Toktrapport/Havforskningsinstituttet/ISSN 1503 6294/Nr. 11–2016

Cruise report SI_ARCTIC/Arctic Ecosystem survey R/V Helmer Hanssen, 19 August-7 September 2014

Survey: 2014806

Ingvaldsen, R.B., Bucklin, A., Fauchald,P., Gjøsæter, H., Haug, T., Jørgensen, L.L., Knutsen, T., Naustvoll, L.J., Wiebe. P.

Content

Introduction

The survey was a joint SI_ARCTIC and Barents Sea eco system survey (Arctic Ecosystem survey). The aim of the survey was twofold:

1. Conduct a baseline study of the Arctic Ocean ecosystem (oceanography, nutrients, phyto-plankton, zooplankton, fish, benthos, marine mammals and birds. SI_ARCTIC – exploratory focus).
2. Conduct the northern part of the joint IMR-PINRO Barents Sea ecosystem survey (the Barents Sea Ecosystem survey/Arctic ecosystem survey-annual monitoring focus).

Location of stations and survey lines are shown in Figure 1. Details of equipment and samples taken at each station are given in Table A1. During the survey we conducted 3 case study stations, two sections from shelf break and into Fram Strait (Fram Strait south and north), two sections crossing the shelf break north of Svalbard and as far into the ice as possible (Wijdefjorden and Hinlopen), some stations along the shelf break and along the ice edge. In addition underway meteorological and sea surface temperature measurements and visual observations of marine mammals and sea birds were conducted. List of participants are given in Table A2.

Description of activity

The cruise started off on August 19, 2014 from Longyearbyen, Svalbard. We started with a case study station (Case 1) in Atlantic Water at the shelf break at approximately 509 m bottom depth to the west of Isfjorden (Figure 1). The station was extensively sampled (Table A1), but due to the short distance from Longyearbyen (only 6 hour steaming), LADCP, MIK and Multinett were not ready for use at Case 1. Zooplankton sampling was conducted using WP2/Juday and Macroplankton trawl and fish sampling using Harstad trawl and Campelen trawl. Benthos was sampled from the Campelen trawl catch and from 3 replicates with Beam trawl. The grab did not work and the grab sampling on Case 1 was conducted when returning to the station at the end of the survey on 4 September. After Case 1 we went northwards and conducted a Campelen trawl underway (Arctic ecosystem station).

On 21-23 August we conducted a section (Fram Strait north section) from the shelf-break (300 m depth) and westwards into Fram Strait at approximately 79^{o}40’N until we met the ice at approximately 5^{o}24’E. The last station at the Fram Strait north section was within the ice. At this section all equipment was ready for use. Vertically integrated zooplankton sampling was conducted using WP2/Juday to bottom on most stations and MIK on one station. On the westernmost station, vertically stratified sampling of zooplankton was conducted using Multinett. Fish sampling (pelagic) was conducted using Harstad trawl. Trawling depth was determined on each station based on acoustic registrations and trawling depth spanned the range from 40 m to 411 m (Table A1). At the westernmost station, Åkra trawl with Fish lift was used instead of Harstad trawl. The Åkra trawl was deployed at 1086 m depth and was dragged for 2 hours. The catch was very low. Trawling on the survey was limited to the upper ~1400 m due to wire length and on this section Campelen trawling was conducted down to 1054 m. The Campelen trawl was damaged at both at station 2009 (at 797 m) and at station 2011 (at 1054 m).

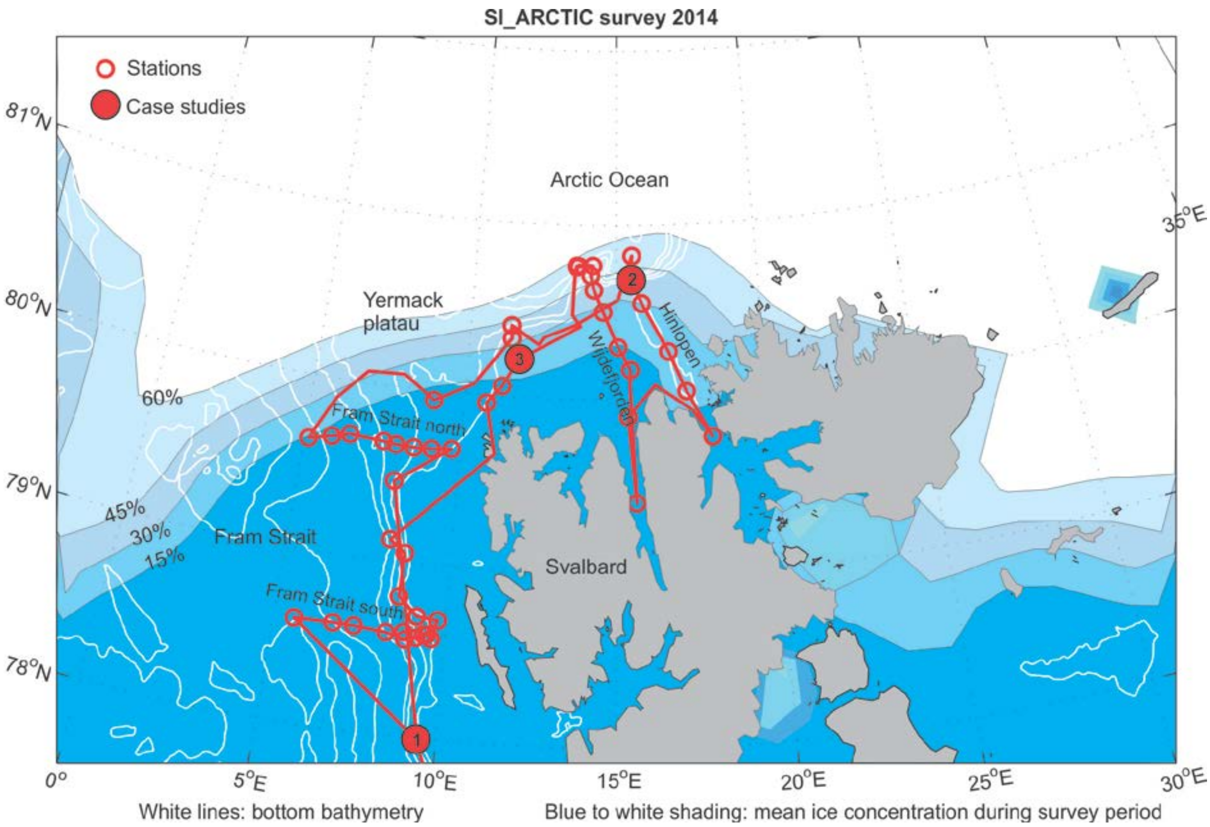


Figure 1. Cruise map showing stations and steaming line.

24-25 August we followed the ice edge eastwards conducting one station (Arctic ecosystem station) south of the Yermack platau and two more stations on the shelf break east of Yermack. Large amounts of cod were caught in the station at 208 m depth east of Yermack (station 2016). All these three stations were in partly ice covered water. Thereafter we continued eastwards following the ice edge heading for a lead north of Hinlopen (as evident in the provided maps from the Ice map service met.no). We reached our northernmost position during the survey (80^{o}49.50'N, 15^{o}33.23'E, bottom depth 1848 m) during evening on 25 August. On this station we conducted extensive zooplankton sampling (WPII/Juday, MIK, Multinett and a deep haul with Makroplankton trawl). Fish trawling was conducted with Harstad trawl in 0-40 m depth. From there on we conducted a section southwards and into Hinlopen. A case study station (Case 2) was conducted at this section at the shelf break (at approx 534 m bottom depth) and in partly ice covered waters. In this section most equipment, including extensive plankton hauls and fish trawls were conducted (Table A1).

Thereafter we conducted a section from inside Wijdefjorden and northwards (28-29 August). Due to the close vicinity to the extensively sampled Hinlopen section, the shelf part of the Wijdefjorden section was mainly sampled with CTD-LADCP, phytoplankton and WP2/Juday hauls. When reaching the shelf break, the ice conditions were to server to conduct trawling. We continued northwards as far as possible (and to the ice) conducting vertical sampling (CTD-LADCP, plankton nets) underway. At the northernmost position we conducted a 14-hour CTD-LADCP station (hourly vertical hauls).

Heading southwards again (30 August) along the ice edge we conducted the third case study station (Case 3) on the shelf at 167 m depth and with moderate ice cover. In addition two more stations were sampled on the shelf. Thereafter we went southwards into eastern Fram Strait, conducting five Arctic ecosystem survey stations along the shelf break. On 1-3 September we conducted another section (Fram Strait south section – at approx. 78°35'N) from the shelf (189 m depth) and westwards until 5°24'N. There was no ice at this section. After finishing the section we returned to Case 1 to conduct the 3 replicates of grab. After finishing the last station, we steamed southwards along the shelf break for a few hours visually observing and making registrations of marine mammals. Marine mammals observing was also conducted in Isfjorden when heading for Longyearbyen. The vessel arrived in Longyearbyen on 6 September.

Methods

Sea ice distribution

Sea Ice images were downloaded as netCDF files daily to the Helmer Hanssen from a University of Hamburg website (ftp://ftp-projects.zmaw.de/seaice/AMSR2/3.125km/) For information about the images see Kaleschke et al., 2001; Spreen et al, 2008; Beitsch et al., 2013). The NetCDf files were read into Matlab and the data plotted using the M_Map toolbox (Version 1.4f - http://www.eos.ubc.ca/~rich/).

Underway meteorological and oceanographic measurements

Along-track measurements were made continuously during the course of the cruise, to provide information on environmental conditions. Atmospheric measurements of air temperature, barometric pressure, wind speed and direction, other meteorological variables, plus sea surface temperature were collected along with time, latitude, and longitude at one minute intervals. These data were saved on the ship's data server on a daily basis in a several file formats including the "csv" file format. The daily csv files were moved into a single Excel "xlsx" file on separate sheets and then data of interest were read directly into Matlab for further processing and plotting. The daily files were aggregated for display to correspond to the transect sections sampled on this cruise.

The along track data were divided into seven chronological sections to highlight the variation observed on the cruise using the CTD stations to mark beginning and ending of the sections:

	Start CTD (for location see Table A1)	Stop CTD (for location see Table A1)
Longyearbyen-Along shelf break - Fram Strait north section		547
Along ice edge	547	551
Hinlopen section (north to south)	551	558
Wijdefjorden section (south to north) – southern part	558	564
Wijdefjorden section (south to north) –northern part-along ice edge	564	582
Along shelf break in Fram Strait	582	587
Fram Strait south section- to final grab station (Case 1)	587	

Hydrography, fluorescence and oxygen (CTD)
Temperature and salinity was measured on all stations using a Seabird 911plus CTD with water carousel sampler (Figure 1 and Table A1). The CTD was lowered to ~5 m above seafloor, and samples for salinity calibration were taken at every station before up-cast started. The CTD was equipped with fluorescence and oxygen sensors. The fluorescence data (Seapoint sensor) gives an estimate (relatively distribution) of phytoplankton chlorophyll (Fluorescence) distribution. Fluorescence profiles was attain from all CTD stations. Oxygen data were collected at all stations using oxygen sensor (SBE 43). Samples for calibration using Winkler's methods were not collected.

Ocean currents (LADCP and ADCP)
Velocities were measured using a RDI 75 kHz ADCP as well as with a RDI Sentinel 300kHz LADCP mounted on the CTD (looking downward). The LADCP was configured with 15 bins with bin length 8 m. The LADCP data were processed using methods common in the oceanographic community (LDEO-IX-8, Visbeck 2002). The data was corrected for magnetic declination, and the tidal components were removed from the processed profiles using the Arctic Ocean Tidal Inverse Model (AOTIM-5, Padman and Erofeeva, 2004).

Nutrients
On all CTD stations waters samples was collected from specific depth, using 5 L Niskin water bottles on the CTD-carousel sampler (Figure 1 and Table A1). At all stations the ICES standard depths was used from surface to maximum depth. For a higher and better resolution of nutrients, fixed depth were selected for the upper 200m (5, 10,20,30,50, 100, 150 and 200m) at all stations. A total of 48 CTD stations were sampled for nutrients. The nutrient samples was preserved with chloroform and stored in refrigerator. The samples will be analysed at the chemistry laboratory at IMR after the cruise. The water samples will be analysed for nitrate, nitrite, silicate and phosphate.

Phytoplankton
Quantitative samples. At all standard CTD stations approximately 100 ml water samples from 5 and 20m were taped to glass bottle (Table A1). The samples were preserved with neutralized lugol solution. The samples will be analysed at the algae laboratory at IMR. The samples will be worked up using Uthermöl method (IOC Manual and Guides, no 55.2010) after the cruise.

Qualitative samples. At all standard CTD stations a vertical phytoplankton net hauls were made from 30 to 0 m (Table A1). The phytoplankton net has a mesh size of 10 µm and was hauled at 0,1 m/s. The samples were preserved with neutralized formalin. The samples will be analysed using light microscope after the cruise.

Biomass – chlorophyll a. Chlorophyll samples have been collected from ICES standard depth from 0-200m. Samples have been taken from the same bottles and stations as nutrients (Table A1). 265 ml water samples have been filtered onto GF/F filters (0.45 µm mesh), placed in vials and frozen at -20°C. All chlorophyll samples will be analysed after he cruise at the IMR chemistry laboratory.

