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INTERNATIONAL ECOSYSTEM SURVEY IN NORDIC SEA (IESNS) IN April – June 2014

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Introduction

In April-June 2014, five research vessels; RV Dana, Denmark (joined survey by Denmark, Germany, Ireland, The Netherlands, Sweden and UK), RV Magnus Heinason, Faroe Islands, RV Arni Friðriksson, Island, RV G.O. Sars, Norway and RV Fridtjof Nansen, Russia participated in the International ecosystem survey in the Nordic Seas (IESNS). The survey area was split into three Subareas: Area I, Barents Sea area, Area II, Northern and central Norwegian Sea Area, and Area III, the South-Western Area (Figure 1). The aim of the survey was to cover the whole distribution area of the Norwegian Spring-spawning herring with the objective of estimating the total biomass of the herring stock, in addition to collect data on plankton and hydrographical conditions in the area. The survey was initiated by the Faroese, Iceland, Norway and Russia in 1995. Since 1997 also the EU participated (except 2002 and 2003) and from 2004 onwards it was more integrated into an ecosystem survey. This report is compilation of data from this International survey stored in the PGNAPES databases and supported by national survey reports from each survey (Dana: Anonymous 2014, Magnus Heinason: Smith & í Homrum FAMRI 1416-2014, Arni Friðriksson: Oskarsson and Sveinbjornsson 2014, Fridtjof Nansen: Rybakov PINRO 2014 and G.O. Sars: not (yet) available.

Material and methods

Coordination of the survey was done only by correspondence as its main platform for discussions, the Working Group on Northeast Atlantic Pelagic Ecosystem Surveys (WGNAPES), was emerged with WGIPS in 2012 and only few scientists involved in this survey attend its meetings. The participating vessels together with their effective survey periods are listed in the table below:

Vessel	Institute	Survey period
Dana	Danish Institute for Fisheries Research, Denmark	13/5–1/6
G. O. Sars	Institute of Marine Research, Bergen, Norway	3/5-31/5
Fridtjof Nansen	PINRO, Russia	14/5–10/6
Magnus Heinason	Faroe Marine Research Institute, Faroe Islands	1/5- 12/5
Arni Friðriksson	Marine Research Institute, Island	30/4-22/5

Figure 2 shows the cruise tracks and the CTD/WP-2 stations and Figure 3 the cruise tracks and the trawl stations. Survey effort by each vessel is detailed in Table 1. Frequent contacts were maintained between the vessels during the course of the survey, primarily through electronic mail.

In general, the weather condition did not affect the survey even if there were some days that were not favourable. In the central area the weather conditions were generally excellent during the survey.

The survey was based on scientific echosounders using 38 kHz frequency. Transducers were calibrated with the standard sphere calibration (Foote *et al*., 1987) prior to the survey. Salient acoustic settings are summarized in the text table below.

Acoustic instruments and settings for the primary frequency (boldface).

	Dana	G.O. Sars	Arni Friðriksson	Magnus Heinason	Fridtjof Nansen
Echo sounder	Simrad EK 60	Simrad EK 60	Simrad EK60	Simrad EK60	Simrad EK60
Frequency (kHz)	**38**	**38**, 18, 70, 120, 200, 333	**38**, 18, 120, 200	**38**,200	**38**, 120
Primary transducer	ES38BP	ES 38B - Serial	ES38B	ES38B	ES38B
Transducer installation	Towed body	Drop keel	Drop keel	Hull	Hull
Transducer depth (m)	3	8.5	8	3	4.5
Upper integration limit (m)	5	15	15	7	10
Absorption coeff. (dB/km)	6.9	10.1	10	10	10
Pulse length (ms)	1.024	1.024	1.024	1.024	1.024
Band width (kHz)	2.425	2.425	2.425	2425	2.425
Transmitter power (W)	2000	2000	2000	2000	2000
Angle sensitivity (dB)	21.9	21.9	21.9	21.9	21.9
2-way beam angle (dB)	-20.5	-20.6	-20.9	-20.8	-20.73
Sv Transducer gain (dB)					
Ts Transducer gain (dB)	25.33	25.5	24.64	25.61	25.72
s_A correction (dB)	-0.55	-0.65	-0.84	-0.72	-0.63
3 dB beam width (dg)					
alongship:	6.73	6.84	7.31	7.02	6.99
athw. ship:	6.77	6.85	6.95	7.01	7.04
Maximum range (m)	500	500	750	500	500
Post processing software	LSSS	LSSS	LSSS	Sonardata Echoview 5.1	LSSS

Post-processing software differed among the vessels but all participants used the same post-processing procedure, which is according to an agreement at a PGNAPES scrutinizing workshop in Bergen in February 2009 (ICES WKCHOSCRU 2009).

Generally, acoustic recordings were scrutinized with the different software (see table above) on daily basis and species identified and partitioned using catch information, characteristic of the recordings, and frequency between integration on 38 kHz and on other frequencies by a scientist experienced in viewing echograms.

All vessels used a large or medium-sized pelagic trawl as the main tool for biological sampling. The salient properties of the trawls are as follows:

	Dana	G.O.Sars	Arni Friðriksson	Magnus Heinason	Fridtjof Nansen
Circumference (m)		832	640	640	500
Vertical opening (m)	25-35	45–50	45–55	45–55	50
Mesh size in codend (mm)		40	40	40	16
Typical towing speed (kn)	3.0-40	4.0–4.5	3.0–4.5	3.0–4.0	3.1–4.3

Catches from trawl hauls was sorted and weighed; fish were identified to species level, when possible, and other taxa to higher taxonomic levels. Normally a subsample of 30–100 herring and blue whiting were sexed, aged, and measured for length and weight, and their maturity status were estimated using established methods. An additional sample of 70–300 fish was measured for length.

Acoustic estimates of herring and blue whiting abundance were obtained during the surveys. This was carried out by visual scrutiny of the echo recordings using post-processing systems. The allocation of sA-values to herring, blue whiting and other acoustic targets were based on the composition of the trawl catches and the appearance of echo recordings. To estimate the abundance, the allocated sA-values were averaged for ICES-squares (0.5° latitude by 1° longitude). For each statistical square, the unit area density of fish (sA) in number per square nautical mile (N*nm-2) was calculated using standard equations (Foote *et al*., 1987; Toresen *et al*., 1998). The following target strength (TS) function was used:

Blue whiting: TS = 20 log(L) – 65.2 dB (rev. acc. ICES CM 2012/SSGESST:01)

Herring: TS = 20.0 log(L) – 71.9 dB

The target strength for herring is the traditionally one used while this target strength for blue whiting was first applied in 2012 (ICES 2012).

To estimate the total abundance of fish, the unit area abundance for each statistical square was multiplied by the number of square nautical miles in each statistical square then summed for all the statistical squares within defined subareas and over the total area. Biomass estimation was calculated by multiplying abundance in numbers by the average weight of the fish in each statistical square then summing all squares within defined subareas and over the total area. The Norwegian BEAM software (Totland and Godø 2001) was used to make estimates of total biomass and numbers of individuals by age and length in the whole survey area and within different subareas.

For the first time, the whole survey area was divided into 5 geographical strata (Figure 4). For each of the strata, east-west transects (except for stratum 6 in the Barents Sea with north-south transects) were decided prior to the survey. Within each stratum, transects were distributed equally apart and the distance was based on available survey time and surveys in previous years. Thus the survey coverage was comparable to previous years, but with more organized interval between transects. This approach will allow for robust statistical analyses of uncertainty of the acoustic estimates in the future.

A new software package (StoX) is under development by IMR, Norway. This is open source software with an infrastructure hosting various types of survey estimation programs for acoustic surveys and trawl surveys (swept area). The program is a stand-alone application build with Java for easy sharing and further development in cooperation with other institutes. The underlying high resolution data matrix structure ensures future implementations of e.g. depth dependent target strength and high resolution length and species information collected with camera systems. Despite this complexity, the execution of an index calculation can easily be governed from user interface and an interactive GIS module, or by accessing the Java function library and parameter set using external software like R. Accessing StoX from external software may be an efficient way to process time series or to perform boot-strapping on one dataset, where for each run, the content of the parameter dataset is altered. In the first version a stratified transect design is assumed (e.g. the IESNS survey plan 2014) and standard statistical methods to estimate mean and variance of abundance will be used. Other methods will be implemented, however, expert specification demands, documentation and statistical rigorousness is essential in the development of "StoX". The software was tested on data collected on this year's IESNS survey.

StoX was used for verification and sensitivity analyses of the biomass estimates of herring. This was done to verify the effect of leaving out transects from Dana because of time-lag of their coverage compare to other vessels (around 10 days later) and obvious nearly lack of herring registrations in parallel adjoining transects with G.O. Sars. This was an exploratory work and the obtained biomass estimates from the program will not be used until a thorough investigation and comparison with the estimates from the BEAM software has taken place. The expectation is that the StoX software will replace the outdated BEAM program in the near future.

Further work on the stratification will take place in the coming years, including defining the most appropriate stratum size and layout of each stratum.

The hydrographical and plankton stations by survey are shown in Figure 2. All vessels collected hydrographical data using a SBE 911 CTD. Maximum sampling depth was 1000 m. Beside the hydrographical sampling from the vessels listed above, hydrographical data from four fixed hydrographical transects (Slétta, Langanes-NE, Langanes-E and Krossanes; Figure 15; total 32 stations) east and north east of Iceland were also used. They were sampled in the spring survey around Iceland by RV Bjarni Sæmundsson during 18-22 May 2014 using the same kind of CTD as the other vessels.

Zooplankton was sampled by a WPII on all vessels except the Russian vessel which used a Djedi net, according to the standard procedure for the surveys. Mesh sizes were 180 or 200 µm. The net was hauled vertically from 200 m or the bottom to the surface. All samples were split in two and one half was preserved in formalin while the other half was dried and weighed. On the Danish, the Icelandic and the Norwegian vessels the samples for dry weight were size fractionated before drying. Data are presented as g dry weight per m^2.

Results

Hydrography

Temperature distribution for April-June 2014

The temperature distributions in the ocean at selected depths between 10 m and 400 m depths are shown in Figures 5-10. The temperatures at the surface ranged between 2°C in the Iceland Sea and 9°C in the southern part of the Norwegian Sea. The Arctic front was encountered slightly below 65°N east of Iceland extending eastwards towards the 0° Meridian where it turned almost straight northwards up 70°N. The front was visible throughout the observed water column. The warmer North Atlantic water formed a broad tongue that stretched far northwards along the Norwegian coast with temperatures > 7 °C to 70° N in the surface layers and to 68 ° N at 200 m depth.

Relative to a 19 years long-term mean, from 1995 to 2013, the temperature at 20 m depth northeast of Iceland was considerable higher in 2014 compared to the long-term mean (Figure 11). There, the anomaly was maximum 2°C. This pattern was also observed at 0-50 m depth at the standard hydrographic sections northeast off Iceland (Figures 15-17). At deeper depths the difference between 2014 and the long term mean was smaller (Figures 12-14). In general, at 200 m and shallower depths the western part of the Norwegian Sea and the Iceland Sea was somewhat warmer than the long-term mean. It was also observed at the standard hydrographic section off northeast Iceland (Figure 18). In the eastern part of the Norwegian Sea the temperature was lower than the mean, particular in the upper layer where it was about 0.5 °C colder than the mean (Figure 11). At 200 m and particular at 400 m depth the temperature was lower than the long-term mean (about 0.25-0.50 °C) in the central Norwegian Basin.

Zooplankton

Biomass of zooplankton and sampling stations are shown in Figure 19. Sampling stations were relatively evenly spread over the area, and most oceanographic regions were covered. The zooplankton biomass was relatively uniform over the whole area, except for higher concentrations off the Norwegian coast around 65°N, and still continues the upwards trend since the lowest recorded value in the time series in 2009 (Figure 20). Recorded zooplankton biomass in the two areas west and east of 2°W equaled 9.4 and 9.8 g dry weight m^{-2}, respectively, while total mean was 9.7 g dry weight m^{-2}. When limiting the area to west of 17°E (eliminating Barents Sea measurements), the biomass indices become 9.4 (west), 9.9 (east) and 9.7 (total) g dry weight m^{-2}. This year, no zooplankton was sampled on the continental slope south and west of Iceland (west of 14°W).

In the Barents Sea, the mean zooplankton biomass was 1.6 g dry weight m^{-2}. It was noted that the Djedy net applied by the Russian vessel in Barents Sea seems to be less effective in catching zooplankton in comparison to WP2 net applied by other vessels in an overlapping area. Thus, the biomass estimates for the Barents Sea are not directly comparable to the other areas, but are comparable among years within the Barents Sea.

Norwegian Spring-spawning herring

Survey coverage in the Norwegian Sea was considered adequate in 2014 and in line with previous years. It is therefore recommended that the results can be used for assessment purpose. The herring distribution in 2014 was similar to the 2013 distribution. The highest concentrations were found in the central to southwestern part of the Norwegian Sea (Figures 21 and 22), and consisted mainly of older part of the stock (age 8 and older; Table 2). A dense concentration was also found in the northeast (around 69°N and 5°E) and consisted of a mixture of all age classes from age 2-14. Overall the herring density was relatively low and herring was never observed in big schools. In 2014, like in previous three years, almost no herring were observed north of 70°N, while it was found further north in 2010. The center of gravity of the acoustic recordings of herring reflects the distribution and shifted in a southwesterly direction compared to 2013 (Figure 23).

