjort” (14.08-20.09)	**Part 1 (14-30/08):** J. Alvarez, B. Ellertsen, E.Eriksen, M. Fonn, P. Fossum (cruise leader), C. Forså, V. Haukeland, H. Larsen, P. Liebig, F. Midtøy, J.E. Nygård, E. Osland, B. Skjold, T. Thangstad. **Part 2 (30/08-11/09):** S. Aanes (cruise leader), B. Endresen, Ø.L. Hansen, J. Erices, H.Ø. Hansen, V. Haukeland P.J. Helgesen, A. Kristiansen, J.de Lange, H. Larsen, M. Mjanger, J.H. Nilsen, J.E. Nygård, F. Uiblein. **Part 3 (11/09-20/09):** B. Endresen, J. Erices, H.Ø. Hansen, Ø.L. Hansen, V. Haukeland, C. Hvingel (cruise leader), A. Kristiansen, H. Larsen, A. Leithe, M. Mjanger, J.H. Nilsen, B. Skjold, Ø. Torgersen.
“Jan Mayen” (08.08-17.08 and 11.09-29.09)	**Part 1 (08-17/08):** A.K. Abrahamsen, I. Ahlquist, L. Austgulen, P. Dahl, K.A. Fagerheim, E. Grønningsæter, E. Hermansen A. C. Knag, G. Langhelle, E. Rafter, S. Seim, A. Sæverud, W. Richardsen, T. de L. Wenneck (cruise leader). **Part 2 (12/9-29/09):** A. Harbitz, E. Hermansen, Å. Høines (cruise leader), A-L. Johnsen, H. Larsen, W. Richardsen, L. Solbakken.

APPENDIX 2

Ecosystem survey 2006

SPHERE CALIBRATION OF ECHOSOUNDERS, ER60,
(on copper sphere CU60, TS=33,6 dB, at frequency 38 kHz)

Research vessel	G.O. Sars	Johan Hjort	Jan-Mayen	Smolensk	F. Nansen
Type of echosounder	ER60	ER60	ER60	ER60 (2.1.2)	ER60
Date	17.01.2006	03.02.2006	12.09.2006	17.08.2006	14.08.2006
Place	Uggdalseidet	Båtsfjord	Coles bay Spitsbergen	Orlovka Bay	69º12' N 35º15' E
Bottom depth (m)	89	50	41	28	46
Depth to sphere (m)	20.4	16.0	37	14.43	25
Temperature (ºC)	8.27	4.04	1.0	8.7	8.7
Salinity (‰)	33.27	34.29	34.0	33.9	33,9
TS of sphere (dB)	-33.6	-33.7	-33.6	-33.6	-33.6
Transducer type	ES38B	ES38B	ES38B	ES38B	ES38B
Transducer depth (m)	5.5	0		0	0
Real sphere depth (m)		19.0		14.43	25
Sound velocity (m/sec)	1481.1	1466.0	1453.0	1484	1487.7
Absorption coefficient (dB/km)	9.591	9.76	9.32	9.88	9.86
Pulse length (Short/Med./Long, ms)	1.024	1.024	1.024	1.024	1.024
Bandwidth (Wide/Narrow)	2.425 kHz	2.43		Wide	2.43 kHz
Maximum power (W)	2000	2000	2000	2000	2000
Transmit power (W)	2000	2000	2000	2000	2000
Angle sensitivity	21.9	21.9	21.9	21.9	21.9
2-way Beam Angle (10lgΨ , dB)	-20.8	-21.0	-20.6	-20.76	-20.74
Adjusted Sv Transducer Gain (dB)	-0.66 (Sa corr.)	-0.67	-0.66		-0,61
Adjusted TS Transducer Gain (dB)	25.54	26.83	26.08	25.06	25.57
3-dB Beamwidth Alongship (deg.)	7.10	7.09	6.91	6.99	6.99
3-dB Beamwidth Athwartship (deg.)	7.10	7.07	7.11	6.96	6.99
Alongship (fore/aft.) Offset (deg.)	-0.07	-0.07	-0.06	-0.02	-0.12
Athwartship Offset (deg.)	-0.14	0.12	-0.02	0.02	-0.02
Theoretical Sa (m /nm)				10779	
Measured Sa (m /nm)				10695	
$Sa=\sigma*1852^2/(r^2\Psi)$ $\sigma=4\pi*10^{0,1\,TS}$					