Zooplankton collections

Zooplankton and micro-nekton were sampled with four different sampling systems, a WP2/Juday net pair, a 0.25 m2 Multinet system, a MIK net system, and a Macroplankton trawl. The principal zooplankton sampling system was a combination WP2 and Juday net pair mounted on a single frame with two rings on which the net mouths were tied. The tow pair was used at most stations where a CTD was deployed that collected water samples for nutrients and chlorophyll measurements (70 tows – Figure 2A). The frame was attached to the end of the towing wire and the nets deployed vertically, usually to within 10 m of the seafloor. Both nets had 180 µm mesh. At most stations, two tows were taken back-to-back. The sample from the first tow was processed using a standard IMR procedure. The WP2 sample was split and 50% was fixed in borax-buffered 4% formaldehyde for identification and enumeration purposes. The other 50% was used for biomass estimation according to IMR standards. This part was divided into 3 size fractions using sieves with mesh-sizes 2000, 1000 and 180 µm. Most animals retained on the 2000 µm sieve were sorted, identified, counted, and their lengths measured prior to rinsing in fresh water. The biomass retained on the 1000 and 180 µm as well as the identified animals belonging specific groups; Chaetognaths, Amphipods, fish, krill, shrimps, and the copepods *Pareuchaeta* sp. and *Calanus hyperboreus* retained on the 2000 µm sieve were put on pre-weighed aluminum dishes and dried in an oven at 60°C overnight, where after they were packed and store in an freezer at -20 degrees awaiting new drying and weighing in the onshore laboratory at IMR. After drying the summed dry biomass per group is measured. The Juday net catch from the first haul was preserved in 95% alcohol for later genetics analyses. For the catches from the second tow pair, the WP2 sample was preserved in 95% alcohol for genetics work at the University of Connecticut. The second Juday net sample was used for picking individual species for genetic, stable isotope and fatty acid analyses. Some species were preserved individually by freezing in liquid nitrogen after which they were stored in a -80 c freezer, or directly stored in the -80°C freezer depending on the analyzes pending. Others were preserved in alcohol. There is more detail about the intended genetic analyses in the Genetics portion of this cruise report.

The MIK net was used twelve times to collect the large macroplankton and microneckton (Figure 2B). It had a circular mouth area of 2 m diameter and a net with ~2 mm mesh. Two Simrad acoustic sensors (depth and velocity) was deployed on the MIK mouth to determine its depth during a tow. This system was generally towed to just above the seafloor or to

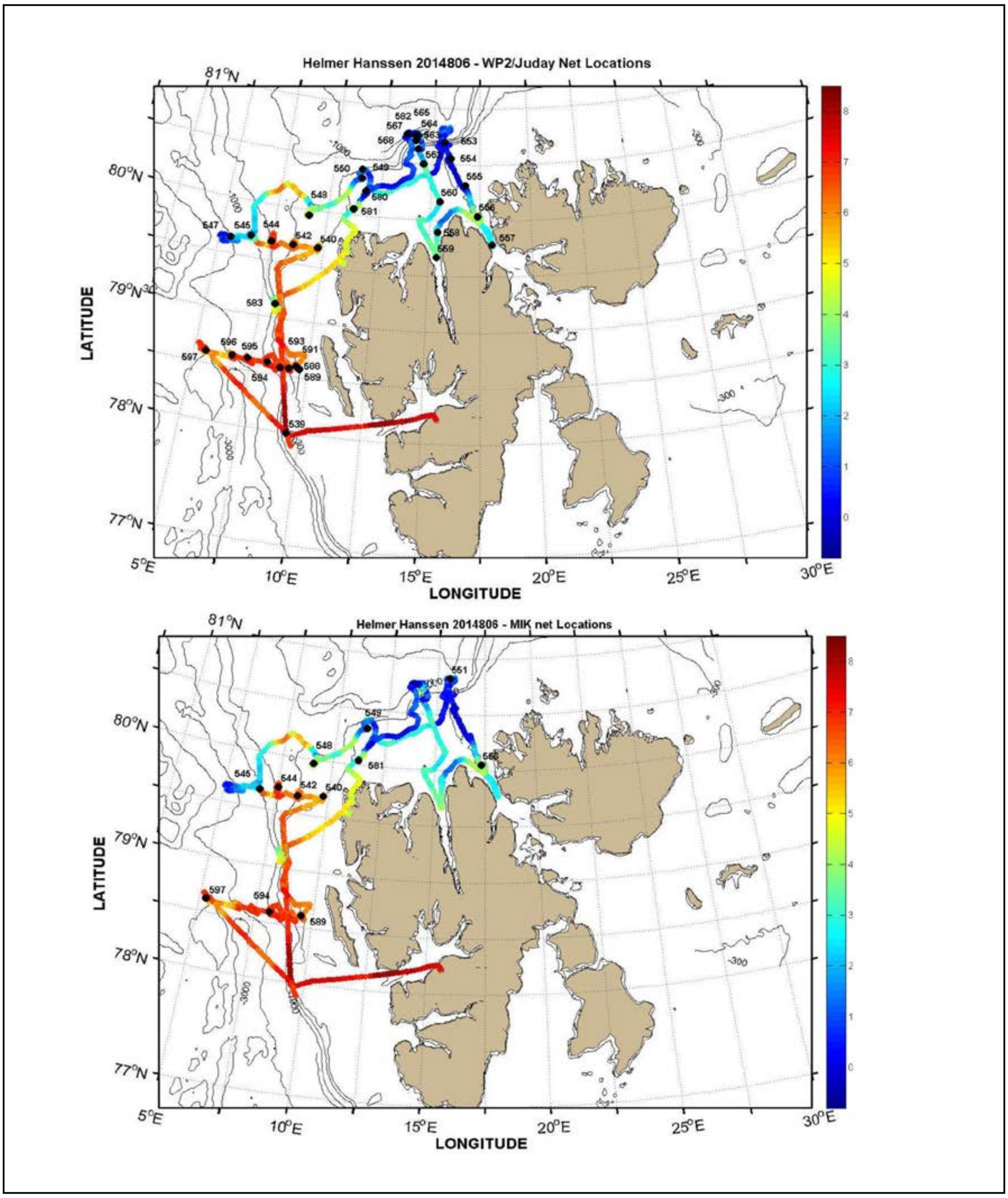


Figure 2. Location of zooplankton and micronekton sample collections.
A. WP2/Juday paired net system. B. MIK net system.

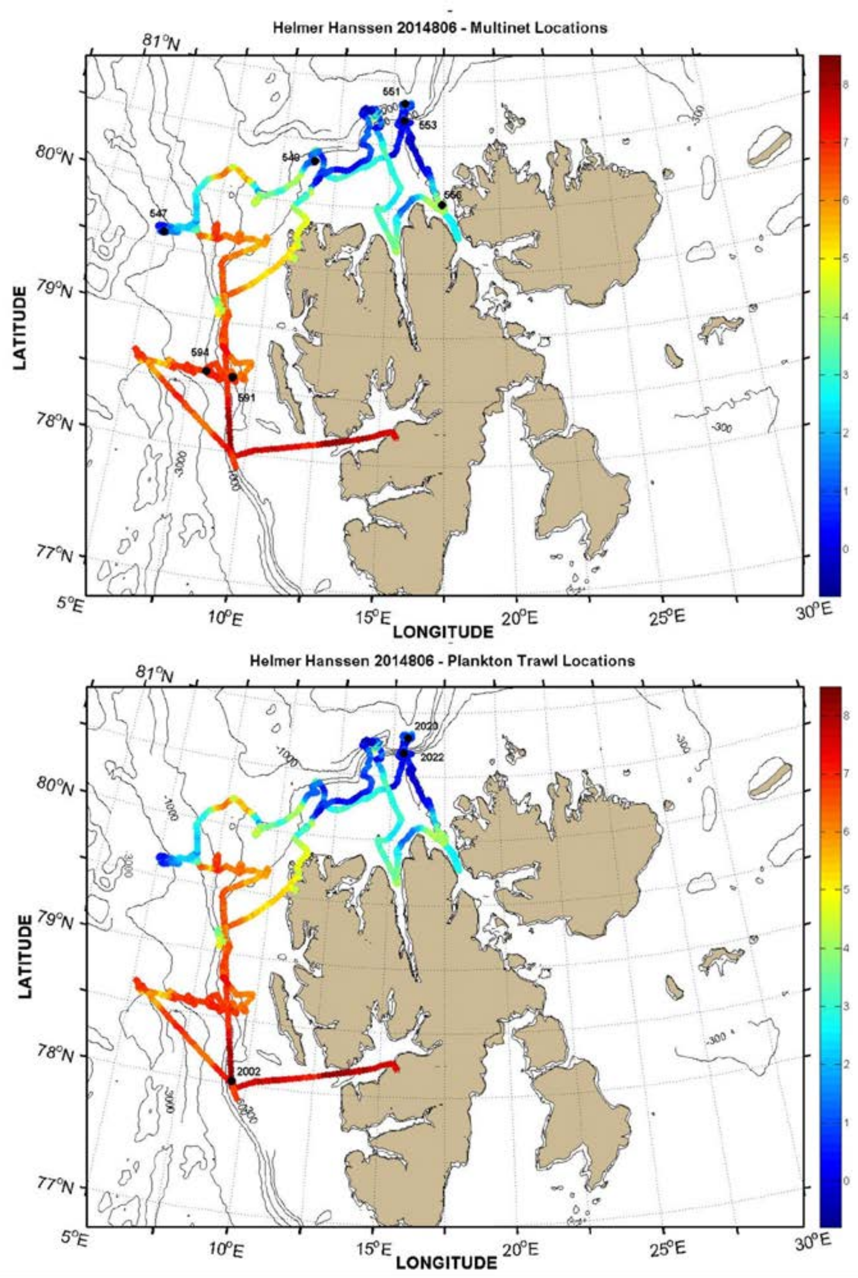


Figure 2 continues. Location of zooplankton and micronekton sample collections.
C. Multinet system, D. Macroplankton Trawl.

1000 m when in water deeper than 1000 m. It was used on one occasion to target sample an intense acoustic layer around 60 m depth. The samples were generally split into fractions suitable for analysis. One fraction was used to determine bulk biomass of the sample. Another was preserved in formalin for identification and enumeration purposes. A third fraction was preserved in alcohol for genetic studies, and the remainder of the sample was used for picking individual species for genetic and for stable isotope analyses as described above.

The Multinet system with five 180 μm mesh nets was used for stratified sampling on seven occasions to determine the depth distribution of the zooplankton (Figure 2C). The first tows were used to do vertical tows from just above the seafloor to the surface. But too few zooplankton were captured because of the small volumes of water sampled. So the system was rigged to do oblique tows and the sampling was much improved.

The Macroplankton trawl was deployed on three occasions (Figure 2D). This trawl has a 36 square meter opening and a net with a mesh size of 3 mm all the way from trawl opening to the cod-end. The flow through the mouth opening of the trawl was measured acoustically with acoustic catch sensors. The three oblique hauls sampled variable depths. One was to 250 m, one to a 410 m, and a third to approximately 1200m. On this latter tow, a number of the plastic head rope floats imploded and the catch was littered with fragments of these destroyed floats. Upon completion of hauls the catches were weighed, and entire catches or subsamples were sorted, weighed, and measured at the desired taxonomic resolution, usually to species level where possible. Some species were picked from the sample alive and preserved for genetics analyses. This trawl might have seen more use, but it needed to be changed in place of the Harstad Trawl and this took too much time.

Zooplankton genetics

Overview of Scientific Rationale and Objectives

The primary goals of our collaborative participation in the SI_Arctic project are the analysis and interpretation of molecular indicators of species diversity, detection of cryptic species, population genetic structure, and related topics for marine zooplankton collected from various North Atlantic and Arctic / Boreal regions.

The zooplankton samples collected during the cruise will be examined for species of interest, for which the mitochondrial cytochrome oxidase subunit I (COI) barcode region will be sequenced. This gene region has been widely used as a "DNA barcode" for discrimination and identification of species (Bucklin et al., 2011) and is increasingly used for rapid biodiversity analysis of zooplankton samples by environmental DNA sequencing or metagenetics (i.e., the large-scale analysis of taxon richness via the analysis of homologous genes). Continued progress toward a taxonomically-comprehensive DNA barcode database for Arctic zooplankton species is intended as one goal of this SI_Arctic effort (see Bucklin et al., 2010).

More specifically, the primary zooplankton groups for our particular interest are crustaceans, including copepods, euphausiids, and amphipods. The target species include the copepods

Calanus hyperboreus, C. glacialis, and (if present) *C. finmarchicus; Euchaeta norvegica* and *E. barbata*; the euphausiids *Meganyctiphanes norvegica, Thysanoessa inermis*, and *T. longicaudata;* and the amphipods *Themisto libellula* and *T. abyssorum*.

Population genetic analysis will include DNA sequencing of mitochondrial gene regions (e.g., cytochrome oxidase subunit I, cytochrome b, among others) and possible population genomic approaches using high throughout next-generation DNA sequencing (e.g., detection of single nucleotide polymorphisms or SNPs). The population genetic results will be used to evaluate patterns of exchange (migration) and population connectivity among North Atlantic regions, including exchange across the Atlantic / Arctic interface and among sampling locations of this cruise, as well as samples from other North Atlantic cruises, which may be used to continue examination of ocean basin-scale patterns of population genetic structure, e.g., the three-gyre concept (see Bucklin et al., 2000, Wiebe et al., 2001). Samples and specimens for population genetic analysis were preserved in 95% undenatured ethyl alcohol (ethanol).

Environmental transcriptomic analysis will be designed to allow new insights into the ecological significance and life history causes of large-scale patterns of genetic variation across N. Atlantic and Arctic Ocean zooplankton populations. Differential expression of genes hypothesized to be significant in adaptations of zooplankton to climate change, including warming and ocean acidification, will be analyzed. Analysis will include high throughput whole-transcriptome sequencing for gene expression (e.g., RNA-seq) and quantitative PCR (QPCR) analysis of genes of known physiological functions. Identified specimens for transcriptomic or gene expression analysis were flash-frozen in liquid nitrogen, moved to a -80^{o} C freezer for short-term storage, and then placed in a dry-shipper for transport to the University of Connecticut.

Specific topics of interest are explained in greater detail here.

<u>*Calanus* species at the Atlantic / Arctic interface: species distribution, stage structure, and population genetics</u>

Our particular interest focused on key species of *Calanus*: *C. finmarchicus, C. glacialis,* and *C. hyperboreus*. For juvenile (copepodite) stages and females, discrimination of the species is based primarily on size-at-stage (prosome length). To avoid morphological misidentification of *Calanus* spp., we use genetic approaches that allow developing an unbiased view of species distribution and population genetic structure of the species. We are particularly interested in genetic evidence of hybridization between *C. finmarchicus* and *C. glacialis*; plans include screening for hybrids in samples selected based on results of morphological taxonomic analysis using a published molecular protocol by Smolina et al. (2014). Our goal is to contribute to the ongoing discussions – amongst oceanographers in Norway, the US, and elsewhere – to determine and describe the ecological (distributional) shift and evolutionary (population genetic / selection / genetic diversity and effective population sizes) responses to climate change of *Calanus* species. Use of population genomic markers based on high throughput DNA sequencing will allow comparison with earlier studies of *C. finmarchicus* (e.g., Bucklin et al., 2000; Unal and Bucklin, 2010), which revealed small, but significant subregional scale structuring and large-scale population differentiation consistent with two, three, or four distinct populations.