As in previous years the smallest fish were found in the eastern area of the Norwegian Sea where size and age were found to increase to the west and south (Figure 24). Correspondingly, it was mainly older herring that appeared in the southwestern areas (area III).

The herring stock is now dominated by 10 year old herring (2004 year class) in numbers but 5, 8, 9, 11 and 12 year old herring (the 2009, 2006, 2005, 2003 and 2002 year classes) are also numerous (Table 2), which is similar to previous years. The 2009 year class appears to be the largest of the younger age groups even it appears to be only around 50% of average size of five year olds in the times series since 1997. The six year classes from 2002 to 2006 and 2009 contribute to 6%, 10%, 22%, 14%, 12% and 14%, respectively, of the total biomass.

The total biomass estimate of herring in the Norwegian Sea from the 2014 survey was 5.1 million tons. This estimate is 0.3 million tons lower than in 2013. The biomass estimates in the last six years has fluctuated, with 10.7 million tons in 2009, 5.8 million tons in 2010, 7.4 million tons in 2011, 4.6 million tons in 2012, 5.4 million tons in 2013 and now 5.1 million tons in 2014.

The investigations of herring in the Barents Sea covered the area from 44°E to the 20°30′ E. The total abundance estimate was higher than in the last two years, with 5876 million individuals of age 1 (mean length of 11.5 cm and weight of 8.7 g), 2185 million individuals of age 2 (mean length of 17.8 cm and mean weight of 32.4 g), 2156 million individuals of age 3 herring (mean length of 23.8 cm and mean weight of 76.3 g) and 242 million individuals of age 4 herring (mean length of 25.7 cm and mean weight of 95.9 g). Only very few older herring were observed.

The total number of herring recorded in the Norwegian Sea was 9.6 billion in the northeastern area and 10.4 billion in the southwestern area, compared to 12.8 and 13.0 billion in the northeastern and 7.2 and 7.4 billion in the southwestern area in 2012 and 2013, respectively.

Blue whiting

The total biomass of blue whiting registered during the May 2014 survey was 0.63 million tons (Table 3), which is somewhat less than the biomass estimate in 2013. The stock estimate in number for 2014 is 8.9 billion, which is approximately the same number as in 2012 estimate. The decrease in biomass without a decrease in abundance is caused by more young fish in the stock. Age one is dominating the estimate whereas in 2013 the 1-group was more or less absent. The estimate of 1-

goup in 2014 is 3.7 billion compared to only 0.6 billion in 2013. The number of 2 year olds was lower than in 2013, 2.5 billion compared to 6.3 billion. These results confirm the weak 2012 year class and suggest that the 2013 year class is stronger. This year class constituted to 41% of the total number and 26% of the total biomass.

An estimate was also made from a subset of the data or a "standard survey area" between 8°W–20°E and north of 63°N, which has been used as an indicator of the abundance of blue whiting in the Norwegian Sea because the spatial coverage in this area provides a coherent time-series with adequate spatial coverage. This standard survey area estimate is used as an abundance index in WGWIDE. The age-disaggregated total stock estimate in the "standard area" is presented in Table 4, showing that the blue whiting in this index area was dominated by fish at age 2 in terms of numbers and age 3 in terms of biomass, i.e. the youngest fish (age 1) is mostly found outside the "standard survey area".

The distribution of blue whiting in 2014 was similar to 2013, but the strong concentration found in the north eastern corner of the Norwegian Sea found in 2013 was absent in 2014. The main concentrations were observed both in connection with the continental slopes of Norway and south and southwest Iceland and in the open sea in the southern part of the Norwegian Sea (Figures 25 and 26). The mean length of blue whiting is shown in Figure 27. It should be noted that the spatial survey design was not intended to cover the whole blue whiting stock during this period.

Mackerel

In later years an increasing amount of mackerel has been observed in the Norwegian Sea during the combined survey in May targeting herring and blue whiting. The edge of the distribution has also been found progressively further north and west. However, the mackerel was mainly found in the eastern part of the survey area up to 67°N in May 2014, with few exceptions at western stations further south. This distribution is comparable to the May surveys in 2012 and 2013. It should be noted, however, that the sampling may not provide a representative picture of mackerel distribution because of its vertical distribution and relatively low trawling speed.

Stomach samples from the three pelagic species (herring, blue whiting and mackerel) were collected by the Norwegian, Icelandic and Faroese vessels. These samples have however, not been analyzed yet and will be reported by other means later.

Discussion

Hydrography

Discussions related to the oceanographic condition in April/July 2014 are provided in the results section above, while more general patterns are introduced in this section.

Two main features of the circulation in the Norwegian Sea, where the herring stock is grazing, are the Norwegian Atlantic Current (NWAC) and the East Icelandic Current (EIC). The NWAC with its offshoots forms the northern limb of the North Atlantic current system and carries relatively warm and salty water from the North Atlantic into the Nordic Seas. The EIC, on the other hand, carries Arctic waters. To a large extent this water derives from the East Greenland Current, but to a varying extent, some of its waters may also have been formed in the Iceland and Greenland Seas. The EIC flows into the southwestern Norwegian Sea where its waters subduct under the Atlantic waters to form an intermediate Arctic layer. While such a layer has long been known in the area north of the Faroes and in the Faroe-Shetland Channel, it is only in the last three decades that a similar layer has been observed all over the Norwegian Sea.

This circulation pattern creates a water mass structure with warm Atlantic Water in the eastern part of the area and more Arctic conditions in the western part. The NWAC is rather narrow in the southern Norwegian Sea, but when meeting the Vøring Plateau off Mid Norway it is deflected westward. The western branch of the NWAC reaches the area of Jan Mayen at about 71°N. Further northward in the Lofoten Basin the lateral extent of the Atlantic water gradually narrows again, apparently under topographic influence of the mid-ocean ridge. It has been shown that atmospheric forcing largely controls the distribution of the water masses in the Nordic Seas. Hence, the lateral extent of the NWAC, and consequently the position of the Arctic Front, that separates the warm North Atlantic waters from the cold Arctic waters, is correlated with the large-scale distribution of the atmospheric sea level pressure.

Plankton

The zooplankton biomass has been estimated since 1997 (Figure 20). After a severe decline from 2003 until 2009 (~4 g/m^2), the biomass has now been showing an upward trend for 5 years and reached 9.7 g/m^2 in 2014. The biomass now is close to what it was in the period prior to 2004 and shows an increase both in the west and particularly in the east. The decrease in zooplankton biomass until 2009 - was dramatic in the sense that biomass in the cold water decreased by 80% since 2003, while in the warmer water, the biomass decreased by 55% since 2002. The reason for this drop in biomass, or the increase since 2010, is not obvious to us. The unusually high biomass of pelagic fish feeding on zooplankton has been suggested to be one of the main causes for the reduction in zooplankton biomass. However, carnivorous zooplankton and not pelagic fish are the main predators of zooplankton in the Norwegian Sea (Skjoldal *et al.*, 2004), and we do not have good data on the development of the carnivorous zoo-plankton stocks. A fairly strong relationship between NAO and zooplankton biomass was observed, particularly during the late 1990s. However, this relationship seems to be less pronounced now. The linkage between sea temperature and zooplankton abundance is also not fully understood and needs further explorations.

The zooplankton biomass in Barents Sea showed an increase from last year, from 1.2 to 1.6 g dry weight m^{-2}, and in 2012 the biomass was 1.7 g dry weight m^{-2}. However, as stated above, the biomass estimates for the Barents Sea taken with the Djedi net are not directly comparable to the other areas taken by WP2 nets, but are comparable among years within the Barents Sea.

Summing up, the reason for the observed changes in zooplankton biomass is not clear to us and more research to reveal this is recommended. Quantitative researches on carnivorous zooplankton stocks (such as krill and amphipods) across the whole survey area, is an important step in that direction and needs a further effort by all participating countries.

The estimations of average biomass of zooplankton, discussed above, have included the whole areas covered by the survey vessels each year. However, it has been noted that the research effort can vary by a lot in the continental slope area south and west off Iceland. For that reason, and to get biomass indices representative for Norwegian Sea it self, it is recommended to re-estimate the whole time series and limit the area to east of 14°W and west of 17°E. The data are not yet all in the NAPES database so this could not be done at the meeting where this report was prepared.

Norwegian spring-spawning herring

The Norwegian spring-spawning herring is characterized by large dynamics with regard to migration pattern. This applies to wintering, spawning and feeding area. The following discussion will mainly concentrate on the distribution and situation in the feeding areas in May, but no attempt was done to draw up the likely feeding migration that is believed to be comparable to recent years.

The amount of herring measured in the 2014 survey was 6% lower than in 2013. The biomass estimates in the last six years has fluctuated, with 10.7 million tons in 2009, 5.8 in 2010, 7.4 in 2011, 4.6 million tons in 2012, 5.4 million tons in 2013 and 5.1 millon tons in 2014. Work is presently being conducted to obtain an estimate of uncertainty in the survey. The uncertainty, or the CV, round the estimates is estimated to be less than 30% for each of the age groups 3-12 for the years 2009 – 2013 (Stenevik, *et.al.*, 2014). However, the downward trend in the biomass is apparent.

The new approach of dividing the survey area into stratum is considered as valid improvements in terms of securing equivalent coverage among years and allow for robust statistical analyses of uncertainty of the acoustic estimates in the future.

In the last years there have been concerns regarding age reading of herring, because the age distribution from the different participants have showed differences. This is also the case in 2014. Partly, the differences may reflect differing spatial distribution of age groups, and partly, they may reflect variable growth conditions for the stock, and consequently growth rate as seen on the fish scales and otoliths. In spring 2014 an otolith and scale exchange was conducted, as was suggested by the survey group in last year's survey report to address these issues. The results have not yet been finally analysed, and therefore possible necessary changes in age reading procedures have not yet been implemented. The survey group recommend that a age reading workshop is held as soon as possible.

There are concerns with the acoustic estimates from Dana during this year's survey, which adds uncertainty to the present acoustic estimates of the herring. The concerns are because of almost zero registrations of herring on their fourth and fifth east-west transects, and also weak registrations on the third, compare to neighbour transects from G.O. Sars with much higher registrations (Figures 21 and 22). The fact that herring was caught by Dana along these transects in areas without herring registrations adds to the concerns that something is wrong with the data from Dana and needs a further attention. Two possible reasons for this discrepancy are of consideration: (1) Time-lag where Dana was around 10 days later compare to other vessels; (2) Problems related to the scrutinizing procedure in Dana. Catches of herring where herring was not recorded acoustically, only blue whiting, supports the second option and calls for re-scrutinizing of the acoustic data where the procedure described in the WGIPS manual is strictly followed. Until the re-scrutinizing has been done there is not much to add to this discussion.

Blue whiting

The abundance estimate of blue whiting confirms that the 2012 year class is weak and that there is a good signal that the 2013 year class is stronger. A positive sign in development of the stock size was first observed in the 2011 survey where blue whiting at age 1 and 2 were in higher numbers than the previous years. The number of 1 year old in the standard area (Table 4) this year is low, but they are found in a higher degree outside the standard area stating that the 2013 year class is stronger than the previous one.

General recommendations and comments

Recommendation	Adressed to
1. A workshop on scrutinizing of acoustic data from the survey is highly recommended by the group. The procedure is to a large extent subjective and therefore it is very important that all scientists responsible for the scrutinization are following the same general procedure. The workshop should preferably take place during the autumn/winter 2013/2014, or prior to the surveys in 2014. The uncertainty regarding the scrutinizing procedure onboard of Dana in this years survey (above), emphasizes the need for the workshop and also involvement of new scientists responsible for the scrutinizing in the survey (e.g. from Iceland, Norway and the Faroes) since the last workshop was held.	ACOM, WGWIDE, WGIPS
2. The survey group recommends that an age reading workshop will be held as soon as possible. This is to follow up on issues identified following analyses of otoliths and scales exchanges in 2014 (preliminary report available from Jane A. Godiksen, IMR, Norway).	ACOM, WGWIDE
3. Establishment of quantitative researches on carnivorous zooplankton stocks (such as krill and amphipods) across the whole survey area are recommended. It would require use of standardized fishing gears, such as the krill trawl used by Norway in recent years and Iceland in 2014.	Participating countries, WGWIDE, WGIPS

Next years post-cruise meeting

Preliminary dates are 16-18 June, in Copenhagen or Murmansk. Will be decided at WGIPS in January 2015.

Concluding remarks

- At 200 m and shallower depths the western part of the Norwegian Sea and the Iceland Sea was somewhat warmer than the 19 years mean. The temperature at 20 m depth northeast of Iceland was up to 2°C higher than the long-term mean, while around and just above mean in other areas.
- The index of plankton biomass in the Norwegian Sea continues to increase and is now close to the level prior to the period of decline (2004-2010.)
- The estimate of NSSH was 6 % lower compared to last year
- NSSH was dominated by the 2004 year class, but also the 2009 year class contributed significantly

- No strong year classes of NSSH were observed in the Barents Sea indicating poor recruitment since 2004.
- The amount of blue whiting measured in the survey area was similar to last year.
- The blue whiting estimate is dominated by three year classes, 2013, 2012 and 2011, and they constitute 28% of the biomass and 87% of the abundance.

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Tables

Table 1. Survey effort by vessel for the International ecosystem survey in the Nordic Seas in April-June 2014.