APPENDIX 3

Sampling of fish

	Norwegian vessels	Russian vessels	Sum
Capelin			
No of samples	335	315	650
Nos. length measured	11958	14424	26382
Nos. aged	2334	1217	3551
Polar cod			
No of samples	224	224	448
Nos. length measured	6876	17886	24762
Nos. aged	1093	1651	2744
Herring			
No of samples	132	94	226
Nos. length measured	4195	3168	7363
Nos. aged	363	461	824
Blue Whiting			
No of samples	177	35	212
Nos. length measured	7090	2427	9517
Nos. aged	650	694	1344
Cod			
No of samples	546	409	955
Nos. length measured	12600	17340	29940
Nos. aged	1650	1386	3036
Haddock			
No of samples	503	280	783
Nos. length measured	16088	22775	38863
Nos. aged	736	496	1232
Redfish (*Sebastes marinus*)			
No of samples	55	12	67
Nos. length measured	278	66	344
Nos. taken for age	134		134
Redfish (*Sebastes mentella*)			
No of samples	187	59	246
Nos. length measured	4728	1203	5931
Nos. taken for age	737	38	775
Saithe			
No of samples	76	21	97
Nos. length measured	437	29	466
Nos. taken for age	4	17	21
Greenland halibut			
No of samples	437	88	525
Nos. length measured	4978	3559	8537
Nos. taken for age	1732	672	2404
Atlantic Wolffish (Anarhichas lupus)			
No of samples	75	38	113
Nos. length measured	379	114	493
Spotted wolffish (*Anarhichas minor*)			
No of samples	69	64	133
Nos. length measured	110	178	288
Northern wolffish (*Anarhichas denticulatus*)			
No of samples	39	18	57
Nos. length measured	47	20	67
Long rough dab			
No of samples	394	398	792
Nos. length measured	10969	21697	32666

APPENDIX 4

Complete list of all fish species recorded at the ecosystem survey 2006. The species are sorted alphabetically according to the Latin name of the family. Catch rate (wcpue) in kg per nautical towed with demersal trawl, number of demersal trawl stations were the species have been caught (stas., total number of stations for the survey 650) and average length (cm) with range (95% percentiles) from specimens caught in demersal trawl are provided. Specimen classified to family or genus is marked in bold