Population genomics and environmental transcriptomics of Northern Krill (*Meganyctiphanes norvegica*)

Our goal is to understand population dynamics and physiological adaptations that determine and define the Atlantic / Arctic interface for zooplankton species. The SI_Arctic cruise on the FF Helmer-Hanssen provided an opportunity to collect samples of the ecologically important and abundant Northern krill (*Meganyctiphanes norvegica*) in the northern Norwegian Sea, Fram Strait, and at the southern edges of the Arctic Ocean. Previous studies, including our own (e.g., Bucklin et al., 1997; Papetti et al., 2005), have shown significant genetic differentiation among N. Atlantic populations of the krill. The SI_Arctic samples will be used to complement and extend the geographic range of our sampling during the EUROBASIN cruise on the GO SARS (May-June 2013) throughout the Norwegian, Irminger, and Labrador Seas, as well as samples from the Gulf of Maine (Northwest Atlantic) carried out through another project. The associated hydrographic and bioacoustic observations and sampling during the SI_Arctic cruise provided invaluable ancillary data on the zooplankton assemblage and environmental conditions.

Comparative population genetics / environmental transcriptomics of Atlantic and Arctic/Boreal zooplankton species

A particular goal for our participation in the SI_Arctic cruise on the FF Helmer-Hanssen is to obtain samples to allow comparison of Atlantic versus Arctic / Boreal zooplankton species for population genetic and environmental transcriptomic characteristics. For this topic area, we wished to select species based on at-sea examination of net samples, and thus to discover those species that are abundant and likely ecologically important in the zooplankton assemblage. Among these are four species we have not focused on previously, including the euphausiids *Thysanoessa longicaudata* and *T. inermis* and the amphipods *Themisto libellula and T. abyssorum*. When collected in abundance, individuals (ideally 10-20) of these species were picked out of samples immediately after collection and examined under the dissecting microscope to confirm identification. Alive-and-kicking individuals were placed individually in cryovials and flash-frozen in LN2. Specimens that were moribund or recently dead (but not opaque) were placed together in scintillation vials and preserved in ethanol. These LN2 frozen specimens are suitable for environmental transcriptomics; ethanol-preserved samples are suitable for population genetics.

The general plan for these samples is for cross-species comparisons of fundamental physiological processes or environmental stress responses by analysis of whole-transcriptome gene expression patterns (RNA-Seq or similar) or target gene expression levels (QPCR). The general hypothesis is that species typically associated with Arctic / Boreal regions may be expected to be more particularly adapted to Arctic conditions than the temperate / Sub-Arctic species. Species that exhibit broader geographic distributions across both Arctic / Boreal and temperate / Atlantic regions may show population genetic or transcriptomic differences among populations in the different biogeographic provinces. The specific questions to be addressed for the various species will be developed in collaboration with other SI_Arctic investigators and colleagues.

Samples and Specimens Collected

Samples for analysis by this project were taken primarily from a second WP-2 plankton net haul done at many stations for this project. Samples designated for UConn were preserved immediately in 95% undenatured ethyl alcohol (EtOH). Samples or specimens for genetic analysis were also obtained from MIK and Juday net samples, as well as macrozooplankton trawl samples (on a not-to-interfere basis). When possible, these samples were examined for living specimens of the target species; these were identified and either flash-frozen in liquid nitrogen or preserved in alcohol in scintillation vials for genetic analysis. A complete summary of samples collected for zooplankton genetics during the SI_Arctic 2014 Cruise on FF Helmer-Hanssen is shown in Table A3. A summary listing by species of LN2 flash-frozen identified individual specimens in cryovials is provided in Table A4.

Fish and zooplankton acoustics

The Simrad EK60 echosounder was equipped with transducers of three frequencies: 18 kHz, 38 kHz and 120 kHz at 1 ms pulse duration. The echo sounders were connected to transducers mounted on a protruding instrument keel with transducer faces ~3 m below the hull, usually ~8.5 m below the sea surface. Only area backscattering values (s_A) from the 38 kHz was allotted to various species or groups of scatterers and stored in the acoustic database, but the frequency response of scatterers and inspection of echograms at other frequencies were used in addition to the catch from near-by trawl hauls as auxiliary information when scrutinizing and interpreting the echograms. The s_A-values were distributed to the following groups: Cod, Haddock, Saithe, Redfish, Polar cod, Blue whiting, Norway pout, Herring, Capelin, O-group and “Others”. These are the same groups as used during the Barents Sea ecosystem survey.

The LSSS post-processing software was applied for scrutinizing acoustic data, while the data were stored in the LSSS database as well as in the S2D Echosounder database with 10m (vertical) by 1 nautical mile (nmi) horizontal resolution. The scrutinized processing involved spike-filtering (to remove unwanted acoustic temporal noise from e.g. trawl sensors during trawl operations), compensation for the placement of transducers, and noise removal. The main tool for identifying plankton and fish was the frequency response and trawl data were used to corroborate the interpretation of the acoustic data. Data reports with the scrutinized data were output in the “ListUserFile16” text file format and moved into an Excel (XLSX) file. The acoustic backscattering data in the reports were in the form of $s_{A,}$ Nautical area scattering coefficient (NASC) in units of (m^2 nmi^{-2} – MacLennan et al. 2002).

Six sections were additionally processed by kriging of the data using "EasyKrig", a Matlab based, kriging tool written by Dezhang Chu (ftp://globec.whoi.edu/pub/software/kriging/easy_krig/). In the process the acoustic data were transformed to S_A (Nautical area scattering strength dB re 1(m^2 nmi^{-2}) by S_A=10 log10 (s_A). The sections were defined as follows (Figure 3):

		Start position	Stop position	Distance (nm)
Section #1/Along shelf break		78.05N; 9.42E	79.49N; 8.01E	87
Section #2/Fram Strait north section		79.68N; 9.73E	79.60N; 5.17 E	76
Section #3/Along ice edge		79.60N; 5.17 E	80.83N; 15.57E	208
Section #4/Hinlopen section		80.80N;15.51E	79.79N;18.07E	76
Section #5/Wijdefjorden section		79.92N; 15.35'E	80.77; 13.64E	116
Section #6/Fram Strait south section		78.58N; 9.61E	78.62N; 5.41E	112

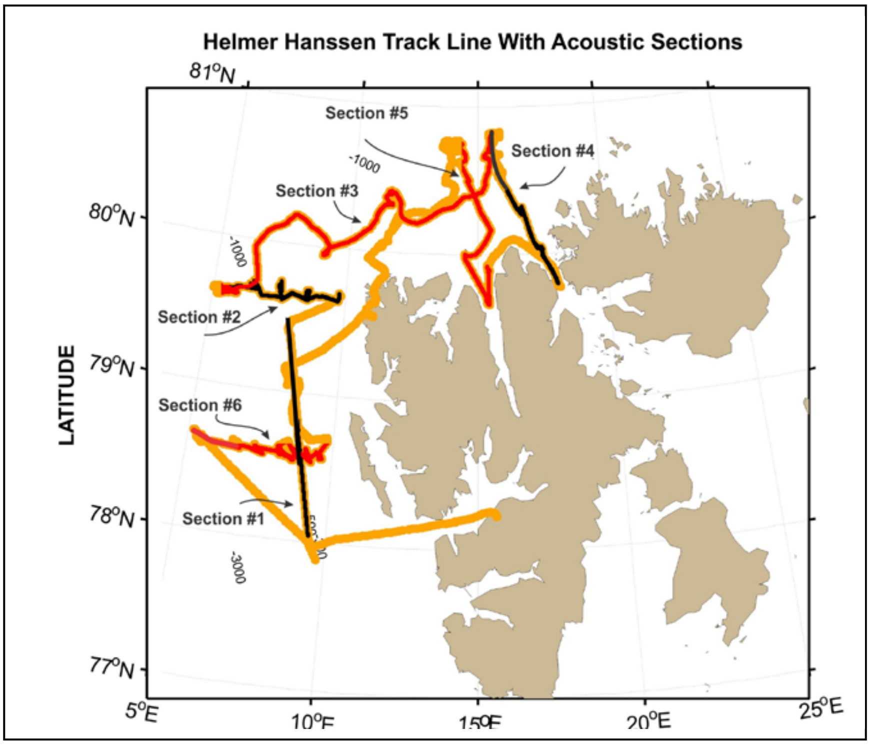


Figure 3. The Helmer Hanssen cruise track in orange with the sections of the track where the 38 kHz acoustic data were plotted are either in red or black.

The 38 kHz data were aggregated in three sets, Total backscattering, All Fish backscattering, and Plankton backscattering. Since much of the “Plankton” backscattering was below the range of the 120 kHz echosounder (which is particularly useful for identifying backscattering from larger planktonic species such as krill), the category “Plankton” is most likely better termed “Mesopelagics” referring to small mid-water fish and other micronekton.

Fish collections

The sampling trawls used for fish were a Harstad Trawl, an Åkra trawl, a Macroplankton trawl towed pelagically, and a Campelen trawl towed at the bottom. Initially the Campelen was rigged with 100 titanium floats, which can withstand the pressure in deepwater hauls. On the 22nd August the trawl was damaged twice (in haul nr 2009 and 2011) and to avoid further damage 25 additional floats were mounted on the headline of the trawl. Each deepwater float has a flotation of 2.4 kg.

The Åkra trawl was equipped with a “fish lift”; a chamber attached to the cod end with low water throughput to avoid damage to fragile fish, cephalopods and jellyfishes caught at deep water.

28 hauls were made with the Campelen trawl (Table A1). Position, depth etc. is given in Table A5. Although the trawl was somewhat damaged during two of the hauls (no 2009 and 2011), it was decided to consider the catches as representative for the area since the damage to the trawl nets probably did not affect the catch very much. 29 hauls were made with the pelagic trawls (Table A6); 7 hauls with an ordinary rigged Harstad trawl, 12 hauls with a Harstad trawl with extra floats (0-group hauls), 7 hauls with the Åkra trawl, and 3 hauls with the Macroplankton trawl. The trawl catches were worked up to species level for fish, while the bycatch of benthos and plankton caught in these trawls were normally only sorted to group levels (krill, amphipods etc.).

Most of the trawl hauls were grouped by section (numbered 1-6) but some stations were originally planned as belonging to the Ecosystem survey of the Barents Sea. This included most of the 0-group hauls and some of the bottom trawl hauls. However, some of these stations were placed on the sections conducted, and those stations were considered as part of these sections.

Benthos

Primary equipment was the Campelen trawl with standard rigging of the net, wire and trawl-doors and steel-chain on the seabed. Location of stations is shown in Figure 4. In addition to the semi quantitative Campelen trawl, two types of quantitative benthic sampling tool were used; a 2m Beam-trawl (5mm mesh size in cod-end and where the sample was sieved through a 5 mm sieve) and a 0.1 m2 grab (where the sample was sieved through a 1 mm sieve). This accounted particularly at the three selected case-study stations “C1 (serial no 2001), C2 (2021), and C3 (2037)”.

All animals were identified to closest possible taxon, counted and weight measured onboard by two benthic experts (LLJ and DZ). The sponges were treated by a guest sponge expert (RP) and were sent to Bergen University (responsible Proff. Hans Tore Rapp) for further identification. Samples of code-labeled sponges were deep frozen and will be delivered to MARBIO (HI in Tromsø) for bio-prospecting. A collecting of different species within sea-spiders will be send to Dr. Franz Krapp, Zoologisches Forschungsmuseum, Bonn, Germany. Sea pen (only one species) was delivered to Dr Chris Yesson, Institute of zoology, Natural History Museum, London, England. Coral data (positions, depth, temp, abundance, biomass) were delivered to the MAREANO coral database driven by NMD (Kjell Bakkeplass).

More than 330 benthic taxons was registered in the Campelen trawl (excluding fish, see other section of the report), Beamtrawl and grab (Table A7). 140.000 individuals and 2500 kg of benthos were treated on the cruise.