Vessel	Effective survey period	Effective acoustic cruise track (nm)	Trawl stations	Aged fish (HER)	Length fish (HER)	CTD stations	Plankton station
Dana	13/5-1/6	2539	32	466	1709	35	36
G.O.Sars	4/5-26/5	3332	52	488	1554	66	68
Fridtjof Nansen	15/5-6/6	3525	47	369	2458	104	106
Magnus Heinason	1/5-12/5	1210	12	285	576	20	20
Árni Friðriksson	30/4-22/5	4039	32	690	2646	43	53
Total	1/5-6/6	14645	171	2298	8943	268	284

Table 2. Age and length-stratified abundance estimates of Norwegian spring-spawning herring in April-June 2014 for total area and abstracts of estimates for subareas I, II and III.

Length	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Number	Biomass	Weight
10																0		
11																0		
12																0		
13																0		
14																0		
15																0		
16																0		
17																0		
18	62	125	0	0	0	0	0	0	0	0	0	0	0	0	0	187	8.4	45
19	0	56	0	0	0	0	0	0	0	0	0	0	0	0	0	56	3.1	55
20	0	248	0	0	0	0	0	0	0	0	0	0	0	0	0	248	15.4	62
21	0	97	63	0	0	0	0	0	0	0	0	0	0	0	0	160	11.6	73
22	0	91	97	0	0	0	0	0	0	0	0	0	0	0	0	188	15.8	84
23	0	27	292	0	0	0	0	0	0	0	0	0	0	0	0	319	30.9	97
24	0	9	195	0	0	0	0	0	0	0	0	0	0	0	0	204	22.4	110
25	0	0	456	15	0	0	0	0	0	0	0	0	0	0	0	471	56	119
26	0	14	254	28	0	0	0	0	0	0	0	0	0	0	0	296	39.9	134
27	0	6	114	72	12	0	0	0	0	0	0	0	0	0	0	204	30.6	150
28	0	0	53	178	125	18	0	0	0	0	0	0	0	0	0	374	62.4	167
29	0	0	64	270	651	79	32	0	0	0	16	0	16	16	0	1144	211.7	185
30	0	0	24	327	533	48	36	24	12	0	0	0	0	0	0	1004	202.8	202
31	0	0	13	91	431	78	26	26	39	13	26	13	0	26	0	782	173.3	221
32	0	0	0	85	693	99	14	85	57	28	0	0	0	0	0	1061	260.9	246
33	0	0	0	29	405	87	260	477	361	246	87	14	0	0	0	1966	529.1	269
34	0	0	0	11	261	109	381	871	828	1275	359	261	54	0	0	4410	1274.1	287
35	0	0	0	0	20	30	163	600	773	1586	763	366	102	41	40	4484	1362.5	303
36	0	0	0	0	9	0	18	71	266	443	363	327	195	62	71	1825	585.6	321
37	0	0	7	0	0	0	0	7	21	63	42	56	91	28	42	357	120	336
38	0	0	0	0	6	0	0	0	0	13	0	25	31	19	32	126	44.9	357
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	2.1	383
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.
41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0.8	405
42																0		
Number 10^6	62	673	1632	1106	3146	548	930	2161	2357	3667	1656	1062	489	192	193	19874	5064	
Biomass 10^3 t	5.9	45.1	198.7	214	711.7	138.9	257.1	617.3	686.8	1091	497.2	325.9	153.8	57.1	63.4	5064	5064.2	
Mean length cm	20.8	20.8	25.4	29.9	31.6	32.3	34	34.5	34.8	35.1	35.3	35.7	36.2	35.4	37		32.8	
Mean weight g	79.9	67.1	121.7	193.4	226.1	241	276.4	285.6	291.5	297.6	300.3	306.4	314.3	298.1	332		254.4	

Table 2. (cont'd)

Area 1

Age	1	2	3	4	5	6	7	8	9	10	11	12+	Total
Number 10^6	5876	2185	2156	242	45	2	1	1	0	0	0	0	10508
Biomass 10^3 t	51	70.9	164.6	23.2	6.9	0.6	0.5	0.6					318.3
Mean length cm	11.5	17.8	23.8	25.7	30	31.3	31.9	32.5					15.7
Mean weight g	8.7	32.4	76.3	95.9	151.5	179.6	192.8	202.7					30.3

Area 2

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total
Number 10^6	63	673	1549	983	2267	262	352	562	660	1117	446	263	214	62	81	9554
Biomass 10^3 t	2.8	45	186.4	186.9	488.9	57.1	93.9	158.4	187.5	327.5	131	79.2	64.2	15	26.5	2050.3
Mean length cm	18.4	20.8	25.3	29.8	31.2	31.3	33.8	34.5	34.7	35.2	35.2	35.5	35.6	32.7	37.1	30.7
Mean weight g	44.2	67.1	120.4	190	215.7	217.3	266.8	281.7	284.1	293.1	293.7	298.6	300.1	245	320	214.5

Area 3

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total
Number 10^6	0	0	81	86	777	328	582	1664	1724	2556	1244	823	254	136	101	10356
Biomass 10^3 t			24.1	19.1	196.6	83.4	162.2	482.6	512.2	772.2	379.7	256.6	83.7	44.9	33.1	3050.4
Mean length cm			26.9	30.4	32.3	33.2	34	34.4	34.8	35.1	35.3	35.7	36.7	36.8	36.9	34.7
Mean weight g			175.5	221.7	252.3	269.5	284.3	290.1	297.1	302	305.2	312.1	329.6	332.7	340	294.6

Area 2 and 3
(Norwegian Sea)

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total
Number 10^6	62	673	1632	1106	3146	548	930	2161	2357	3667	1656	1062	489	192	193	19874
Biomass 10^3 t	5.9	45.1	198.7	214	711.7	138.9	257.1	617.3	686.8	1091	497.2	325.9	153.8	57.1	63.4	5063.9
Mean length cm	20.8	20.8	25.4	29.9	31.6	32.3	34	34.5	34.8	35.1	35.3	35.7	36.2	35.4	37	32.8
Mean weight g	79.9	67.1	121.7	193.4	226.1	241	276.4	285.6	291.5	297.6	300.3	306.4	314.3	298.1	332	254.4

Total
(All areas)

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total
Number 10^6	5939	2858	3787	1312	3080	601	934	2228	2386	3676	1691	1088	468	198	183	30429
Biomass 10^3 t	60	116	365	229.2	689.4	143	260.3	641.3	700.1	1100	510.8	335.9	147.9	59.9	59.6	5418.4
Mean length cm	11.6	18.5	24.5	29.1	31.4	32.3	33.9	34.4	34.8	35.1	35.3	35.7	36.2	35.5	37.1	26.9
Mean weight g	9.6	40.6	96.4	174.7	223.9	245	277.5	287.9	293.5	299.3	302.2	308.8	316.1	305.1	340	178.2

Table 3. Age and length-stratified abundance estimates of blue whiting in April-June 2014, west of 20°E for total area and abstracts of estimates for subareas II and III.

Length	1	2	3	4	5	6	7	8	9	10	11	12+	Number 10^6	Biomass 10^3 t	Mean Weight
10													0		
11													0		
12													0		
13													0		
14													0		
15	0	1	0	0	0	0	0	0	0	0	0	0	1	0	19
16	3	10	0	0	0	0	0	0	0	0	0	0	13	0.3	26
17	63	54	0	0	0	0	0	0	0	0	0	0	117	3.3	28
18	484	403	9	0	0	0	0	0	0	0	0	0	896	29.5	33
19	941	662	10	0	0	0	0	0	0	0	0	0	1613	62.5	39
20	1115	588	4	0	0	0	0	0	0	0	0	0	1707	77.6	46
21	688	250	16	0	0	0	0	0	0	0	0	0	954	50.8	53
22	349	277	48	24	0	0	0	0	0	0	0	0	698	43.1	62
23	22	65	84	15	0	0	0	0	0	0	0	0	186	13.6	73
24	3	36	186	36	0	0	0	0	0	0	0	0	261	21.7	83
25	0	41	229	77	6	0	0	0	0	0	0	0	353	33.5	95
26	0	55	421	122	19	4	0	0	0	0	0	0	621	65.7	106
27	0	28	357	118	34	0	0	0	0	0	0	0	537	64.6	120
28	0	3	181	106	31	0	0	0	0	0	0	0	321	42.5	132
29	5	0	85	113	17	14	0	0	0	0	0	0	234	34.8	150
30	0	0	14	25	27	4	4	2	2	2	0	0	80	13.2	167
31	0	0	0	23	20	13	5	5	3	3	0	0	72	13.3	187
32	0	0	0	17	39	14	5	4	13	8	5	0	105	20.8	200
33	0	0	3	3	0	10	3	15	9	3	0	4	50	10.8	221
34	0	0	0	1	1	5	4	6	1	4	2	2	26	6.3	234
35	0	0	0	0	0	0	12	14	11	1	2	2	42	10.7	257
36	0	0	0	0	1	1	1	1	12	0	12	12	40	12.1	303
37	0	0	0	0	0	1	0	2	0	2	0	0	5	1.8	281
38	0	0	0	0	0	0	2	1	0	0	0	0	3	0.9	282
39													0		
40													0		
41													0		
42													0		
43													0		
Number 10^6	3673	2473	1647	680	195	66	36	50	51	23	21	20	8935	633	
Biomass 10^3 t	167.4	118.3	174.6	83.4	29.8	12.1	7.7	11.5	12.4	4.8	5.7	5.7	633.4	633.4	
Length cm	20.3	20.6	26.4	27.6	29.6	31.7	33.9	34.1	34.3	33.3	35.3	35.5		22.7	
Weight g	45.6	47.9	106.1	122.6	153	187	225.5	230.2	242	216.3	270.6	287		70.9	

Area 2

Age	1	2	3	4	5	6	7	8	9	10	11	12+	Total
Number 10^6	1436	2234	1135	494	85	22	24	39	20	16	0	0	5505
Biomass 10^3 t	59.2	96.6	114.3	57	12.2	3.5	5.5	9	4.7	3.5			365.5
Length cm	19.9	20.1	26	27.1	29	30.4	34.7	34.1	33.7	33.3			22.3
Weight g	41.2	43.2	100.9	115.7	145.1	166.4	240.1	229.7	225	216.8			66.5

Area 3

Age	1	2	3	4	5	6	7	8	9	10	11	12+	Total
Number 10^6	2238	238	514	189	112	45	12	11	31	6	21	20	3437
Biomass 10^3 t	108.2	21.7	60.3	26.4	17.6	8.6	2.2	2.5	7.7	1.3	5.7	5.7	267.9
Length cm	20.6	24.8	27.1	28.8	30	32.3	32.4	34.3	34.6	33.4	35.3	36	23.2
Weight g	48.3	91.5	117.5	140.6	159	197	196	231.9	253.6	214.8	270.6	285	78.1

Area 2 and 3 (Norwegian Sea)

Age	1	2	3	4	5	6	7	8	9	10	11	12+	Total
Number 10^6	3673	2473	1647	680	195	66	36	50	51	23	21	20	8935
Biomass 10^3 t	167.4	118.3	174.6	83.4	29.8	12.1	7.7	11.5	12.4	4.8	5.7	5.7	633.4
Length cm	20.3	20.6	26.4	27.6	29.6	31.7	33.9	34.1	34.3	33.3	35.3	35.5	22.7
Weight g	45.6	47.9	106.1	122.6	153	187	225.5	230.2	242	216.3	270.6	287	70.9

Table 4. Blue whiting in "Standard Area" 8°W - 20°E and north of 63°N in IESNS 2014.

Length	1	2	3	4	5	6	7	8	9	10	11	12+	Number	Biomass	Weight
10													0		
11													0		
12													0		
13													0		
14													0		
15													0		
16	0	10	0	0	0	0	0	0	0	0	0	0	10	0.2	26
17	33	53	0	0	0	0	0	0	0	0	0	0	86	2.3	27
18	334	373	10	0	0	0	0	0	0	0	0	0	717	23.1	32
19	449	559	9	0	0	0	0	0	0	0	0	0	1017	38.6	38
20	356	495	0	0	0	0	0	0	0	0	0	0	851	38	45
21	152	219	8	0	0	0	0	0	0	0	0	0	379	19.9	52
22	74	222	49	25	0	0	0	0	0	0	0	0	370	22.7	61
23	0	18	75	13	0	0	0	0	0	0	0	0	106	7.5	71
24	0	4	141	23	0	0	0	0	0	0	0	0	168	13.4	80
25	0	6	152	69	3	0	0	0	0	0	0	0	230	21.1	92
26	0	7	249	75	14	0	0	0	0	0	0	0	345	35.9	104
27	0	0	200	75	15	0	0	0	0	0	0	0	290	34.8	120
28	0	0	84	62	16	0	0	0	0	0	0	0	162	21.6	134
29	4	0	41	64	4	11	0	0	0	0	0	0	124	18.8	152
30	0	0	3	9	8	2	3	2	0	2	0	0	29	4.7	173
31	0	0	0	5	3	3	3	5	3	0	0	0	22	4.1	196
32	0	0	0	13	25	6	0	6	19	13	0	0	82	17.4	213
33	0	0	3	3	0	3	3	12	9	3	0	0	36	8.2	226
34	0	0	0	2	2	0	2	4	2	2	0	0	14	3.7	258
35	0	0	0	0	0	0	8	11	4	0	4	4	31	8.2	270
36	0	0	0	0	7	7	7	7	0	0	7	0	35	10.3	279
37	0	0	0	0	0	1	0	2	0	2	0	0	5	1.7	279
38	0	0	0	0	0	0	2	1	0	0	0	0	3	0.8	285
39													0		
40													0		
41													0		
42													0		
43													0		
Number 10^6	1402	1966	1024	438	97	33	28	50	37	22	11	4	5112	357.0	
Biomass 10^3 t	57.7	84.9	103.3	51.9	15.9	6.9	6.9	12.5	8.1	4.8	3.1	1	357	357.3	
Length cm	19.9	20.1	26	27.2	30	32.5	34.8	34.3	33.1	33.3	36.2	35.5		22.5	
Weight g	41.1	43.2	101	118.7	166.3	207.3	250.2	243.4	223.4	223.6	275.9	270.3		69.9	