Family	Latin name	English name	Stas.	wcpue	Length (cm)
Agonidae	*Ulcina olrikii*	Arctic alligatorfish	37	0.004	6.5 (5-7)
Agonidae	*Agonus cataphractus*	Hooknose	3	<1g	12.3 (8-15)
Agonidae	*Leptagonus decagonus*	Atlantic poacher	267	0.059	13.9 (9-17)
Ammodytidae	*Ammodytes marinus*	Lesser sand-eel	0		
Ammodytidae	***Ammodytidae***	**Sand lances**	**8**	<1g	8.4 (7-9.8)
Ammodytidae	*Ammodytes tobianus*	Small sandeel	3	<1g	9 (5-12)
Ammodytidae	*Ammodytes tobianus*	Small sandeel	1	<1g	9 (9-9)
Anarhichadidae	*Anarhichas denticulatus*	Northern wolffish	56	1.133	84.4 (75-103)
Anarhichadidae	*Anarhichas minor*	Spotted wolffish	127	0.942	47.3 (28-68)
Anarhichadidae	*Anarhichas lupus*	Atlantic wolffish	97	0.92	32.8 (11-72)
Anarhichadidae	***Anarhichadidae***	**Wolffish**	**5**	**0.001**	14.2 (7-15)
Argentinidae	*Argentina sphyraena*	Argentine	6	0.001	14.5 (10-17)
Argentinidae	*Argentina silus*	Greater argentine	31	0.193	28.4 (14-36)
Chimaeridae	*Chimaera monstrosa*	Rabbit fish	1	0.008	52.3 (48-59)
Clupeidae	*Clupea harengus*	Atlantic herring (NSS*)	62	0.134	23.1 (14.8-38.3)
Clupeidae	*Clupea harengus*	Atlantic herring (WS**)	2	0.001	21.2 (12.5-32)
Cottidae	*Triglops pingeli*	Ribbed sculpin	19	0.104	9 (7-12.5)
Cottidae	*Gymnocanthus tricuspis*	Arctic staghorn sculpin	29	0.108	12.1 (9-16)
Cottidae	*Triglops nybelini*	Bigeye sculpin	124	0.175	8.1 (7-12)
Cottidae	*Triglops sp.*		38	0.035	11.8 (5-14)
Cottidae	*Artediellus atlanticus*	Atlantic hookear sculpin	408	0.136	7.8 (5-10)
Cottidae	*Triglops murrayi*	Moustache sculpin	126	0.062	10.1 (8-12)
Cottidae	*Icelus spatula*	Twohorn sculpin	2	<1g	7.1 (6-8)
Cottidae	*Icelus bicornis*	Twohorn sculpin	48	0.008	6.3 (5-8.5)
Cottidae	*Icelus sp.*	Twohorn sculpin	19	0.025	6 (5-9.5)
Cottidae	***Cottidae***	Sculpins	**2**	<1g	3.5 (3.5-3.5)
Cottidae	***Cottidae***	Sculpins	**1**	<1g	4 (4-4)
Cottidae	*Myoxocephalus scorpius*	Shorthhorn sculpin	9	0.012	17.7 (11-28)
Psychrolutidae	*Cottunculus microps*	Polar sculpin	110	0.021	10.8 (7-15)
Psychrolutidae	***Psychrolutidae***	**Fatheads**	**4**	<1g	11.2 (10-12.5)
Liparidae	*Careproctus sp.*	Snail fish	90	0.049	9.9 (7-13)
Liparidae	*Careproctus reinhardii*	Sea tadpole	56	0.009	11.4 (8-16.5)
Liparidae	*Liparis fabricii*	Gelatinous snailfish	45	0.009	9.6 (6-12)
Liparidae	*Liparis gibbus*	Variagated snailfish	51	0.022	11.1 (8-16)
Cyclopteridae	***Cyclopteridae***	**Lumpfishes**	**19**	<1g	5.8 (4.5-9)
Cyclopteridae	*Cyclopterus lumpus*	Lumpsucker	22	0.06	21.1 (7-38)
Cyclopteridae	*Eumicrotremus derjugini*	Leatherfin lumpsucker	7	0.001	5.9 (4-8)
Liparidae	*Liparis liparis*	Striped sea snail	2	<1g	10.6 (9-12)
Cyclopteridae	*Eumicrotremus spinosus*	Atlantic spiny lumpsucker	25	0.009	14.4 (6-10)
Lotidae	*Brosme brosme*	Cusk	20	0.113	55.6 (23-56)
Gadidae	*Merlangius merlangius*	Whiting	2	0.001	30 (26-33)
Gadidae	*Melanogrammus aeglefinus*	Haddock	414	31.898	31.7 (15-60)
Gadidae	*Arctogadus glacialis*	Arctic cod	1	<1g	23 (23-23)
Gadidae	*Micromesistius poutassou*	Blue whiting	202	19.678	42.1 (22-49)
Merlucciidae	*Merluccius merluccius*	European hake	1	<1g	27.3 (26-29)
Gadidae	*Boreogadus saida*	Polar cod	270	24.205	20.9 (8-29)
Gadidae	*Pollachius virens*	Saithe	47	1.031	58.4 (47-73)
Gadidae	*Gadiculus argenteus*	Silvery pout	28	0.024	12.3 (8-12)
Gadidae	*Gadus morhua*	Atlantic cod	530	27.664	35 (13-81)
Gadidae	***Gadidae***	**Cod fishes**	**1**	<1g	7 (7-7)
Gadidae	*Trisopterus esmarkii*	Norway pout	143	1.89	17.7 (11-21)