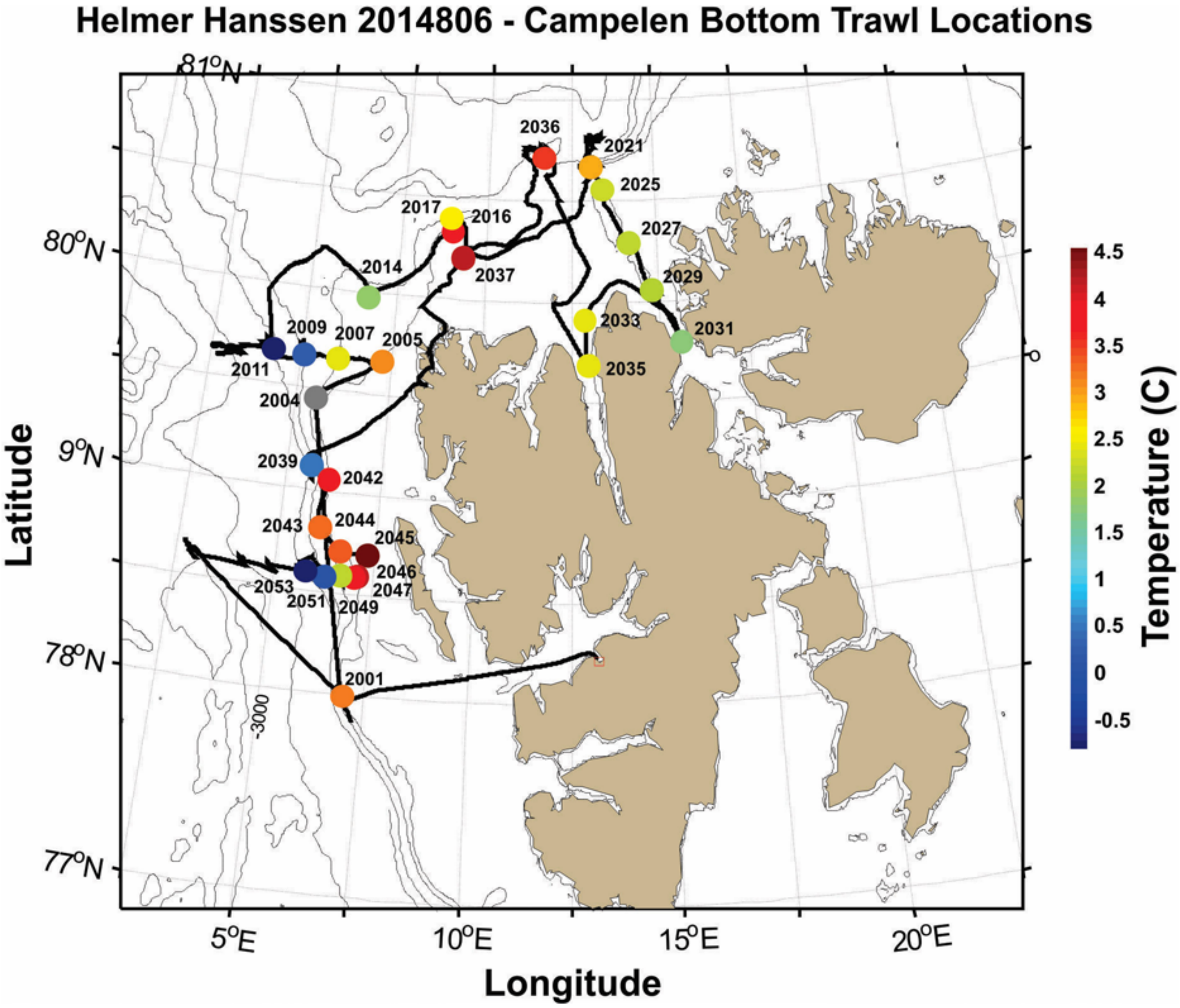


Figure 4. Map of "depth-transect": **A** (Fram Strait south section, St. 2046, 2047, 2049, 2051, 2053), **B** (Fram Strait north section, St. 2005, 2007, 2009, 2011), **C** (North Western shelf transect, St. 2016, 2017, 2037), **D** (Wijdefjorden section, 2033, 2035, 2036), **E** (Hinlopen Section, St. 2021, 2025, 2027, 2029, 2031). Color show bottom temperature from CTD.

Invertebrate and vertebrate animals was selected from the entire water column (i.e. the pelagic, mesopelagic and benthic parts), representing key-species (large biomass), all feeding types from detrivore, filtrators, sessile filtrating predators, moving predators, scavenger/ predators. From these selecting a total of 21 fish stomachs (total of 10 species) was identified and 235 isotope analyses (69 fish, 104 benthos, 54 pelagic fish and invertebrates, 3 POMs, 5 sediment samples, see Table A1) was frozen (-20ºC). Details are given in Table A8.

DNA analyses of 6 individuals of supposedly *Gorgonacea ecnemis* (3 ind) and *Gorgonacea arctica* (3 ind) was conserved in 90% absolute alcohol, and frozen (-20 ºC) for possible analyses.

Marine mammals

Visual observations of marine mammals were conducted by 2 experienced observers on the bridge covering approximately the front 90° sector (45° each). Species were recorded along the cruise transects when steaming between stations and when visibility were sufficient and the observers were on post. Species were also recorded when the ship was doing station work or working its way through the ice, coding the data accordingly. In describing the data below all observations have been included, also the sightings when the ship was laying still.

The spatial coverage of the sightings is obviously completely determined by the cruise track (see Figure 1) as well as by visibility, suitable sighting conditions and observers on post. Thus “no sightings” does not mean that there were no marine mammals present.

Sea birds

Seabird observations were carried out by standardized strip transect methodology. Birds were counted from the vessel’s bridge while the ship was steaming at a constant speed of ca. 10 knots. All birds seen within an arc of 300 m from directly ahead to 90° to one side of the ship were counted. On the vessels Helmer Hansen, GO Sars and Johan Hjort, birds following the ship i.e. “ship-followers”, were counted as point observations within the sector every ten minutes. Ship-followers included the most common gull species and Northern fulmar. Seabird observers and total transect lengths covered by the Helmer Hansen in 2014 (and 2012 and 2013 for comparison) is shown below.

Seabird observers and total transect lengths with seabird observations in 2012, 2013 and 2014.

Survey	Observer	Total transect length (km)
2012	Stuart Murray	1295
2013	Eirik Grønningsæter	1145
2014	Jon Ford	1069

Results

Sea ice distribution

The wind speed and the directional shifts had an apparent impact on the sea ice margin (Figures 5A,B). At the beginning of the cruise (19 August), the sea ice margin north of Svalbard was in its most northerly position and much of the sea ice was more than 50 % concentrated right to the ice edge and remained so until about 24 August during the transit from the first Fram Strait transect up to the first northern station area on 25/26 August when it began to move southward and became less concentrated. This fragmentation of the ice edge continued during the transects to Hinlopen Strait on 27 August and from Wijdefjorden back to the deep continental slope water off the Northern Svalbard shelf on 28 August (Figure 5A,B). After completing the CTD profile time-series at the second northern station, attempts to move westward along the ice edge on 30 August were thwarted by the expansion of the moderate ice concentrations to the south. Thereafter, the cruise track was directed southwestward away from the ice edge and to the shelf region west of Svalbard for the second Fram Strait transect. The sea ice continued to move to the south during the remaining days of the cruise.

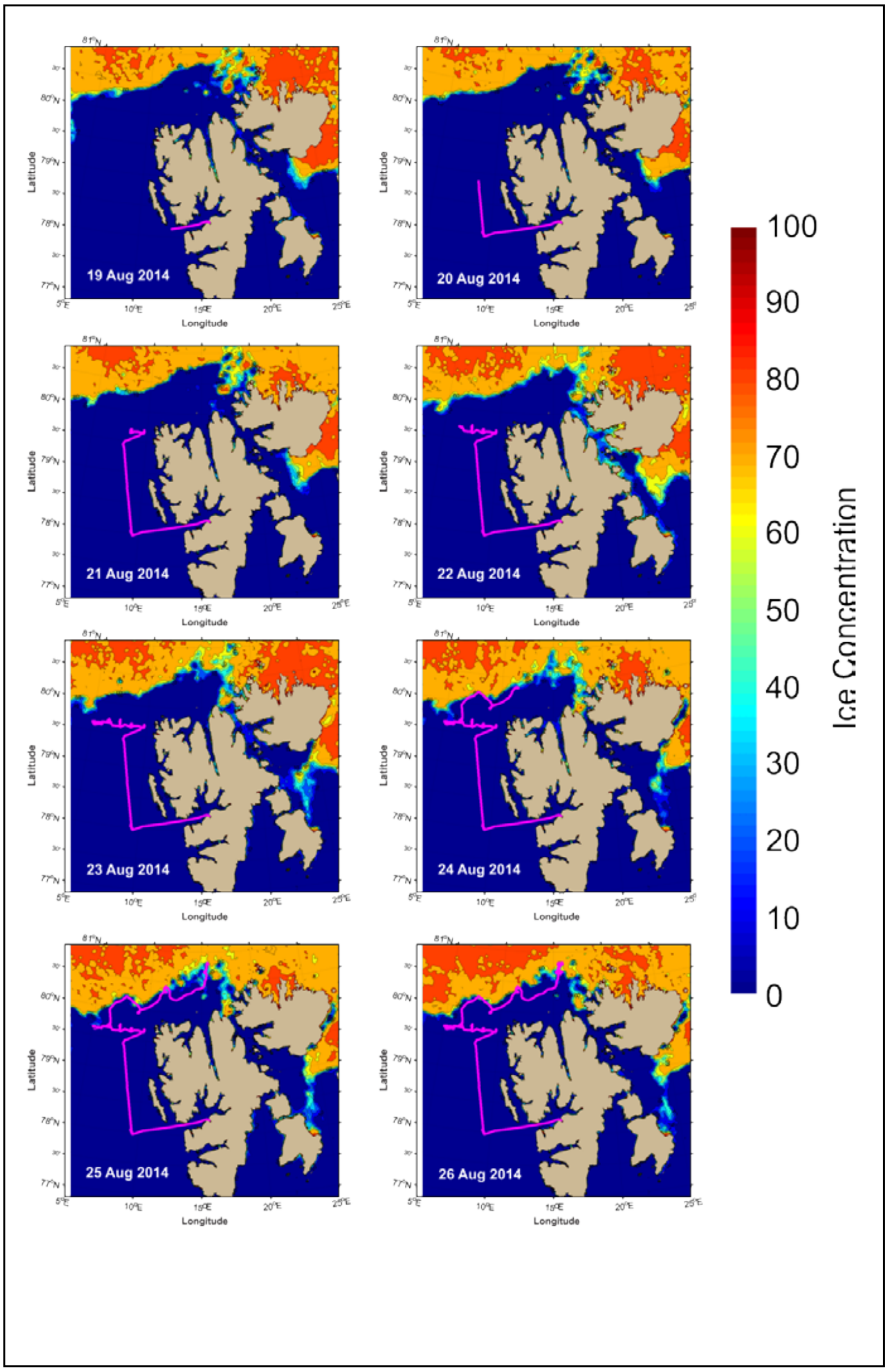


Figure 5A. Ice concentration maps for each day of the cruise (two panels).

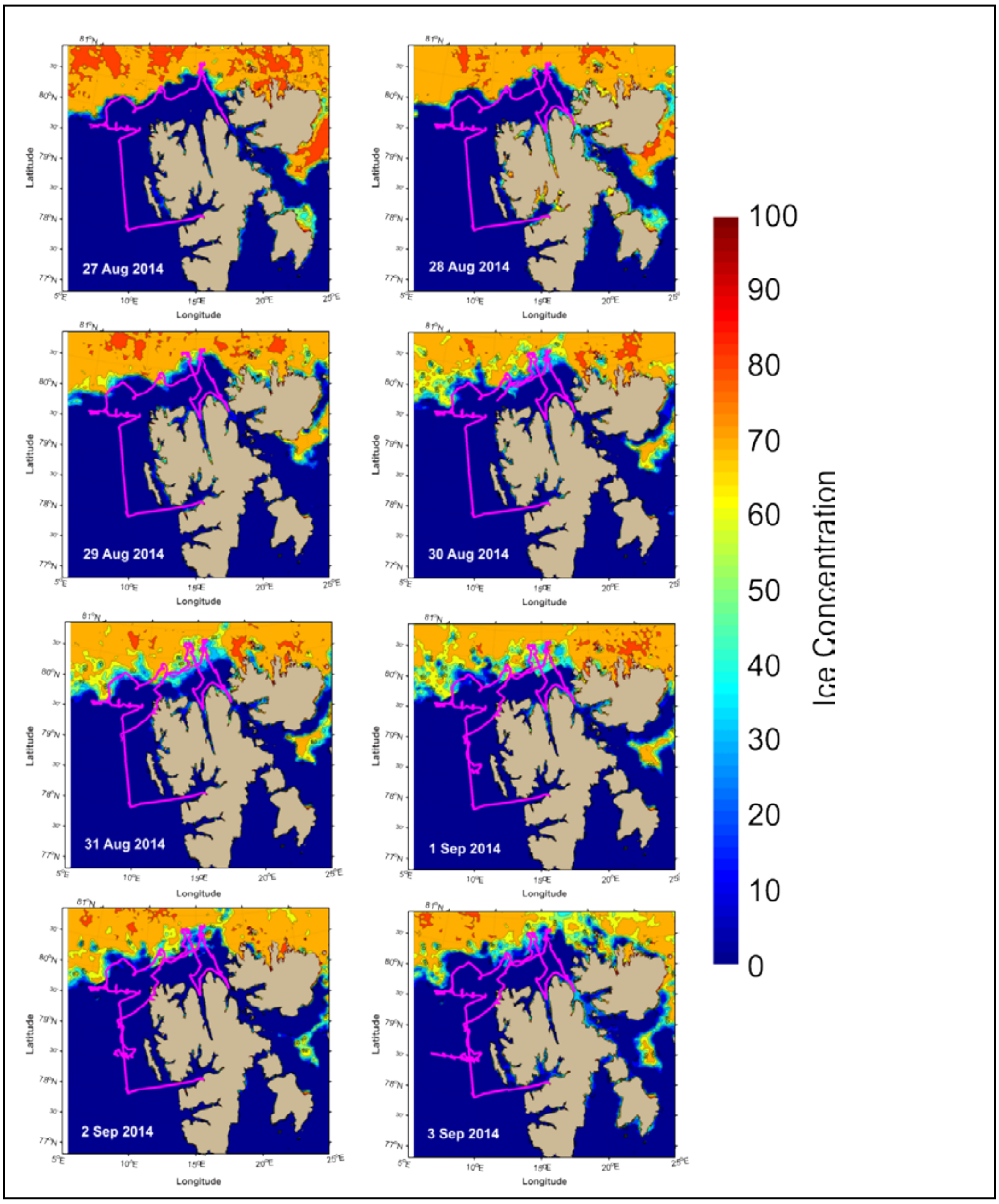


Figure 5.B. Ice concentration maps for each day of the cruise (two panels).

Underway meteorological and oceanographic measurements

Sea surface temperatures were highest (mean of 6.4^{o}C in section 1) in the warm Atlantic seawater flowing north along the Svalbard coast (Figure 6 and 7, Table 1). Moderate temperatures were encountered on the shelf north of Svalbard and in Hinlopen Strait and Wijdefjorden, averaging 1.8 to 2.7^{o}C (Sections 3 and 4). Lowest sea temperatures were encountered in the western portion of the Fram strait transect and in the deep waters off the continental slope waters north of Svalbard within the pack ice with temperatures as low as -0.8^{o}C (Figure 6 and 7).

Mean wind speeds varied throughout the cruise (Table 1). There were no high wind events with winds exceeding 21 m/s (~41 kts). The only period with winds up to 20.7 m/s (~40kts) occurred once during the transit from the stations in Hinlopen Strait to that in Wijdefjorden (Figure 6). Air temperature was correlated with sea surface temperature, but it varied widely and ranged from well above 7^{o}C to as low as -6.5^{o}C. Barometric pressure remained above 1000 mb for the duration of the cruise and oscillated between 1000 and 1020.9 mb.