Figures

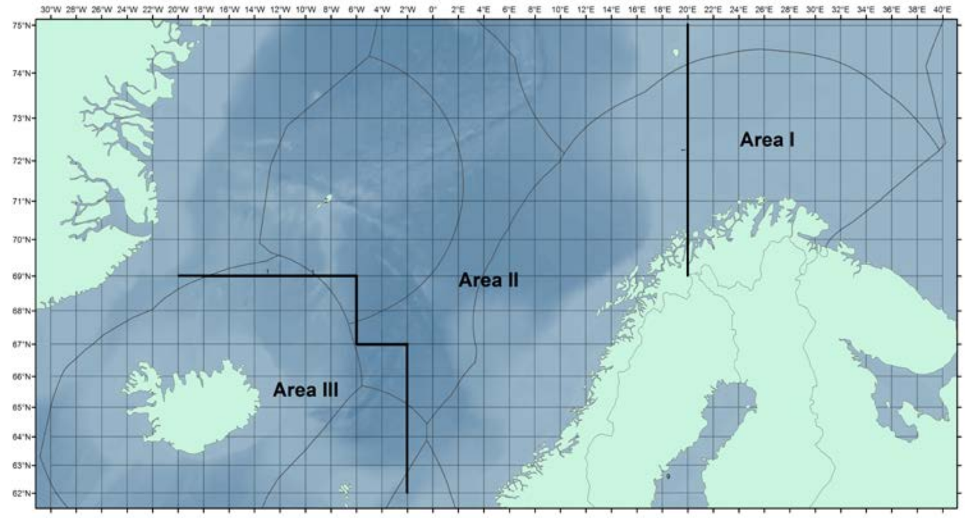

Figure 1. Areas defined for acoustic estimation of blue whiting and Norwegian spring-spawning herring in the Nordic Seas.

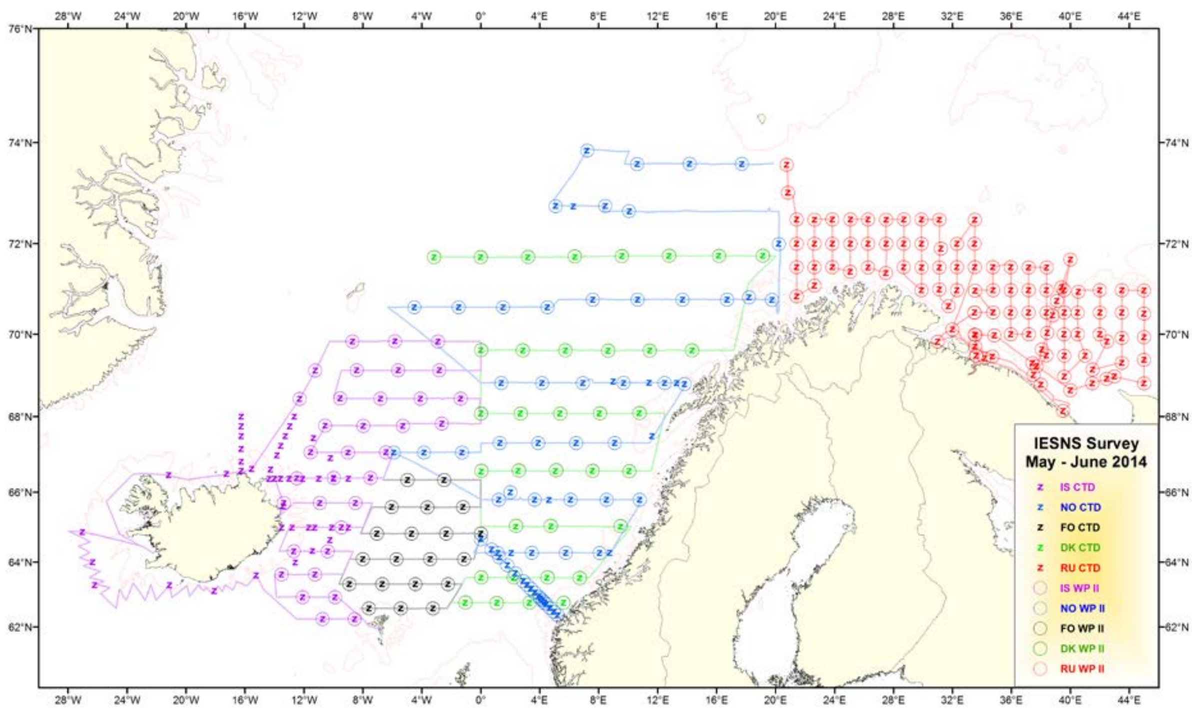

Figure 2. Cruise track, CTD and WP II stations by country for the International ecosystem survey in the Nordic Seas in April-June 2014.

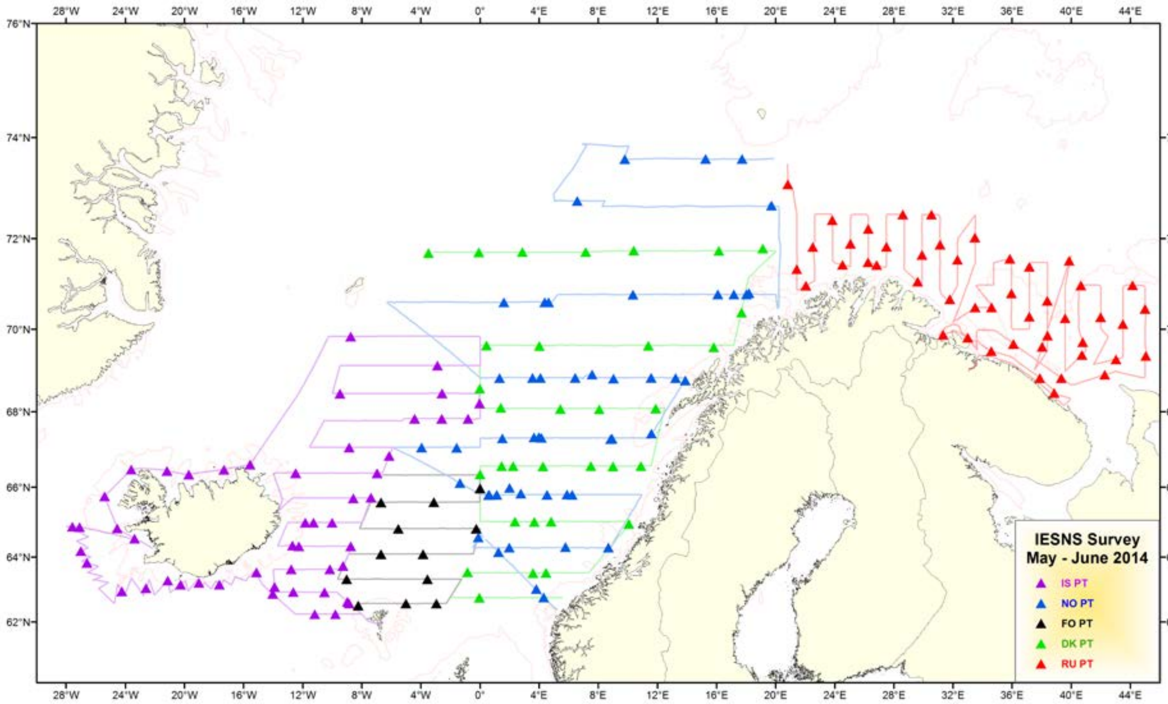

Figure 3. Cruise tracks during the International North East Atlantic Ecosystem Survey in April-May 2014 and location of trawl stations.

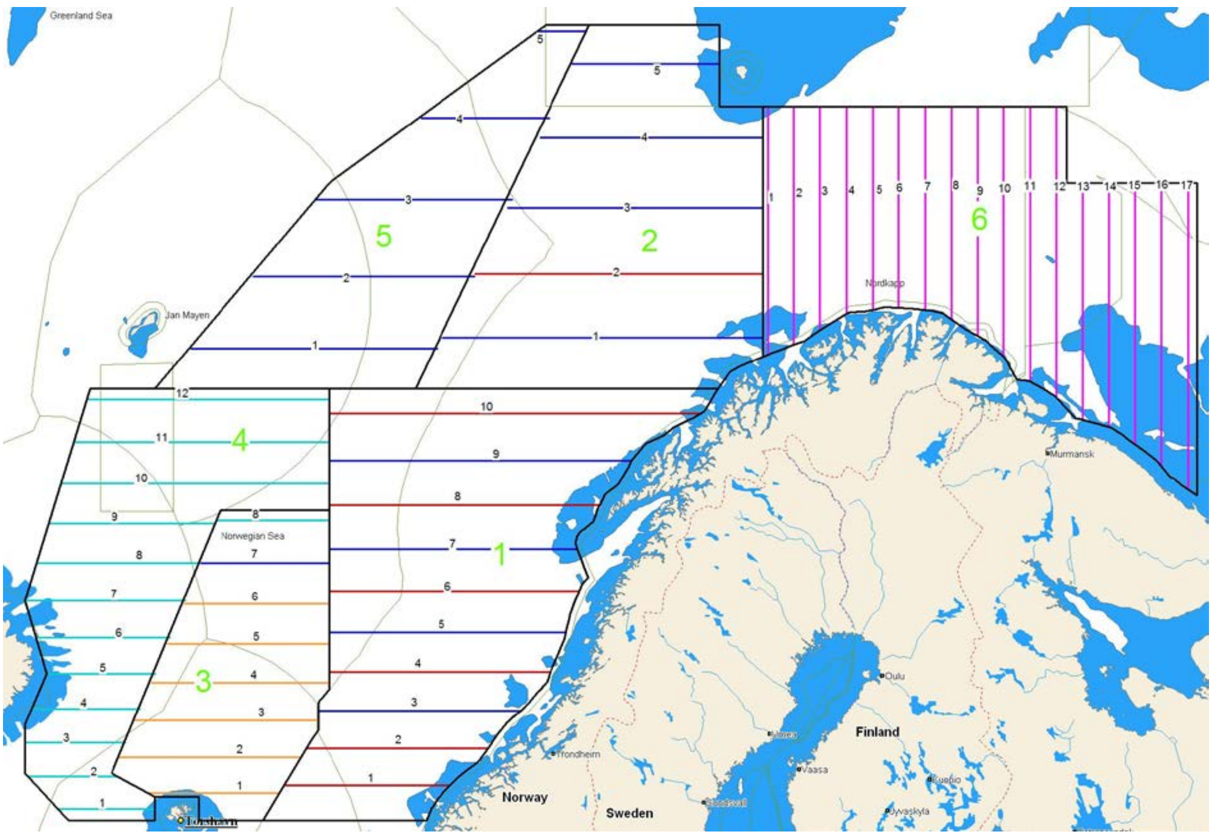

Figure 4. The planed cruise tracks and division of the five stratum used in the IESNS survey 2014.

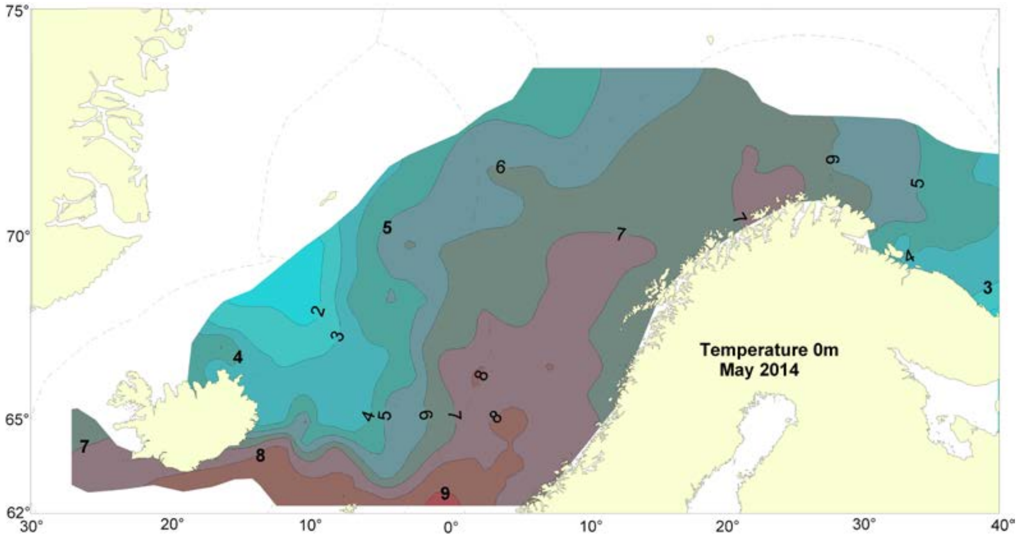

Figure 5. The horizontal sea surface temperature distribution in April-June 2014.