*Norwegian spring spawning herring ** White sea herring continued

Family	Latin name	English name	Stas.	wcpue	Length (cm)
Gasterosteidae	*Pungitius pungitius*	Ninespine stickleback	1	<1g	6 (6-6)
Gasterosteidae	*Gasterosteus aculeatus*	Three-spined stickleback	48	0.004	6 (5-7.5)
Lophiidae	*Lophius piscatorius*	Anglerfish	0		
Lotidae	*Enchelyopus cimbrius*	Fourbeard rockling	11	0.002	23.5 (21-30)
Lotidae	*Gaidropsarus argentatus*	Arctic rockling	11	0.003	22.1 (18-27)
Lotidae	*Gaidropsarus vulgaris*	Three-bearded rockling	0		
Stichaeidae	*Lumpenus fabricii*	Slender eelblenny	4	<1g	14 (12.5-15)
Stichaeidae	***Stichaeidae***	**Pricklebacks**	**5**	<1g	7.5 (5.5-9)
Stichaeidae	*Lumpenus l ampret aeformis*	Snake blenny	163	0.092	24.3 (16-30)
Stichaeidae	*Anisarchus medius*	Stout eelblenny	20	0.007	12.8 (11-16)
Stichaeidae	*Leptoclinus maculatus*	Daubed shanny	311	0.073	12 (9-15)
Macrouridae	*Macrourus berglax*	Rough rattail	11	0.02	22.1 (10-42)
Myctophidae	*Myctophum punctatum*	Spotted lanternfish	0		
Myctophidae	*Myctophidae sp.*	Laternfish	16	<1g	10.4 (5-8)
Myctophidae	*Benthosema glaciale*	Glacier lanternfish	10	<1g	6.2 (6-7)
Osmeridae	*Mallotus villosus*	Capelin	255	2.895	19.4 (10.5-23.5)
Pleuronectidae	*Reinhardtius hippoglossoides*	Greenland halibut	314	5.073	25.6 (20-53)
Pleuronectidae	*Hippoglossoides platessoides*	Long rough dab	577	10.976	18.6 (7-38)
Pleuronectidae	*Hippoglossus hippoglossus*	Halibut	1	0.021	48.8 (41-60)
Pleuronectidae	*Microstomus kitt*	Lemon sole	6	0.026	26.6 (19-44)
Pleuronectidae	*Pleuronectes platessa*	Europeian plaice	57	1.741	34.4 (26-47)
Pleuronectidae	*Limanda limanda*	Dab	24	0.265	19.3 (14-33)
Pleuronectidae	*Glyptocephalus cynoglossus*	Witch	3	0.003	39 (38-40)
Rajidae	*Bathyraja spinicauda*	Spinetail ray	5	0.108	87.3 (37-149)
Rajidae	*Amblyraja hyperborea*	Arctic skate	34	0.1	35.2 (16-60)
Rajidae	*Amblyraja radiata*	Thorny skate	310	1.212	38.3 (23-52)
Rajidae	*Leucoraja fullonica*	Shagreen ray	1	0.007	72 (72-72)
Rajidae	*Rajella fyllae*	Round ray	38	0.074	29.8 (12.5-49.5)
Rajidae	*Dipturus batis*	Blue skate	1	0.038	146 (146-146)
Salmonidae	*Salmo salar*	Salmon	0		
Scophthalmidae	*Phrynorhombus norvegicus*	Norwegian topknot	1	<1g	8 (8-8)
Scorpaenidae	*Sebastes viviparus*	Norway redfish	33	0.644	19.8 (13-27)
Scorpaenidae	*Sebastes mentella*	Deepwater redfish	237	15.328	29.9 (9-39)
Scorpaenidae	***Sebastes sp.***	**Redfishes**	**209**	**0.122**	37.1 (7-11)
Scorpaenidae	*Sebastes marinus*	Golden redfish	66	0.68	38.2 (28-49)
Squalidae	*Somniosus microcephalus*	Greenland shark	1	0.077	135 (135-135)
Sternoptychidae	*Maurolicus muelleri*	Pearlside	6	<1g	5.6 (5-6)
Sternoptychidae	***Sternoptychidae***	**Hatchet fishes**	**0**		
Sternoptychidae	***Sternoptychidae***	**Hatchet fishes**	**2**	<1g	11 (11-11)
Sternoptychidae	*Arctozenus risso*	Ribbon barracudina	75	0.011	24.6 (22-27)
Sternoptychidae	*Paralepis coregonoides*	Sharpchin barracudina	2	<1g	23 (23-23)
Syngnathidae	*Entelurus aequoreus*	Snake pipefish	31	0	34.8 (25-38)
Syngnathidae	*Syngnathus acus*	Greater pipefish	5	<1g	35 (35-37)
Zoarcidae	*Lycodes frigidus*		5	0.002	19.8 (10-28)
Zoarcidae	*L. pallidus*	Pale eelpout	83	0.025	14.1 (10-19)
Zoarcidae	*L. eudipleurostictus*	Double line eelpout	67	0.031	16.1 (11-25)
Zoarcidae	*Gymnelis viridis*	Fish doctor	4	<1g	12.8 (11-14.5)
Zoarcidae	*Lycenchelys muraena*		2	<1g	15.5 (14-17)
Zoarcidae	*Lycenchelys kolthoffi*		13	0.003	16.6 (14-20)
Zoarcidae	*L. reticulatus*	Arctic eelpout	38	0.02	17.5 (14-32)
Zoarcidae	*L. rossi*	Threespot eelpout	135	0.053	15 (10-23)
Zoarcidae	*Lycodes polaris*	Canadian eelpout	11	0.001	13.4 (9-21)
Zoarcidae	*Lycodonus flagellicauda*		2	<1g	14.5 (14-15)
Zoarcidae	*Gymnelus retrodorsalis*	Aurora unernak	7	<1g	11.8 (11-13)
Zoarcidae	*L. seminudus*	Longear eelpout	67	0.046	16.3 (10-29)
Zoarcidae	*Lychenchelus sarsii*	Sars wolf eel	1	<1g	19 (19-19)
Zoarcidae	*L. esmarkii*	Esmark's eelpout	35	0.061	29.1 (17-52)
Zoarcidae	*L. gracilis*	Vahl's eelpout	209	0.119	17.9 (12-27)
Zoarcidae	***Zoarcidae (genus)***	**Eelpouts**	**11**	<1g	11.7 (6.3-19)

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