When the pressure was low, there were periods of light precipitation either as flurries or drizzle. There were extended periods when pressure remained high and relatively constant, and these were associated with periods of moderate sea conditions and light winds. Some days were mostly cloudy, but others were sunny. The sun remained above the horizon for most of the cruise. The sun began setting at the end of August.

Wind direction was also variable (Figure 6). Winds were predominately from the North for the first 6 days (19 to 24 August) and then shifted to southerly for the next 3.5 days (25 to 28 with a gradual shift to west/northwest from 29 through 31 August. There was another period of winds from the north on 1 September and then another shift to southeasterly on 2 September.

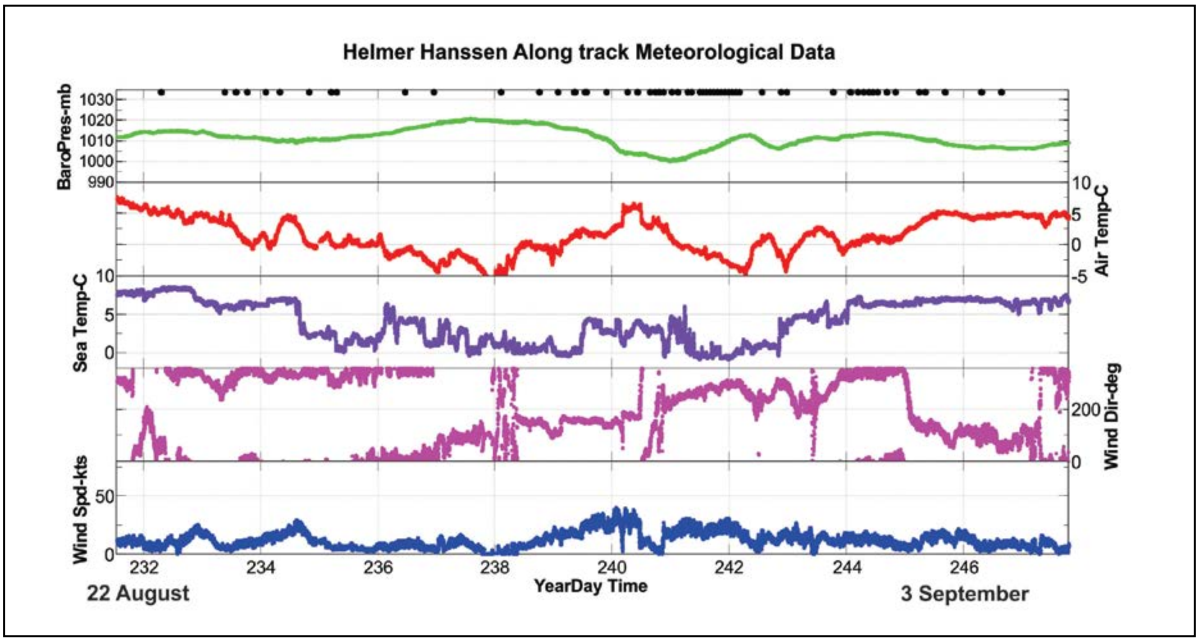


Figure 6. Helmer Hanssen 2014806 along-track sea surface temperature measurements made from 19 August to 4 September 2014. CTD station positions are indicated by the filled circle at the top of the plot.

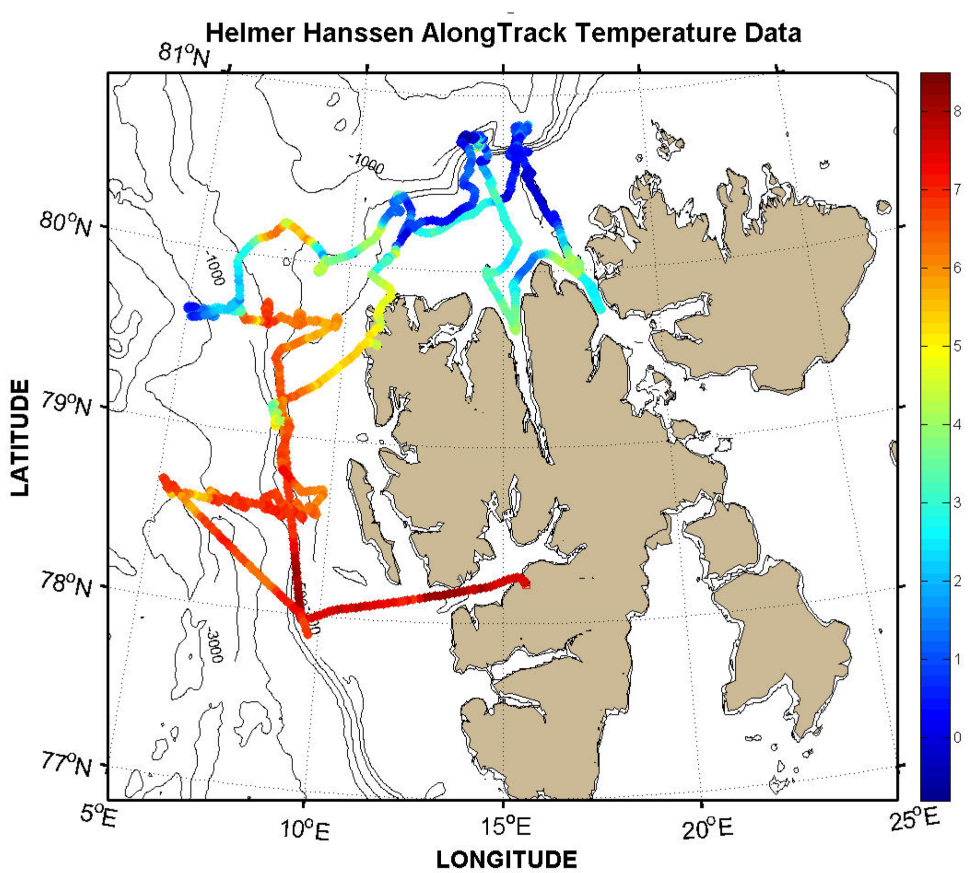


Figure 7. Sea surface Temperature plotted on the cruise track

Table 1. Meteorological (MET) data Summary Statistics.

	YearDay	Air Temp ('C")	Sea Temp ('C")	Wind Speed (m/s)	Wind Direction (Deg)	Barometric Pressure (mbar)	Latitude	Longitude
Longyearbyen-Along shelf break - Fram Strait north section (Longyearbyen to CTD to 547)								
mean	233.41	3.3414	6.35	6.30	270.33	1012.5	79.052	9.171
max	235.29	7.6	8.5	15.24	360	1015.2	79.742	15.614
min	231.55	-0.7	0.4	0.18	0	1009.4	77.966	5.1340
Along ice edge (CTD 547 to 551)								
mean	237.03	-1.65	1.90	3.311	157.1	1017.2	80.267	11.155
max	238.76	1.7	6.4	8.8	360	1020.9	80.831	15.898
min	235.29	-6.5	-0.3	0.01	0	1011.1	79.600	4.995
Hinlopen section (north to south CTD551 to 558)								
mean	239.51	1.34	1.85	11.329	148.0	1013.6	80.228	16.681
max	240.26	6.4	4.5	20.66	194	1019.1	80.697	18.136
min	238.76	-3.2	-0.4	1.27	52	1003.9	79.771	15.343
Wijdefjorden section (south to north) – southern part (CTD 558 to 564)								
mean	240.64	3.80	2.80	8.0562	155.8	1002.7	80.170	14.937
max	241.02	6.6	4.8	19.89	359	1004.6	80.724	15.493
min	240.26	0.9	-0.5	0.1	0	1000.4	79.665	14.071
Wijdefjorden section (south to north) –northern part-along ice edge (CTD 564 to 582)								
mean	242	-1.35	0.85	9.37	268.8	1007.4	80.559	13.188
max	242.98	1.7	6.0	15.83	320	1013.2	80.776	14.317
min	241.02	-4.7	-0.8	1.02	28	1000	79.957	10.731
Along shelf break in Fram Strait (CTD 582 to 587)								
mean	243.69	0.66	5.17	6.76	270.7	1011.6	79.298	9.557
max	244.38	2.8	7.3	13.81	360	1013.8	79.958	11.401
min	242.98	-3.1	3.4	0.02	0	1008.3	78.687	8.008
Fram Strait south section- to final grab station (Case 1) (CTD 587 to 78.00N;9.46E)								
mean	246.03	3.78	6.64	5.21	148.94	1009.4	78.577	7.854
max	247.71	5.4	7.4	11.39	360	1014.2	78.687	9.779
min	244.38	0.3	5.1	0.2	0	1006.6	78.002	5.149

Hydrography (CTD) and currents (LADCP)

Currents from the LADCP showed variable conditions in the study area but relatively barotopic (i.e. small variation with depth) current in the upper 500 m (Figure 8 and 9). Along the shelf break of the Fram Strait south section (section 6) there was a relatively strong off-shelf component probably reflecting a branch recirculating in Fram Strait. A strong (30 cm/s) northward Atlantic Water flow was evident along the slope in the Fram Strait north section (section 2) while further offshore the flow was weaker. Relatively strong (15-20 cm/s) Atlantic Water flow along the slope was also observed to the north of Svalbard (Figure 6), while on the shelf the flow was more variable in direction.

Both sections in eastern Fram Strait was dominated by Atlantic Water (temperature>2°C and salinity>35) from about 600-700 m depth up to the surface layer (Figure 9). In the northern section (Fram Strait north, section 2) there was a fresher surface layer in most of the section, although with strong lateral gradients (Figure 11). In the western part of the section the presence of sea ice and melt water (with low temperature and salinity) created a pronounced surface layer in the upper 30-40 m.

North of Svalbard, at Hinlopen, the northernmost part of the section was dominated by eastward flow of Atlantic Water between 10 and 700 m depth (Figure 9). On top of this (in the upper ~10 m) melting sea ice made a fresh, cold surface layer. Atlantic Water dominated on the slope and on the shelf, except for the innermost (southernmost) part of Hinlopen.

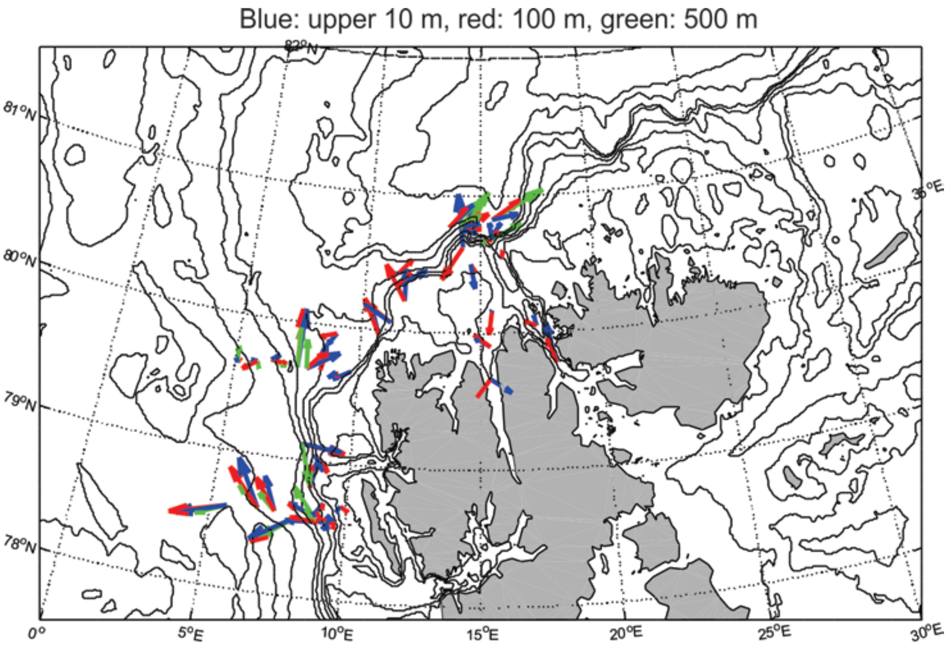


Figure 8. Current from LADCP data in the upper 10 m depth layer (blue), at 100 m depth (red) and at 500 m depth (green).

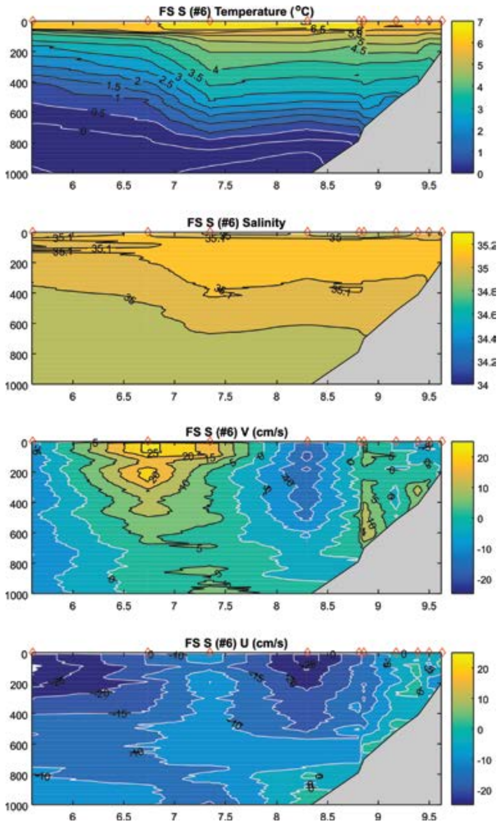


Figure 9. Temperature, salinity, northwarth (V, positive northward) and eastward (U, positive eastward) velocity in the upper 1000 m in the sections. Data from CTD and LADCP, red diamonds show stations. Fram Strait south section (#6).