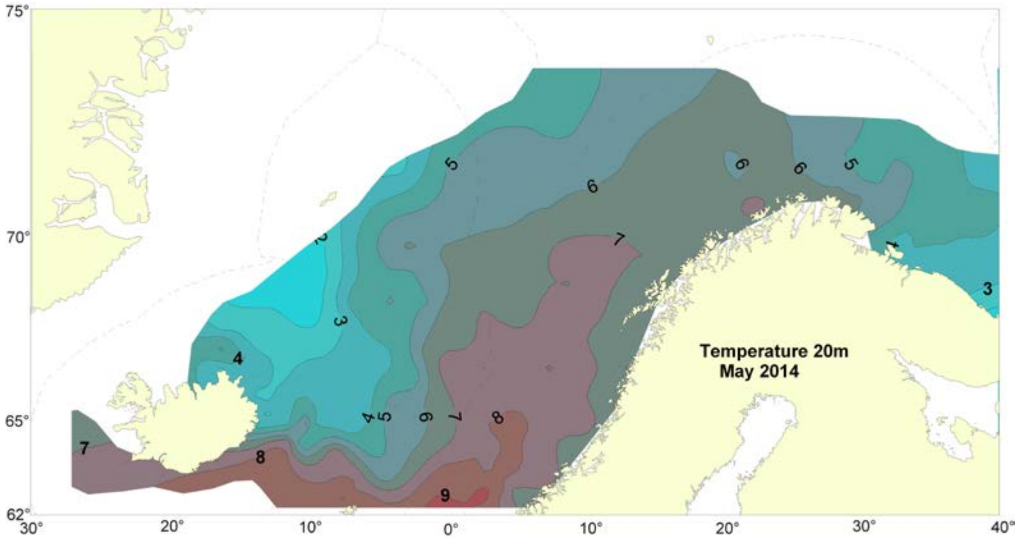

Figure 6. The horizontal distribution of temperatures at 20 m depth in April-June 2014.

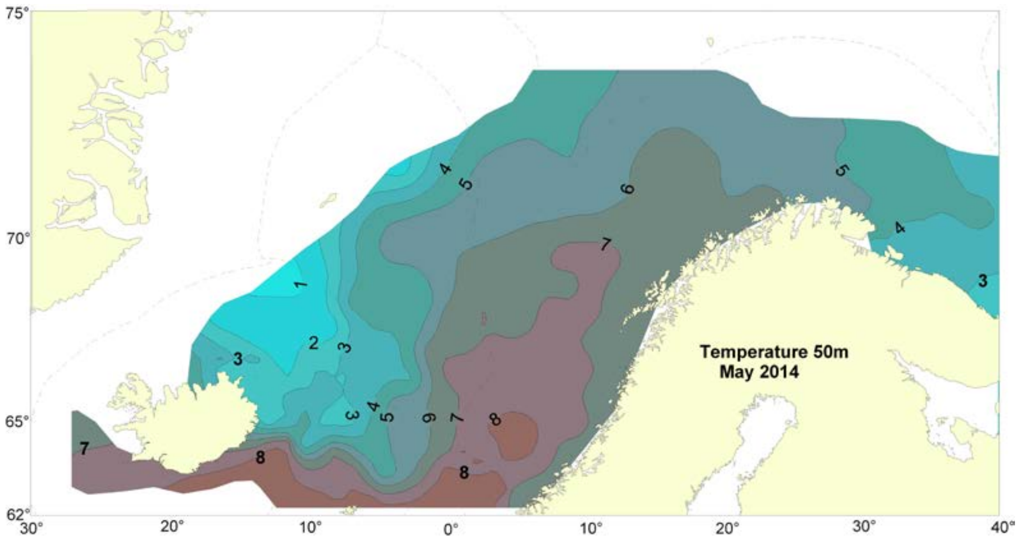

Figure 7. The horizontal distribution of temperatures at 50 m depth in April-June 2014.

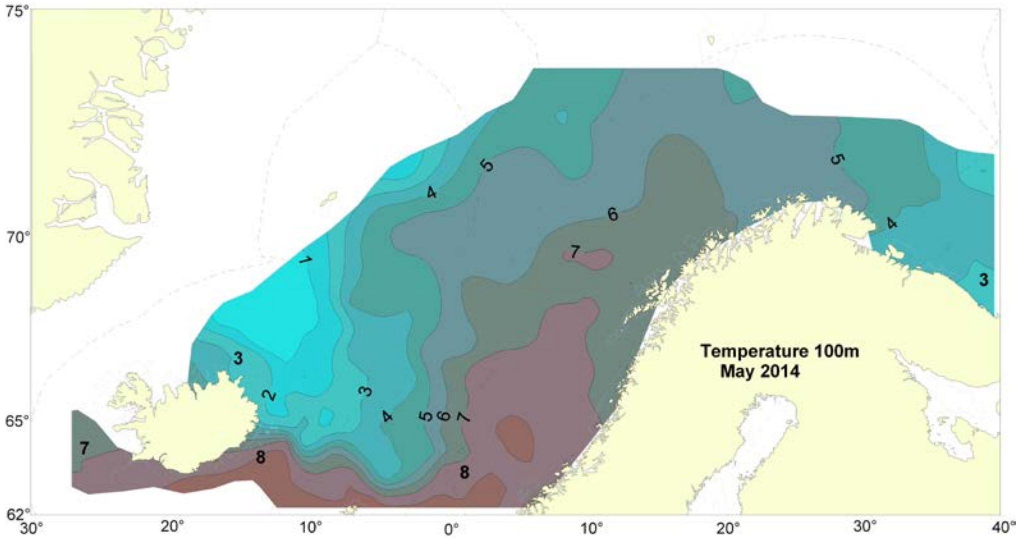

Figure 8. The horizontal distribution of temperatures at 100 m depth in April-June 2014.

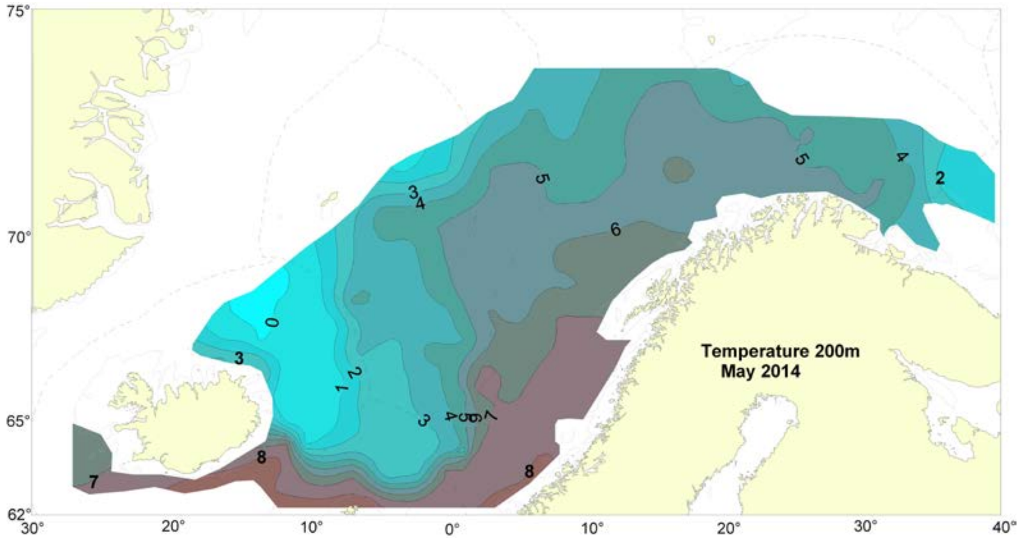

Figure 9. The horizontal distribution of temperatures at 200 m depth in April-June 2014.

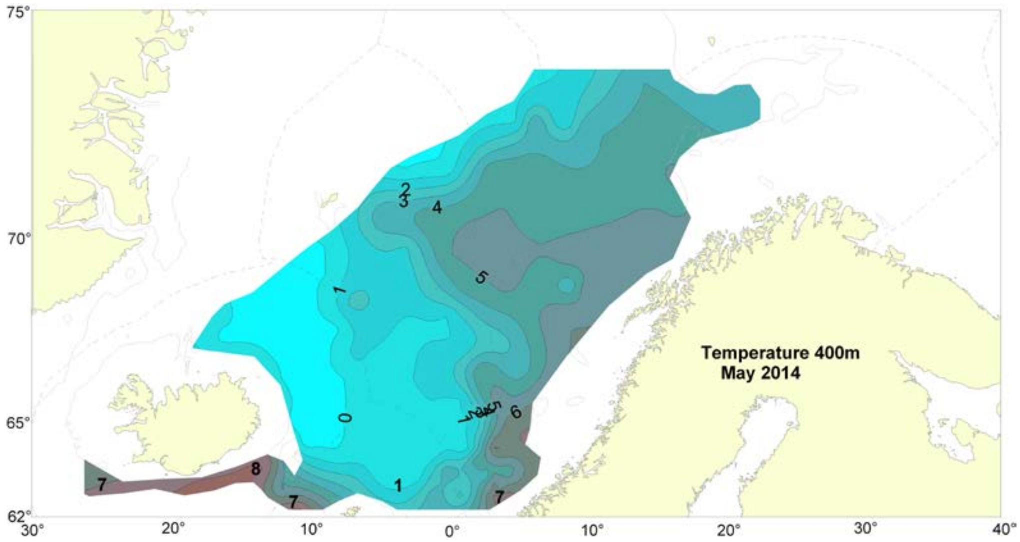

Figure 10. The horizontal distribution of temperatures at 400 m depth in April-June 2014.

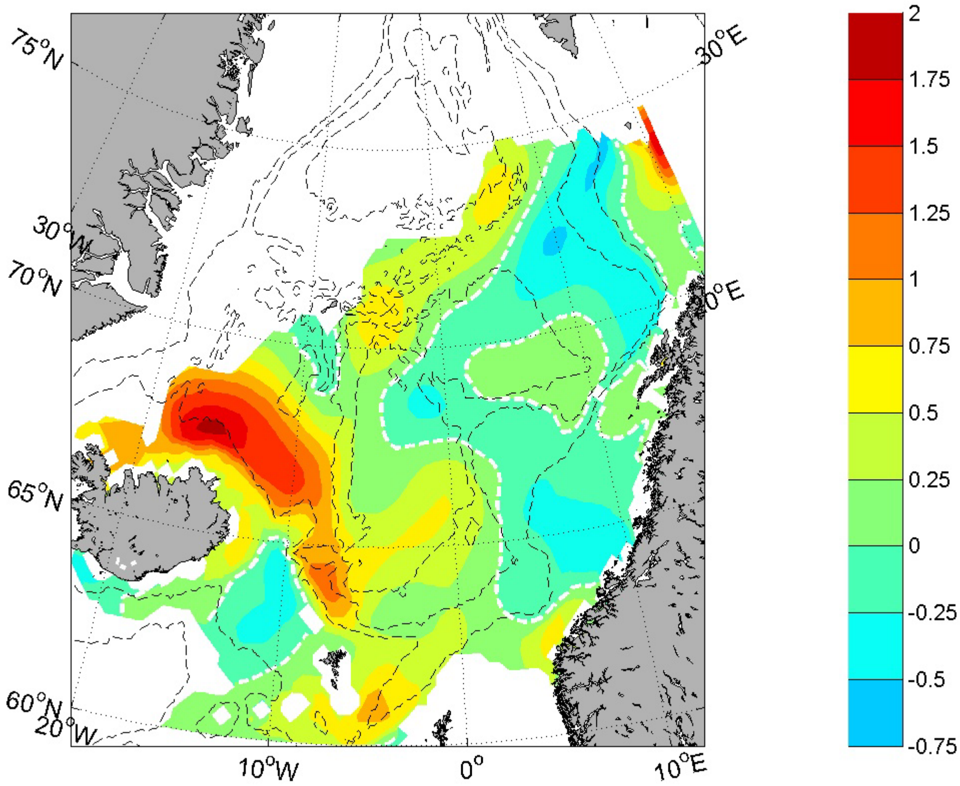

Figure 11. Temperature anomaly at 20 m depth for May 2014. Reference period: 1995-2013.

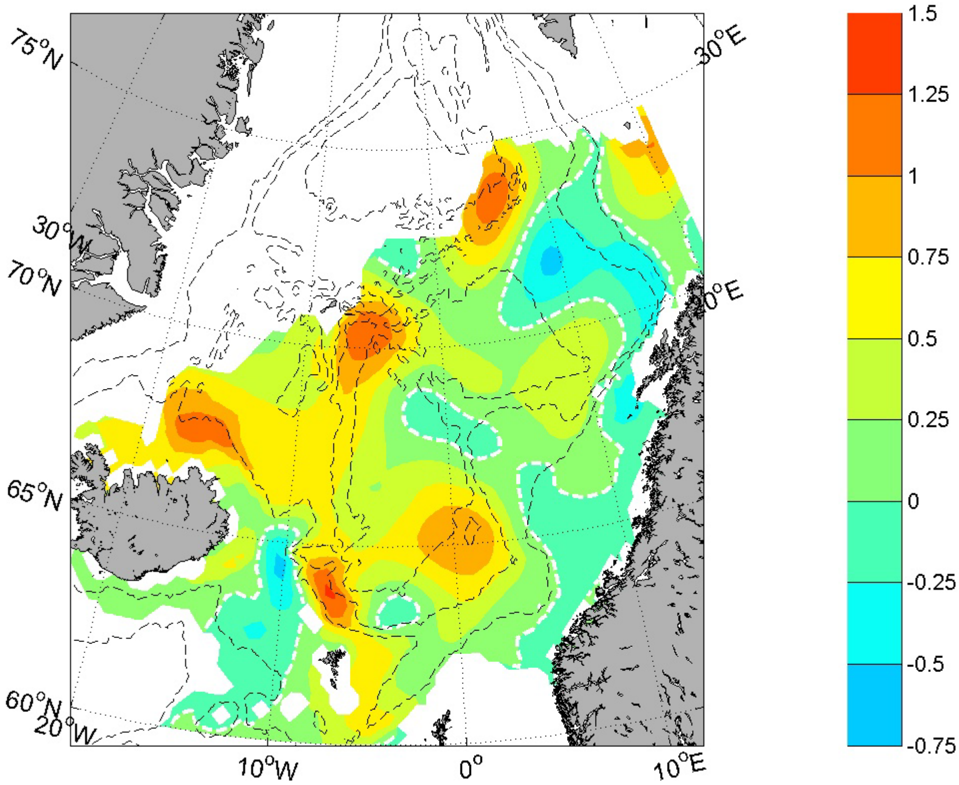

Figure 12. Temperature anomaly at 100 m depth in May 2014. Reference period: 1995-2013.