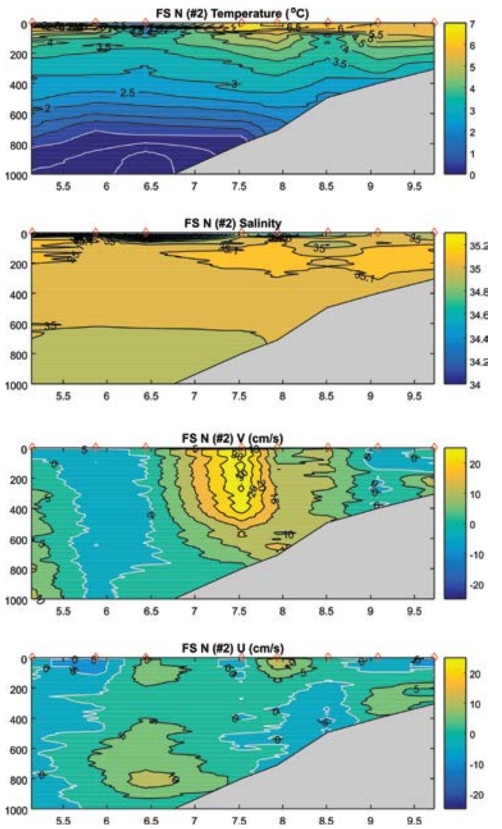


Fig. 9 continues. Fram Strait north section (#2).

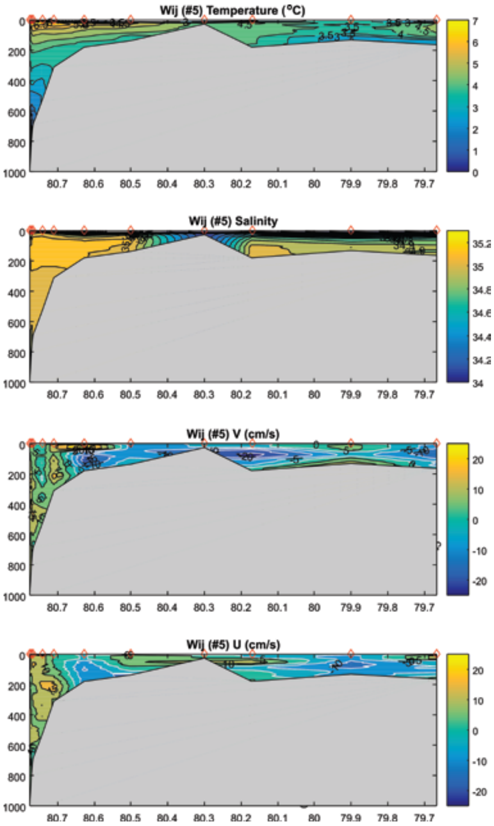


Fig. 9 continues. Wijdefjorden section (#5).

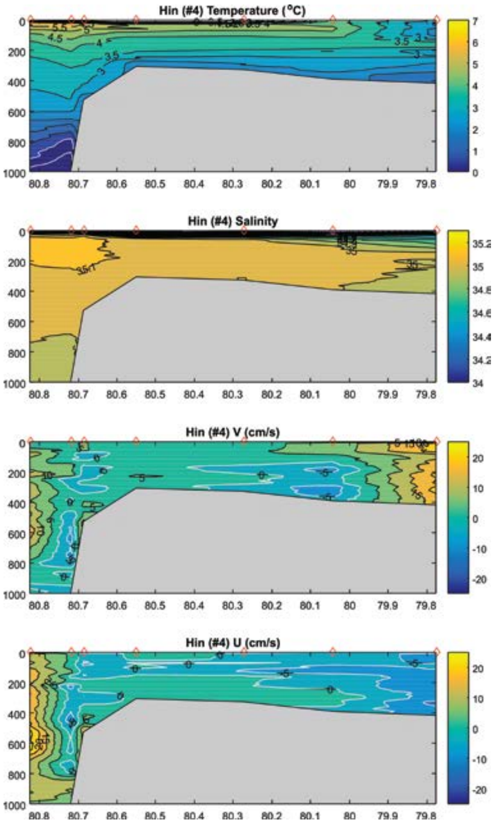


Fig. 9 continues. Hinlopen section (#4).

Fluorescence and oxygen

In the Fram strait north transect (section 2) the chlorophyll-fluorescence data from the CTD sensors show that the phytoplankton was distributed evenly in the top 30m in the eastern part of the transect (Figure 10). The fluorescence was lower in the eastern part of the transect with increasing levels towards the west. There was a clear drop in the chlorophyll-fluorescence in the surface water (upper 20m) in the artic water masses and a change in the vertical structure. In areas with arctic water there were observed a sub-surface maximum chlorophyll-fluorescence around 40m, between Atlantic and arctic waters. Data from the oxygen sensor showed homogeneous conditions in the Atlantic water masses along the whole transect. In the cold artic water and patches with high phytoplankton biomass the oxygen concentration is higher compared to the Atlantic water masses.

In the Hinlopen transect (section 4) phytoplankton fluorescence was low in the inner and outer part of Hinlopen. Further out on the shelf the chlorophyll-fluorescence increased and remains at approximately the same levels along the transect (Figure 10). Along the whole transect the vertical structure were more or less the same, with a maximum fluorescence around 10m. There was not observed any surface maximum under the ice or close to the ice edge. Below 50m there was more or less homogenous oxygen conditions along the whole transect. In the surface waters higher oxygen levels was observed in the colder melting water on the utter part of the shelf south of the ice edge.

In the Widjefjorden transect (section 5) the vertical structure of chlorophyll-fluorescence showed a subsurface maximum around 20m from Widjefjorden to south of the ice edge (Figure 10). The amount of chlorophyll varies within this area, with spots with higher chlorophyll-fluorescence around a shallower area. In the ice and at the ice edge the chlorophyll-fluorescence maximum is just below the ice in the upper 10m. In areas with

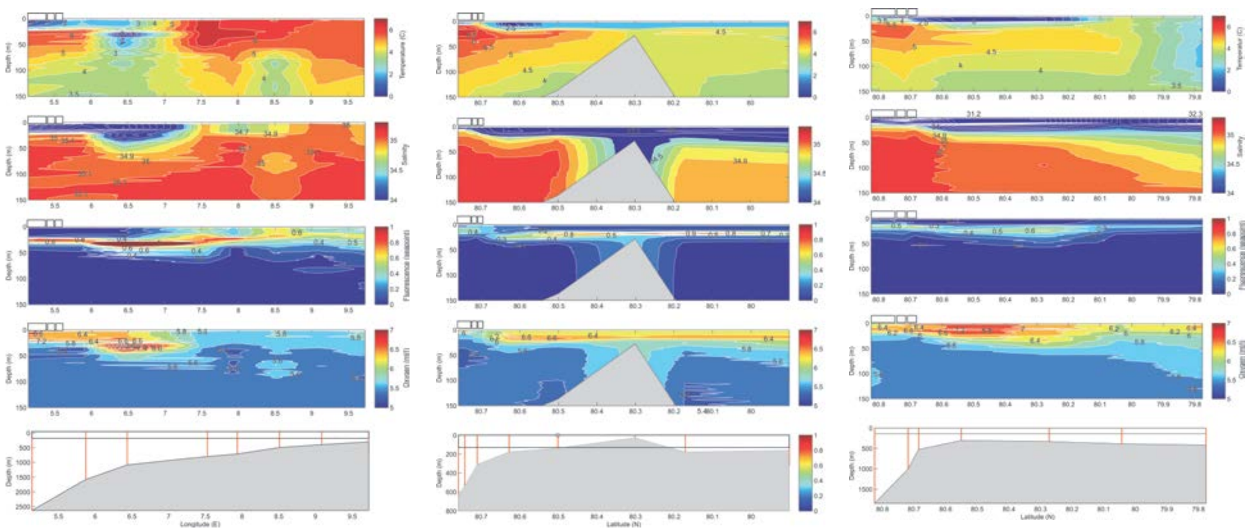


Figure 10. Temperature, salinity, fluerecence and oxygen in the upper 150 m in the Fram Strait north (left), Wijdefjorden (middel) and Hinlopen (right) sections.

melting water the chlorophyll-fluorescence become lower in the surface and increasing in 20-50m. Based on the oxygen sensor data the highest concentration was observed in the upper 20m from the outer Widjefjorden up to the ice edge. At the ice the concentration was somewhat lower. In the underlying deeper waters the oxygen concentration is homogenous along the whole transect.

In the Fram strait south transect (section 6) the fluorescence data showed large horizontal variation in phytoplankton biomass along the transect. In the eastern part of the transect there were lower chlorophyll-fluoresces signal, increasing further out on the shelf associated with lower salinity in the surface. At stations along the slope the fluorescence signal was low. At the western stations, deepest part of the transect, there were an increase in the chlorophyll-fluorescence. Relatively high fluorescence signal were observed from the surface down to 75m. At these stations the salinity profiles indicates an up-welling, that most likely transport nutrient rich water to the surface layers, supporting higher phytoplankton biomass. At this transect the phytoplankton vertical distribution difference from the other transect by showing mostly surface maximum, except from the eastern stations with deeper phytoplankton distribution. The oxygen concentration were more or less homogenous along the whole transect, except for areas with higher chlorophyll-fluorescence on the shelf where the oxygen concentration were somehow higher. There were no changes in oxygen concentration at the eastern stations, where the fluorescence was strongest.

Zooplankton collections

The four different types of zooplankton gear used during the field work catch slightly different parts of the pelagic community. The double-net system, combining a standard 180 µm meshed WP2 and an identically meshed Juday 36 cm diameter net, target the mesozooplankton component as does also the 180 µm 0.25 m2 Multinet system used. One of the key target organisms of interest was the highly important *Calanus* complex, the three species *Calanus finmarchicus* , *C. glacialis* and *C. hyperboreus* that to a smaller or larger degree co-occur in the study region, given that the region is significantly influenced by water masses of both Atlantic and Arctic origin. *C. finmarchicus* is a key species in Atlantic boreal waters while the other two species can be considered true Arctic species having their center of distribution on the Arctic shelf (*C. glacialis*) and in the Arctic Ocean and Greenland Sea (*C. hyperboreus*).

The MIK net and the Macroplakton trawl were used to target the slightly larger and more motile macrozooplankton like krill, amphipods and mesopelagic shrimps. Due to the larger mouth area of the Macroplankton trawl, mesopelagic fish also are possible to quantify if present, although the limited data obtained so far, suggests that the mesopelagic fish component diminishes rapidly moving from the northern part of the Norwegian Sea and Greenland Seas through the Fram strait and into the Arctic Ocean. However, the few number of hauls conducted so far still leaves this an open issue, also given that the water column is difficult to sample quantitatively due to sea ice.

In all regions sampled there were observed a mixed mesozooplankton community with all *Calanus* species present on many of the stations. Due to a seemingly highly variable phytoplankton abundance along the various transects, variable oceanographic conditions, and impact of water masses of both Arctic and Atlantic origin , the mesozooplankton community could also vary significantly from one station to another. On most of the shelf locations around Svalbard the dominating size fraction in terms of biomass was the 180 µm fraction, dominated by smaller copepods like *Oithona* sp and *Oncea* sp, and to some extent *Pseudocalanus* sp. and younger copepodite stages CII-CIV of *Calanus* sp. The size composition of the latter made it difficult to determine which of the two species *Calanus finmarchcus* and *Calanus glacialis* these copepodites could be assigned to since there is strong evidence that their sizes for a given copeodite stage overlap considerably (cf. Parent et al., 2011). Their separation needs to be resolved by more detailed taxonomic analyses in the onshore laboratory and later by genetic analysis. The biomass retained on the 1000 µm fraction was normally low, suggesting that the older copepodites and adults of the above two species were low. In fact only very few females were spotted during the brief, but admittedly incomplete examination of the raw samples.

Macroplankton like the krill Thysanoessa inermis, Thysanoessa longicaudata, Meganyctiphanes norvegica, the amphipods Themisto abyssorum and Themisto libellua were caught on numerous occasions and were sometimes highly abundant, particularly when using the MIK net. On the shelf north of Spitsbergen different scattering layers were observed that could both be assigned to krill like Thysanoessa inermis and the two species of amphipods, the Atlantic *Themisto abyssorum* and the Arctic Themisto libellula, although a more detailed inspection of the acoustic data as well as the biological samples will be necessary to make any firmer conclusion whether these layers are monospecific or consist of a mixture of amphipods and krill. Some catches suggest that both scenarios are possible. The Northern krill *Meganctiphanes norvegica* having its center of distribution much further south, was observed in many of the tows both on the northern Svalbard shelf and over deeper and ice-covered waters further north. Even a specimen of the krill *Nematoscelis megalops* a temperate Atlantic species were found in the same region, probably one of the most northernmost finds of this species ever recorded.

The transects conducted west of Spitsbergen showed particularly interesting although not unexpected features with respect to oceanographic conditions and zooplankton species composition when moving from the shallow eastern shelf to deep waters of the Greenland Sea in the west. Here *Calanus hyperboreus*, a species known to inhabit the deeper and colder waters of the Greenland basin were observed in high concentrations between 1000 and 2000 m depth. There seemed to be a predominance of females in these deeper waters, although a more quantitative analyses must be undertaken to confirm this observation. Also in these waters west of Spitsbergen the surface mesozooplankton were dominated by a mixture of smaller copepods and younger stages of the complex Calanus finmarchicus and C. glacialis.

Fish and zooplankton acoustics

The along shelf acoustic data in section 1 revealed strong Total scattering at the surface to about 50 m in sporadic patches for the entire section (Figure 11A). Harstad trawl collections suggest that the scattering was principally from O-Group fish and amphipods (*Themisto libellula*). Between 300 and 550 m, strong scattering occurred for the first 15 nm at the southern portion of the section and then decreased to lower levels. The ship trackline cut across the meandering shelf slope break and there were patches of higher scattering close to the continental shelf as it shoaled or deepened. The All Fish group accounted for most of this backscattering and Plankton backscattering was substantially lower.

In the Fram Strait #1 (section 2 – Figure 11B), high backscattering at the surface was again evident, with a major contribution from the All Fish fraction. But there were scattered patches of high surface scattering in the Plankton fraction as well across the entire section. A moderately strong scattering layer extended from the continental slope to the western end of the transect between 300 and 450 m. An interesting feature was that the All Fish fraction was present from the slope to about two-thirds of the distance to the west and then became insignificant. Alternatively, the Plankton contribution was moderate from the slope to the point where the fish scattering lost significance and then its backscattering became much stronger to the western end of the section. The abrupt change in the contributions of these two fractions occurred about where there was a cross-over from warm Atlantic Seawater to cold polar and deep seawater.