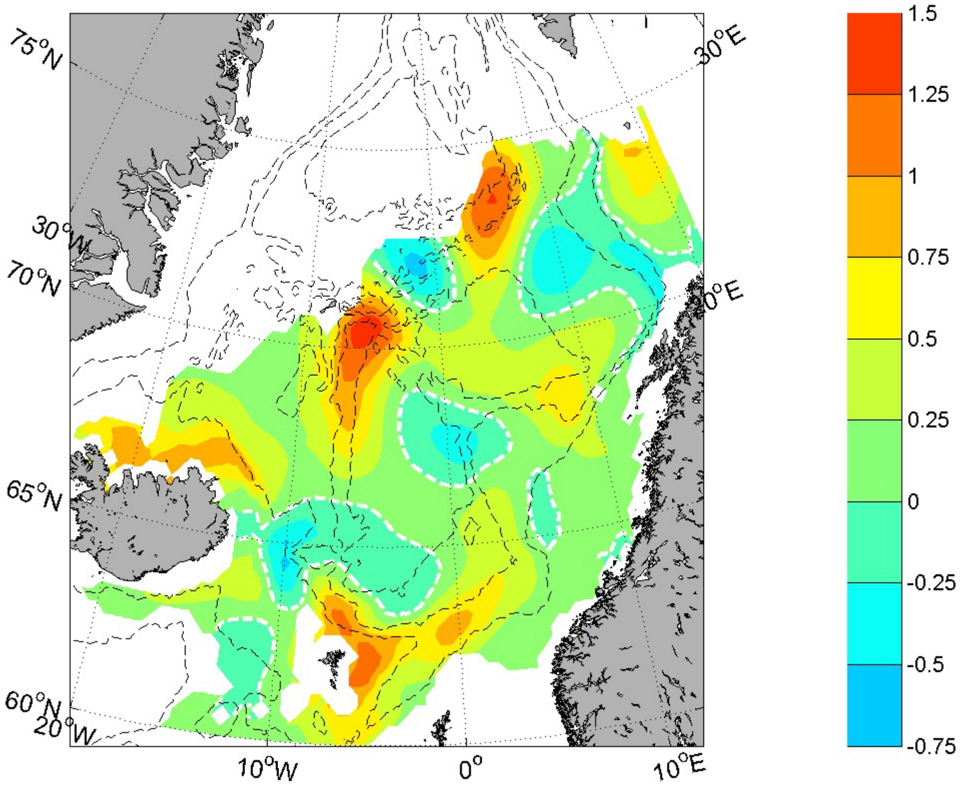

Figure 13. Temperature anomaly at 200 m depth in May 2014. Reference period: 1995-2013.

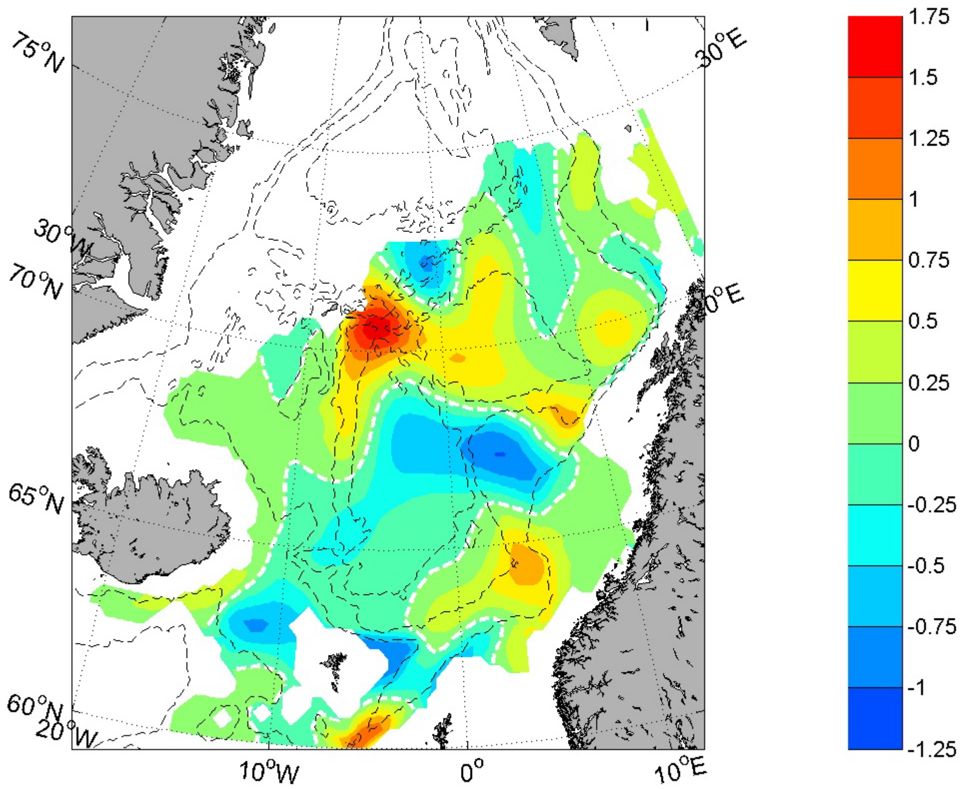

Figure 14. Temperature anomaly at 400 m depth in May 2014. Reference period: 1995-2013.

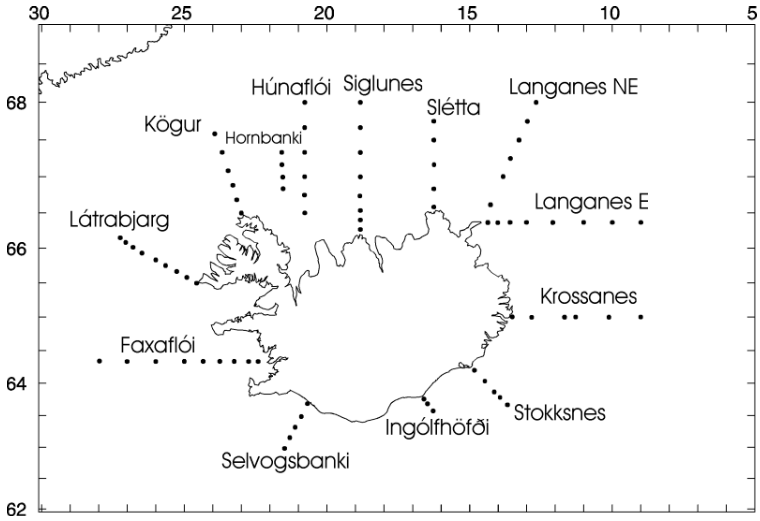

Figure 15. Location of the fixed Icelandic hydrographic sections referred to in the text and Figures 16-18.

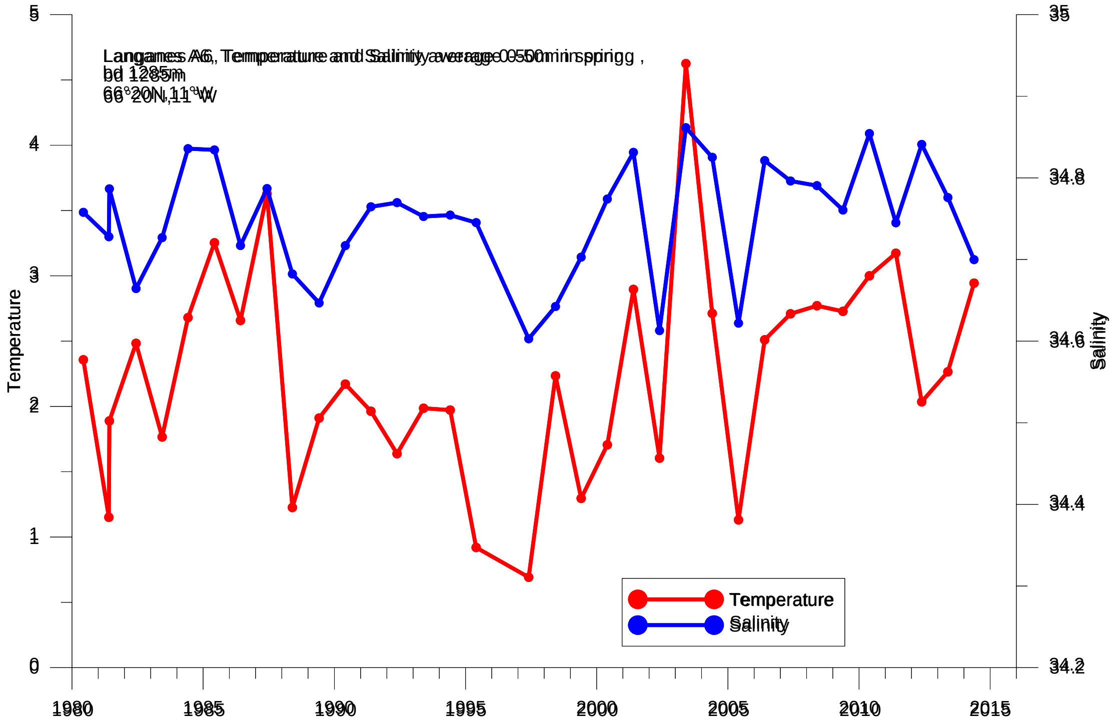

Figure 16. Temperature and salinity in May 2014 east of Iceland, at station Langanes A6 (66°22′N, 11°00′W). Depth averaged 0-50m.

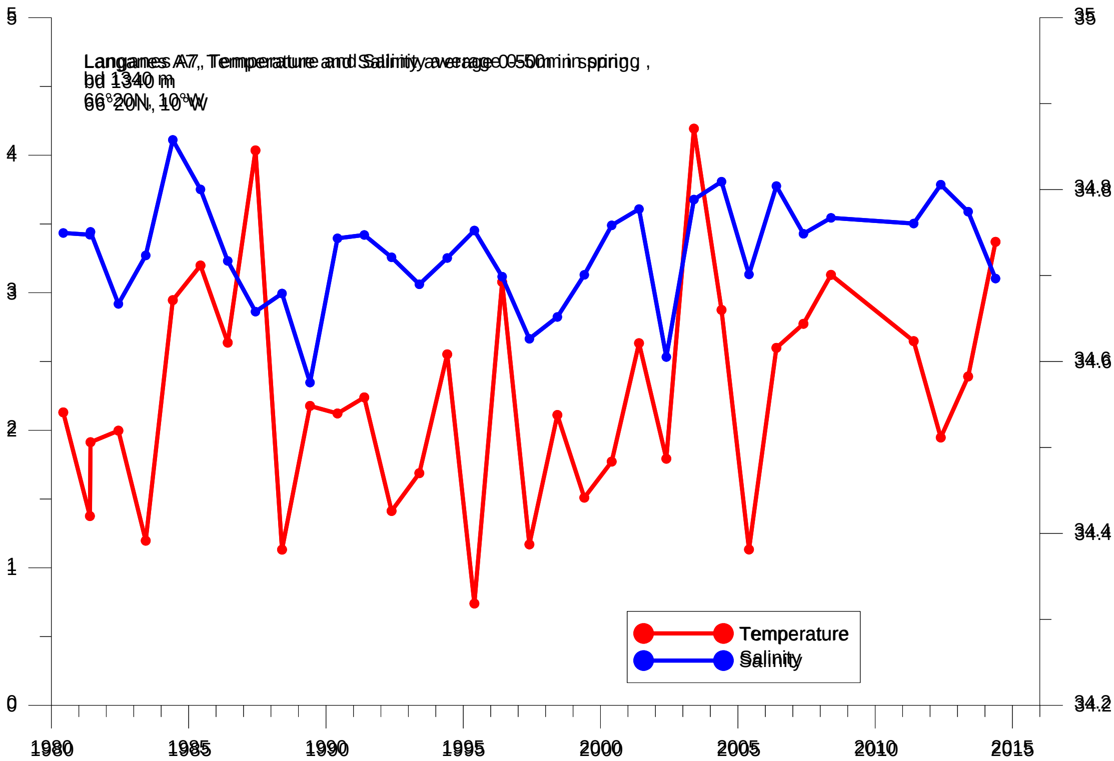

Figure 17. Temperature and salinity in May 2014 east of Iceland, at station Langanes A7 (66°22′N, 10°00′W). Depth average 0-50m.

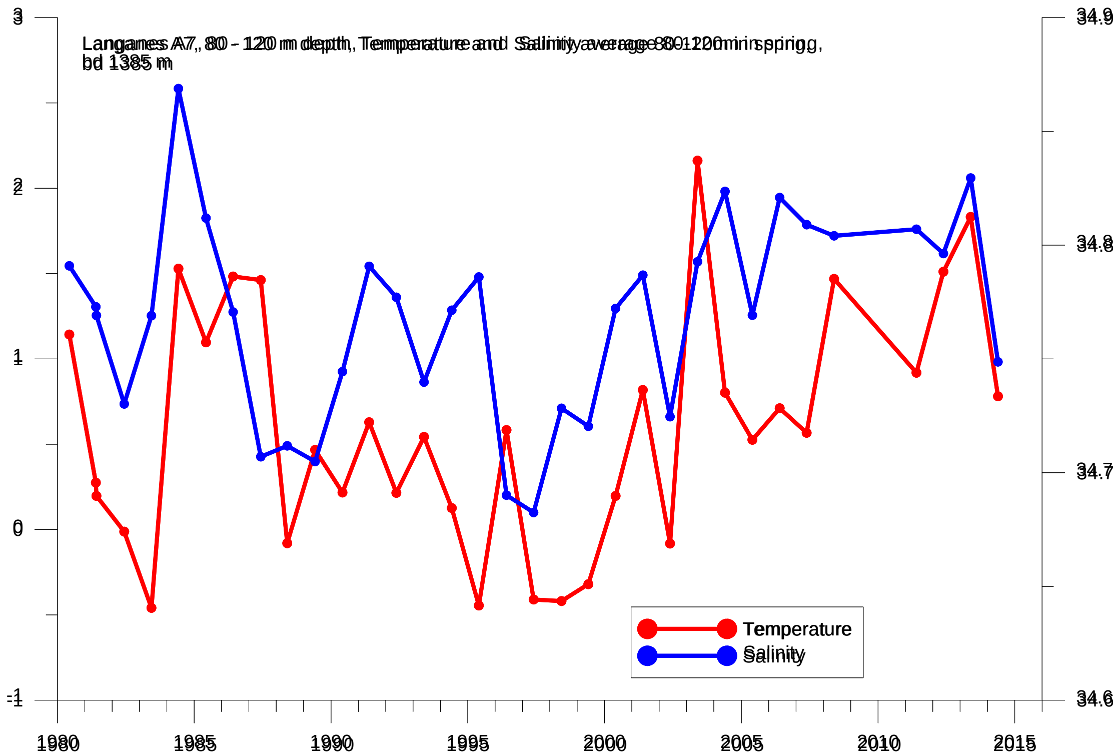

Figure 18. Temperature and salinity in May 2014 east of Iceland at station Langanes A7 (66°22′N, 10°00′W). Depth average 80-120m.

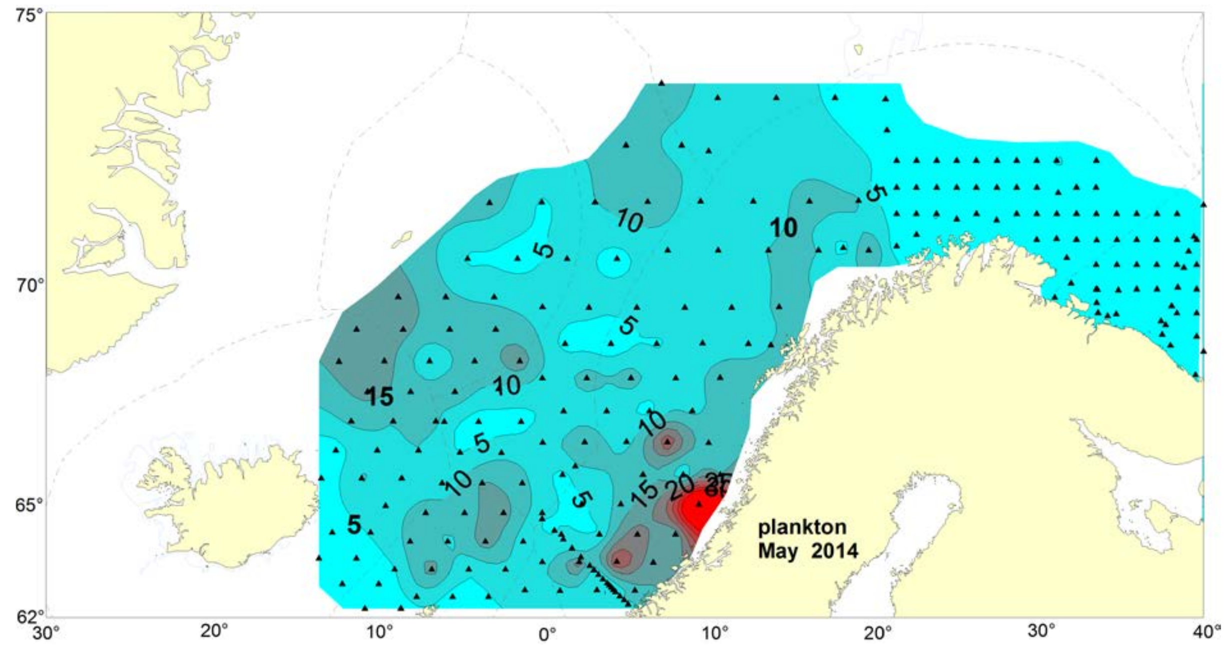

Figure 19. Zooplankton biomass (g dw m-2; 200–0 m in April-June 2014.

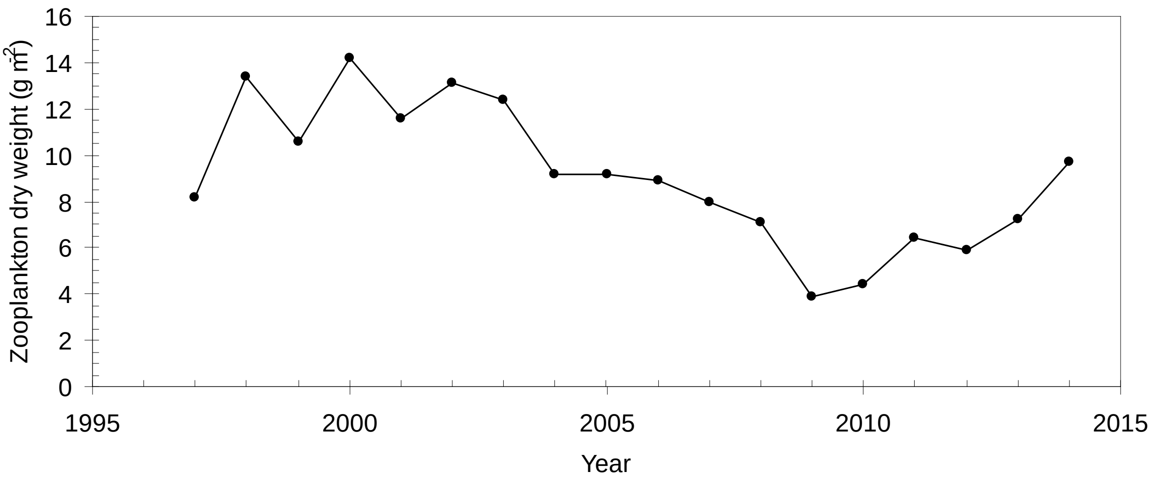

Figure 20. The annual mean dry weight of zooplankton across the whole coverage area in the May surveys in the Norwegian Sea and adjacent waters from 1997 to 2014.

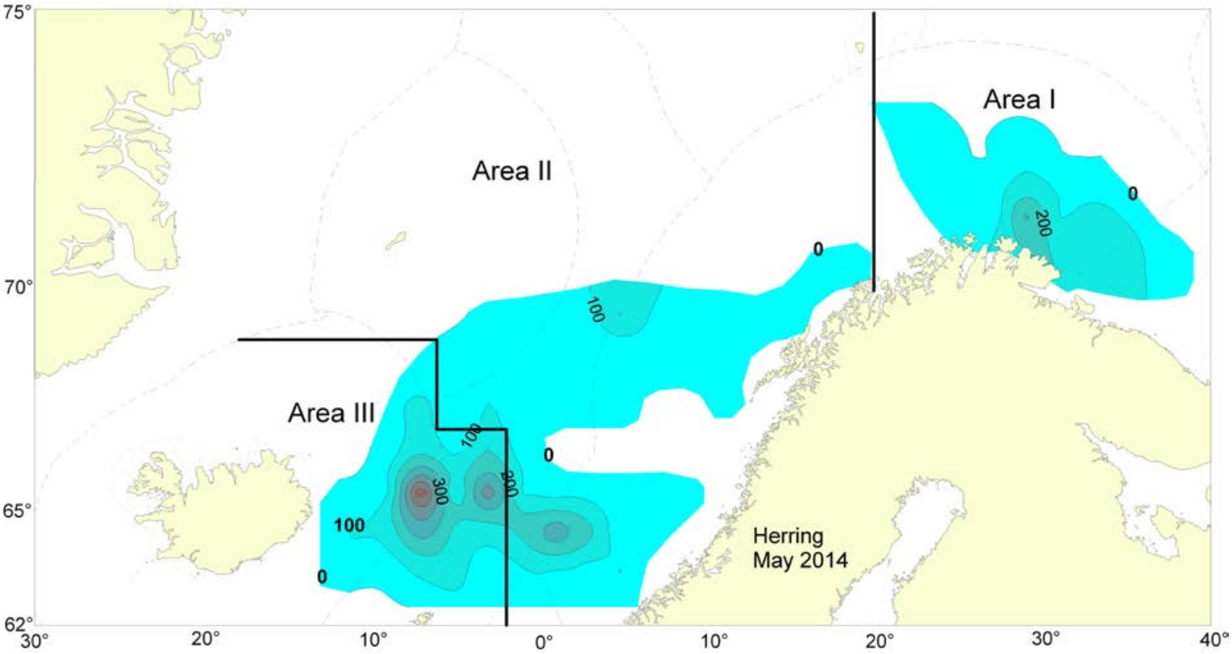

Figure 21. Distribution of Norwegian spring-spawning herring as measured during the International survey in April-June 2014 in terms of s_A-values (m^2/nm^2) based on combined 5 nm values.

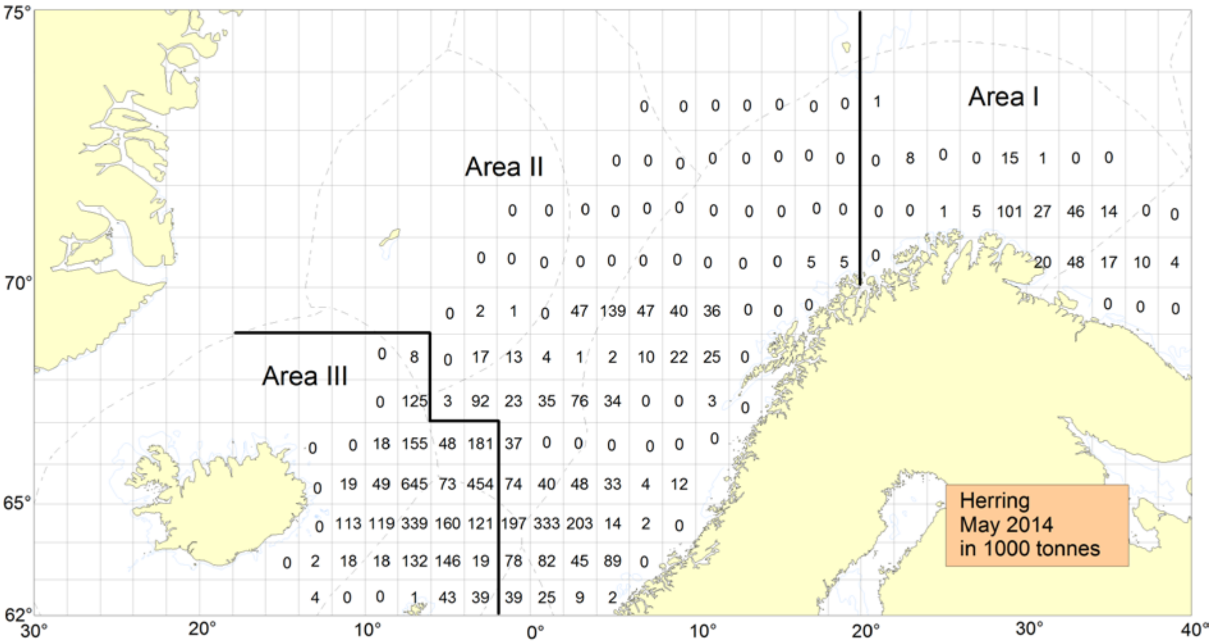

Figure 22. Norwegian spring-spawning herring biomass from IESNS 2014 by sub-area.