From the western end of Fram Strait #1, the cruise track went along the southern edge of the sea ice to the first far North Station. Along this section (3) the pattern of acoustic backscattering paralleled that observed on the Fram Strait transect. There was strong surface to 50 m backscattering until entry into the low concentration sea ice near the far north station (Figure 11C). The deep scattering layer between 300 and 450 m was dominated by Plankton for the first 50 nm and was then diminished when the AllFish scattering increased to moderate levels until the bottom shoaled to about 250 m. High AllFish backscattering occurred at the top of the first move to shoaler water around nmile 110. Very low backscattering occurred at the shallowest portion of the section (about 100 m) at nm 170. In the far North station area in water over 700 m deep, there was a deep scattering layer from 300 to 500 m dominated by high Plankton scattering.

The two sections (4 & 5) across the Northern Svalbard Shelf region and into the deep Arctic slope water had very similar backscattering patterns (Figure 11D, E). The eastern section began in deep water (700 m) off the shelf and ended in Hinlopen Strait. Total backscattering was substantial between 300 and 500 m as was observed on the previous section. Most of this backscattering was accounted for by the Plankton fraction. In this area, the marine mammal observers noted the presence of a number of whales. On the shelf, water column scattering was moderate and mostly in the upper 50 m with scattered patches of moderate scattering also occurring in the 200 to 350 m depth zone. Most of this scattering was accounted for by the Plankton fraction.

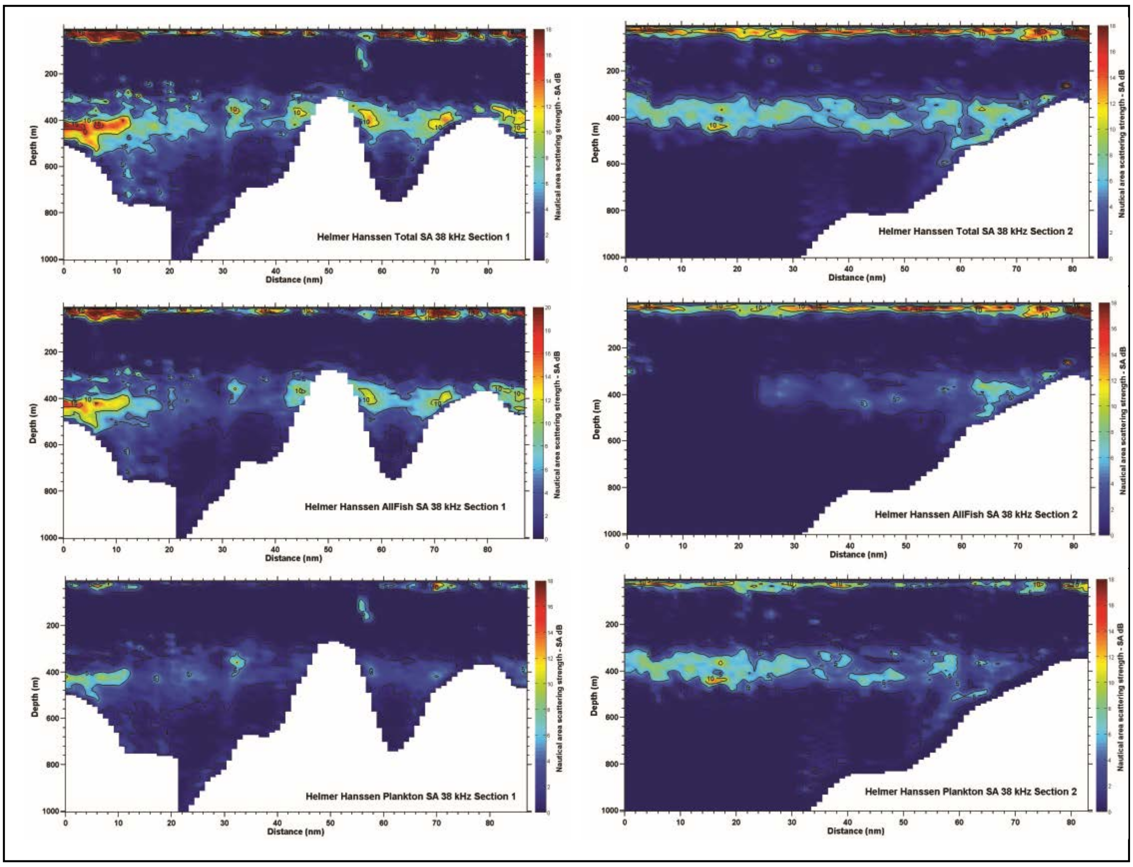


Figure 11. The distribution of total backscatter (Sa values) along cruise tracks down to 1000 m at 38 kHz. A. Section 1, B. Section 2.

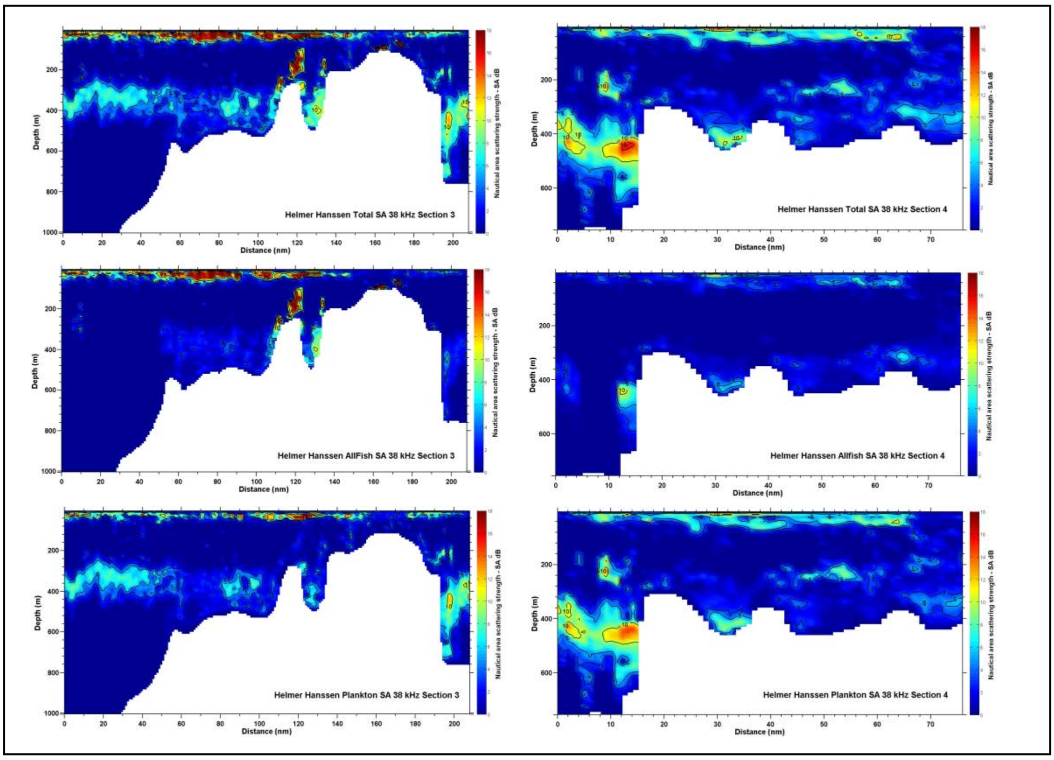


Figure 11 continues. C. Section 3, D. Section 4.

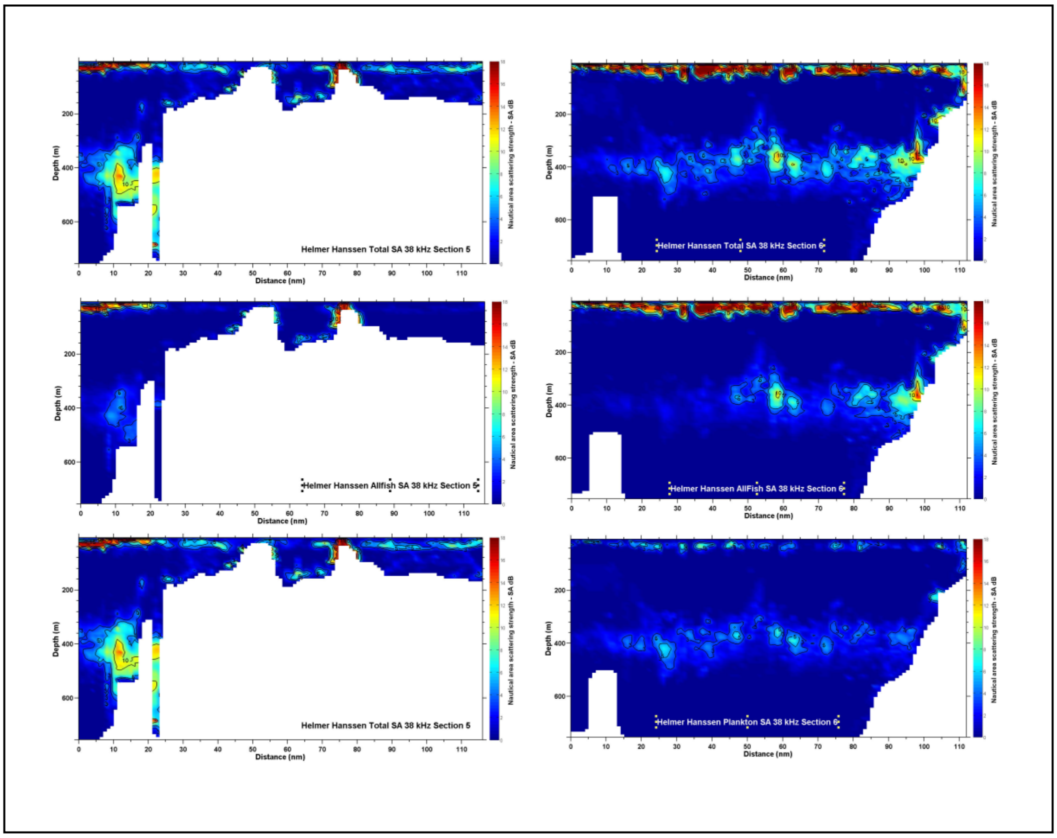


Figure 11 continues. E. Section 5, F. Section 6.

The more western section from Wijdefjorden to the second far North Station was over very shallow water depths (Figure 11E). Moderate surface to 50 meter backscattering was evident over the shelf and again most was accounted for by the Plankton fraction. Midway along the shelf was a particular shallow bottom feature and in its vicinity there was very strong scattering by the All Fish fraction. To the north beyond the shelf break, there was strong surface scattering in which both All Fish and Plankton contributed significantly and as in the previous section, there was strong backscattering centered at 400 m dominated by the Plankton fraction.

In the Fram Strait #2 (section 6 – Figure 11F), the high backscattering at the surface seen in earlier section was on this section as well. It extended from the coast and was most intense midway along the section. The fish contribution to the deep-scattering layer from 300 to 450 m was more important than the plankton contribution until midway along the section to the west and then the fish fraction decline in backscattering while the plankton fraction continued to persist thus increasing its contribution to the total. This pattern was also seen in sections 2 and 3 further north.

Fish and prawn collections

Altogether, 104 different species or species or higher taxons were caught in the various trawls. Of these, 53 taxons were fish, all determined to species level. Benthos bycatch in the bottom trawl were mostly lumped into about 20 groups like “Sea stars”, “Crabs” etc., but species that could easily be recognized were recorded to species level. The same way of identification was applied for plankton caught in the fish trawls. Bycatch of benthos and plankton is dealt with in other sections of the report.

Dominance and depth ranges

The most dominating species in terms of number of stations they were caught was cod. This species was found in 47 of the 57 trawl hauls made (Table 2). Next ranged capelin, haddock, polar cod, deepwater prawn, beaked redfish, long rough dab and Greenland halibut, which were found in 30, 26, 25, 24, 23, 21 and 19 hauls respectively. All these are commercial species, apart from the polar cod and the long rough dab, which are not targeted species in this area. The cod also had the highest average catch rate in biomass. Its catch rate of 51 kg per nautical mile was more than three times as high as the deepwater prawns, ranging next with 15 kg per nautical mile. The catch rates in weight of beaked redfish was 11, Long rough dab and haddock 5, Greenland halibut 3, polar cod 1, and capelin only 0.14 kg per nautical mile. Haddock and Greenland halibut showed the largest span in fishing depth in the bottom trawl; from about 125 m to more than 1000m depth. Also capelin, polar cod and long rough dab were found at a large span of depths, from about 150 m to 800-900 m. Cod, deepwater prawns and beaked redfish were caught from about 140 m down to 540 m depth. In the pelagic trawl cod, beaked redfish and Greenland halibut were caught down to about 450 m while the capelin were caught in trawls that fished down to more than 800 m. However, since the catches were low of most of these species in the pelagic trawl, those specimens might have entered the trawl at much shallower depths during setting and heaving. On the other hand, the few cod specimens caught in pelagic trawls down to about 450 m were assumed to be caught at that depth, because echo traces from large fish at that depth could hardly stem from other scatterers than cod, and the trawl hauls were in fact set to confirm that these echoes seen on the echosounder was cod.

Table 2. The most dominating species in terms of presence in trawl hauls, their standardized average catch in biomass and numbers, their average size. Given are also the shallowest and deepest pelagic and bottom trawl haul where the species was observed.

Species	No of stations	Average catch (kg/nmi)	Average catch (n/nmi)	Average size (kg)	Depth range bottom trawl	Depth range pelagic trawl
Cod	47	51.20	61.90	1.075	126-538	0-450
Capelin	30	0.14	8.04	0.015	163-812	0-821
Haddock	26	5.07	15.96	0.447	126-1012	-
Polar cod	25	1.27	44.23	0.012	139-927	-
Deepwater prawns	24	15.34	2900.55	0.005	139-538	-
Beaked redfish	23	10.51	130.18	0.258	178-538	410-438
Long rough dab	21	5.32	42.59	0.147	139-927	-
Greenland halibut	19	2.93	4.78	0.574	126-1023	271-448

Other, mostly non-commercial fish species like skates, sculpins, catfishes, eelpouts and rattails were present in most bottom trawl stations, and dominated, at least in terms of numbers, in the deepest hauls. In the pelagic trawls, mostly early life stages of commercial species (mainly redfish, cod and haddock) dominated in the upper layer together with plankton like krill and amphipods, while various mesopelagic fishes and shrimps were found together with cephalopods and cnidarians in a mesopelagic layer at 400-500 m depth beyond the shelf break.