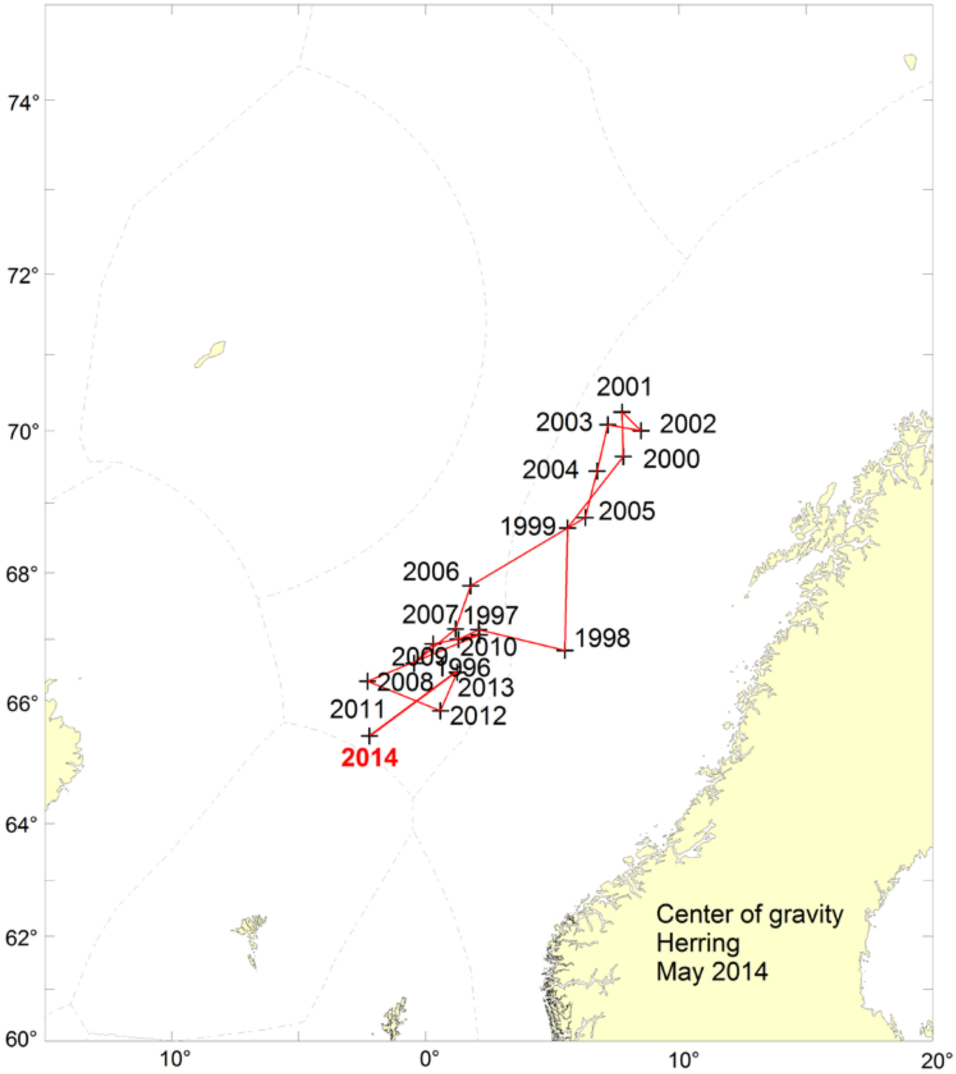

Figure 23. Centre of gravity of herring during the period 1996-2014 derived from acoustic. Acoustic data from area II and III only, i.e. west of 20° E

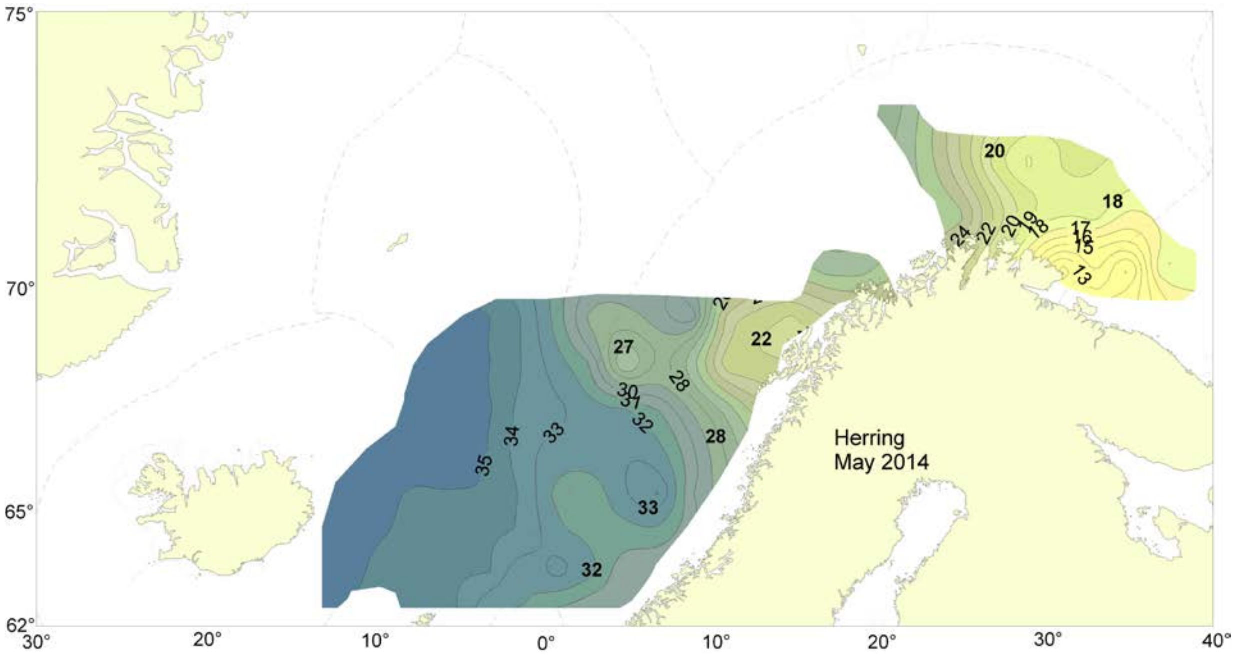

Figure 24. Mean lemgth of Norwegian spring-spawning herring as measured during the International survey in April-June 2014.

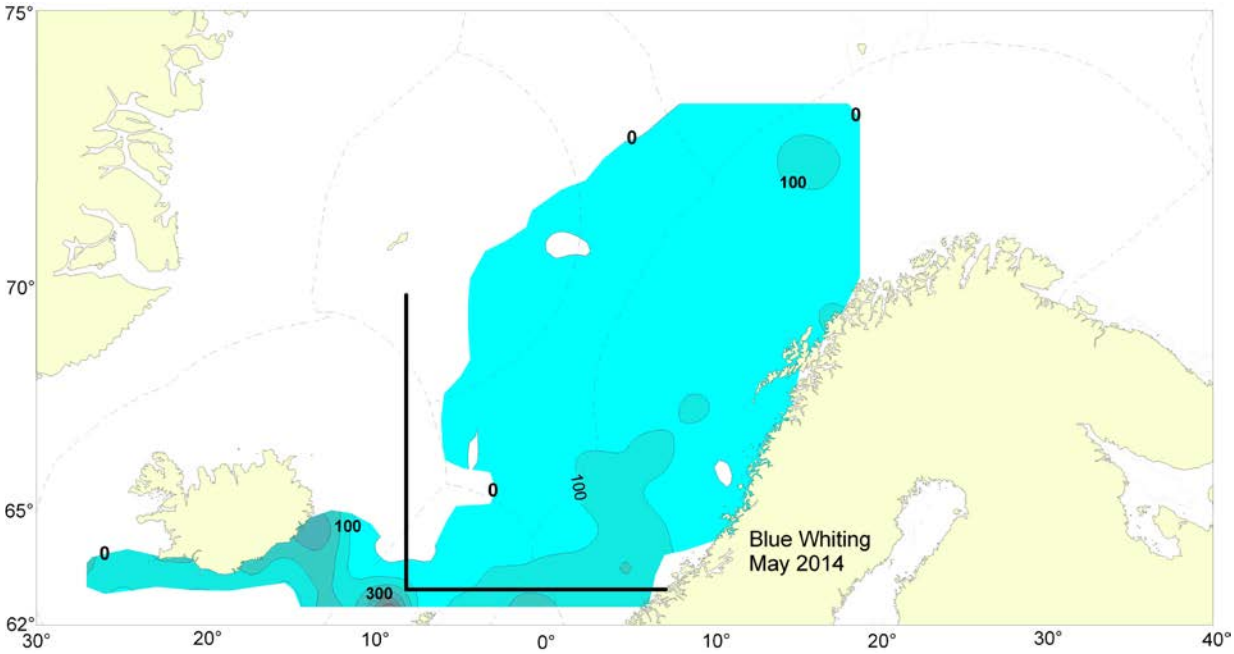

Figure 25. Distribution of blue whiting as measured during the International survey in April-June 2014 in terms of s_A-values (m^2/nm^2) based on combined 5 nm values. The standard area is shown on the map.

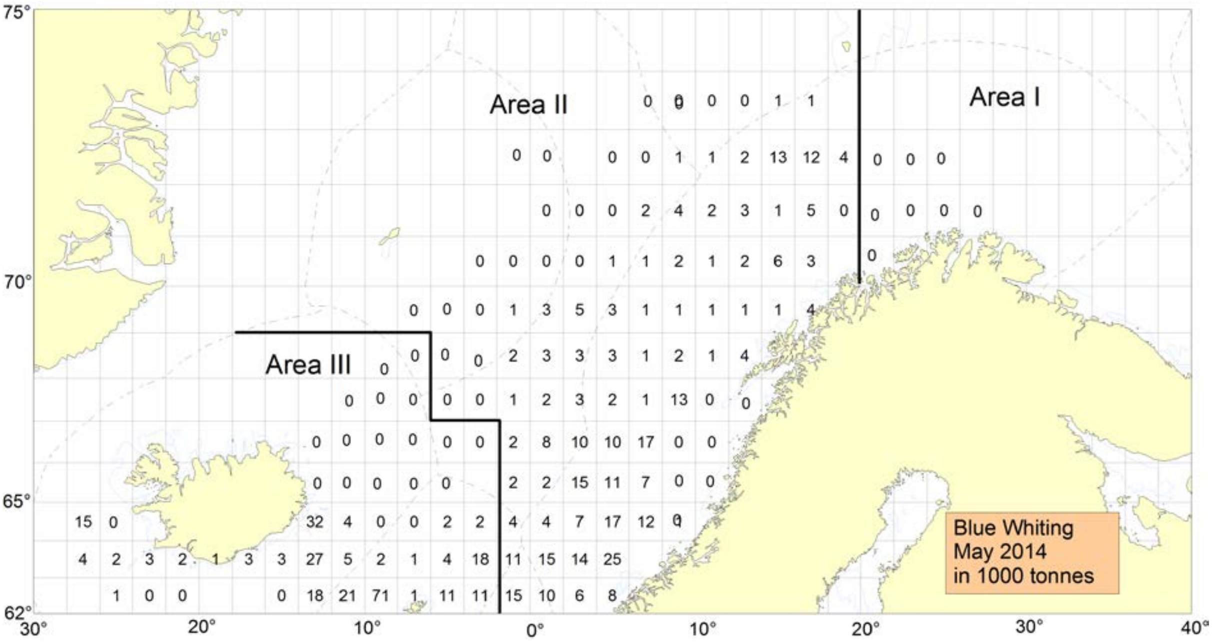

Figure 26. Blue whiting biomass from IESNS 2014 by sub-area.

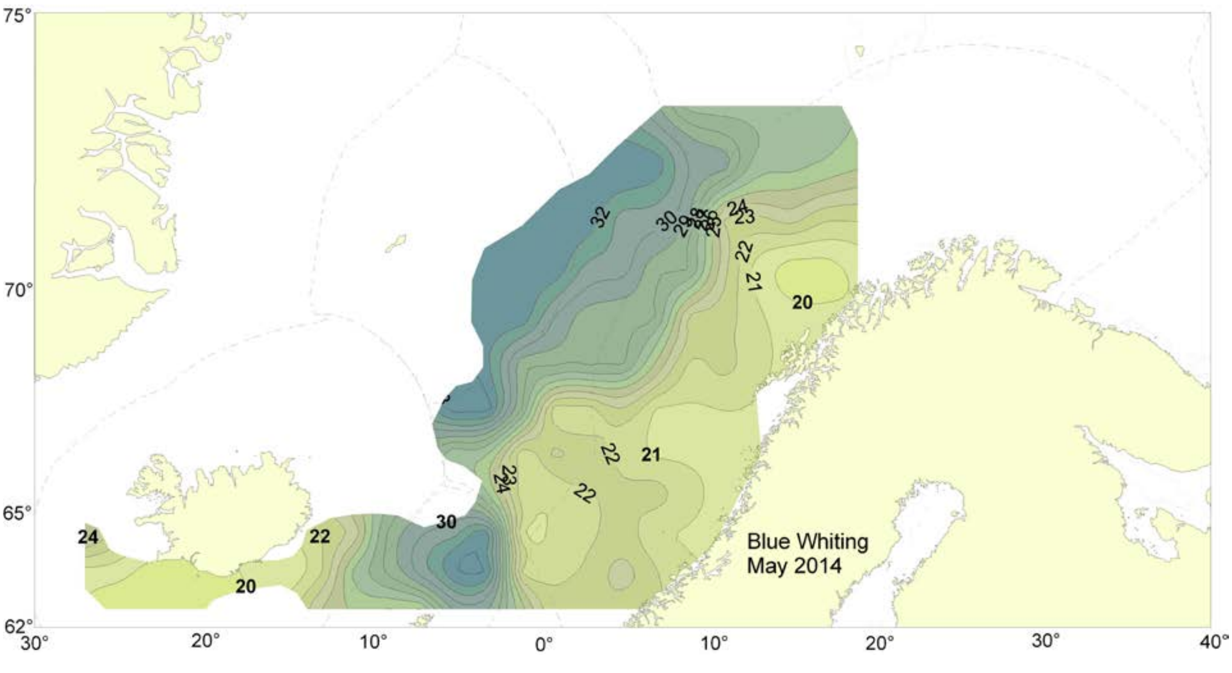

Figure 27. Mean length (cm) of blue whiting recorded in the North-east Atlantic Ecosystem Survey in April–June 2014.