Spatial distribution of fish and benthos in trawl catches

Figure 12 shows the distribution of total catch rates (kg catch per nautical mile hauled) from bottom and pelagic trawls hauls. There is not much geographical variation in catch rates, apart from a clear decreasing trend when moving away from the coast and into deep water. The catch rates of fish catches are shown in Figure 13. The highest catch rates were found at the shelf at 200-500 m depth. Figure 14 shows the catch rates of benthos (bycatch) in the Campelen trawl. High catch rates were found both along the shelf brake and in the Wijdefjorden and Hinlopen north of Svalbard. The catches of benthos are highly affected by which hauls contained sponges, since these hauls were characterized by large catches. Also the large catch of benthos in Wijdefjorden is highly affected by one bentic species, in this case the crab *Hyas arenaria*. Figure 15 shows how the catch rates of cod, the dominant fish species, are distributed geographically in pelagic hauls and in bottom trawl hauls.

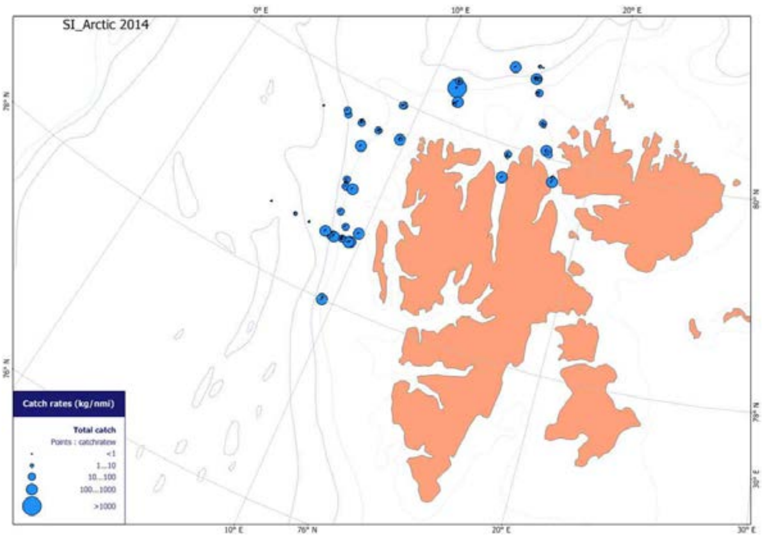


Figure 12. Catch rates in trawl hauls (bottom and pelagic) during the 2014 SI_Arctic cruise.

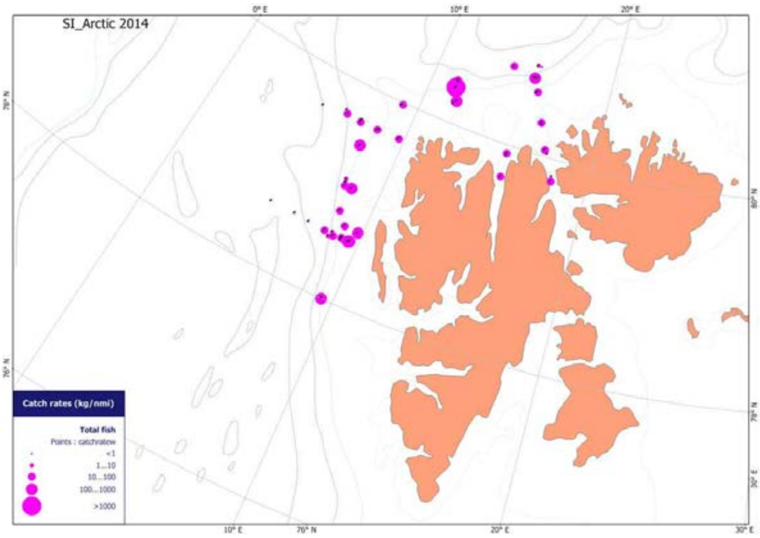


Figure 13. Catch rates of fish in trawl hauls (bottom and pelagic) during the 2014 SI_Arctic cruise.

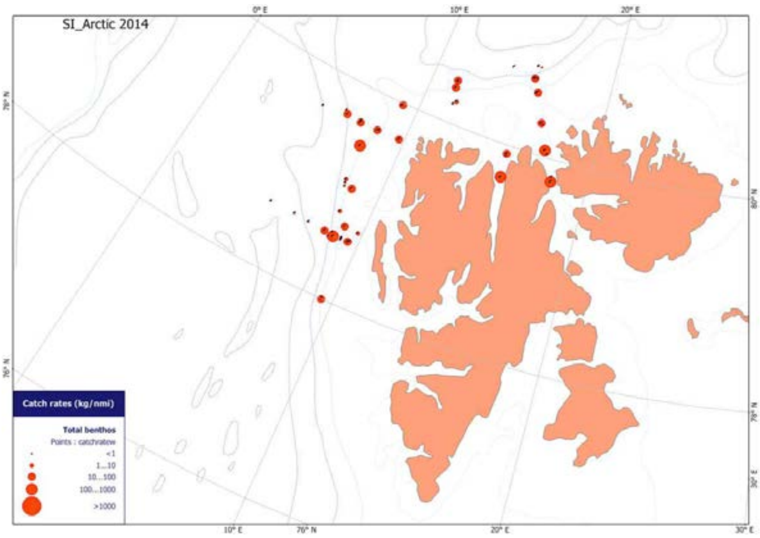


Figure 14. Catch rates of benthic organisms (bycatch) in bottom trawl hauls during the 2014 SI_Arctic cruise.

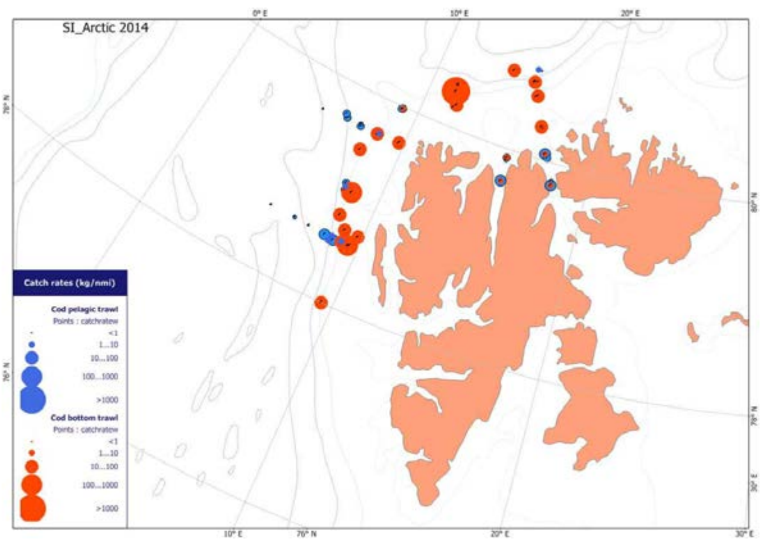


Figure 15. Catch rates of cod in pelagic (blue) and bottom (red) trawl hauls.

Fish species caught at the various transects made during the survey

At section #1 trawl hauls were only conducted at the beginning and end of the section, which started outside Isfjorden at about 78˚N and went along the coast up to about 79˚30'N. Therefore, fish distribution cannot be determined based on trawl hauls along this section.

The Fram Strait north section (section #2) went from the shelf at about 79˚30'N towards the deep water of the Fram strait, and covered a large span of depths, from 300 to 1010 m for the bottom trawls and from 55 to 1085 m for pelagic trawls. The most shallow bottom trawl had about as much fish as benthos; 60 kg, but the benthos was totally dominated (99% of the biomass) by sponges (Geodia). The fish catch consisted of cod (60%), and redfishes, catfishes and a range of small non commercial species. The pelagic trawl haul at the shallow end of the section was small (< 3 kg) and was totally dominated by 0-group fish. The next bottom trawl station at about 500 m depth caught about 110 kg of fish (73%) and benthos (27%). Also in this haul the benthos was dominated by poriferas, while the fish catch was dominated by cod, redfish, and Greenland halibut. In a pelagic haul in 357 m depth where the bottom depth was 500 m gave a catch of 4 adult cod, which totally dominated the catch that also contained some plankton and jellyfishes. Further out, at about 800 m depth, the bottom trawl caught fish and benthos in the ratio 40/60, and the total catch was about 120 kg. The fish catch mostly consisted of Greenland halibut, in addition to skates, eelpouts etc. The benthos fraction was dominated by brittlestars and sponges. In a pelagic haul in 450 m in the same position, only about 3 kg of fish and plankton was caught. However, among the fish catch was one adult cod.

Still further out, at about 1000 m depth, 15 kg of fish and 18 kg of benthos was caught in the bottom trawl. The fish fraction was dominated by skates and some Greenland halibut, and contained some sculpins, eelpouts and other deepwater species. The benthos bycatch consisted of large amounts of sea stars and brittle stars, in addition to other benthos groups.

At this point, a pelagic haul in the upper layer caught only early life stages of fish and some plankton. At the outer end of this section, at a bottom depth of about 1800 m, the bottom trawl could not be used because the trawl wires were not sufficiently long. A pelagic trawl (Åkratrawl) was set at about 1100 m, and the catch of about 2.5 kg was dominated by cephalopods, jellyfishes and cnidarians. The only fish species caught was some Glacier lanternfishes and some Black seasnails. Sea ice prevented a further extension of this section.

From the outer station of the Fram strait north section (section #2), courses were made along the ice-edge northeastwards, to get as far north and east as possible. This section was named #3. Along this track a few trawl stations were made: At 480 m depth a bottom trawl haul and a 0-group haul with the Harstad trawl were made. In the bottom trawl about 92 kg of fish (60%) and benthos (40%) was caught. The fish mostly consisted of cod, redfish, Greenland halibut, and long rough dab, while the benthos consisted almost entirely of deep sea prawns. In the 0-group haul a mixture of plankton (66%) and 0-group redfish (33%) was caught. Another set of trawl stations were made further to northeast at a steep slope at 200 and 480 m depth (station 16-17). The shallowest haul gave a large catch (1380 kg) where fish made up

99%. Cod dominated with a catch of 1280 kg, and in addition some haddock and catfishes were found. The benthos catch mostly consisted of sponges. The deepest bottom trawl station only gave a catch of 27 kg of fish (cod and beaked redfish) and 9 kg of benthos (sponges and deep sea prawns). The pelagic trawl at this site mostly caught amphipods and a few 0-group fish in the upper layer.

A new section; Hinlopen (section 4) was started within drift ice in position 80˚48'N, 15˚27'E, at 1800 m depth, and went in southeastern direction to end inside the Hinlopen Strait. The first pelagic trawl station (no 19), which fished in the upper 50 m caught 4 adult cod (60-90 cm) and a mixture of krill and amphipods. The outermost bottom trawl station (no 21) at 480 m depth gave a catch of 120 kg, of which 90% were fish (cod and redfish). The benthos fraction mainly consisted of deep water prawns and sponges. The next pelagic (0-group) station at 500 m (no 23) gave a catch of almost entirely plankton (krill and amphipods). A deeper pelagic haul nearby (no 24) at 190 m depth showed a similar mixture of krill and amphipods. Further up the slope, at about 300 m depth, one bottom trawl haul (no 25) and one 0-group haul (no 26) were made. The bottom trawl gave about 50 kg catch, 40% benthos and 60% fish. The dominating benthos in terms of biomass was deep sea prawns, and the fish catch consisted of cod, beaked redfish and Greenland halibut. Continuing along the section towards Hinlopen Strait, one bottom trawl (no 27) and one 0-group trawl (no 28) were set at bottom depth of 350 m. The total catch was about 110 kg, and fish consisted of about 70%. Dominating fish species were cod, beaked redfish, catfish and long rough dab. The benthos catch was dominated by deep water prawns. The 0-group trawl caught amphipods only.

At the northern opening of the Hinlopen Strait a bottom trawl haul (no 29) and an 0-group trawl haul (no 30) were made at about 370 m bottom depth. At the bottom about 180 kg of fish (20%) and benthos (805) were caught. The benthos catch was totally dominated by deep water prawns, while the fish catch was dominated by Greenland halibut, long rough dab, and skates. At the 0-group station, a mixture of krill and amphipods were caught, together with a few 0-group fish.

Two stations, one bottom trawl (no 31) and one deep pelagic (no 32), formed the inner end of this section, at position 79˚48'N, 18˚04'E. The bottom trawl caught 225 kg of benthos (83%) and fish (17%). The benthos catch was totally dominated by crabs (Hyas) and deep water prawns, while the catch of fish consisted of Greenland halibut, catfishes, and eelpouts. The pelagic haul caught some few small-sized cod, together with krill, amphipods, jellyfishes and deep water prawns.

Wijdefjorden transect (section 5) started inside Wijdefjorden and crossed the shelf in a northern direction. It was meant to end up in deep water, but was limited by ice in the north. At the inner end of this section a bottom trawl haul (no 35) was made in quite shallow waters (135 m). Here, the catch of about 200 kg consisted of fish (60%) and benthos (40%), and the benthos was dominated by deepwater prawns and sea stars. The fish catch consisted of polar cod, snake blennies and eelblennies, as well as long rough dab. At the outer end of the section another bottom trawl haul was made, at bottom depth 320m (no 36). The catch of 360 kg was totally dominated by sponges (347 kg) and the fish catch, containing mainly cod, only amounted to 13 kg.

The Fram Strait south section (section 6) went from the shelf into deep water at about 78˚30'N. The water depth at the inner station (no 45) was about 125 m and at the outermost station (no 57) about 2300 m. A bottom trawl at the inner station yielded about 127 kg of fish and 1 kg of benthos. The fish catch consisted of 64 kg of cod and 54 kg of haddock, and in addition some catfishes and beaked redfish. The benthos consisted of a large number of animal groups, all in small quantities.

Another bottom trawl set at 200 m (no 46) was also totally dominated by fish; 147 kg versus 3 kg of benthos. Again; cod dominated together with haddock and spotted catfish. A large diversity of benthic animals was found, all in small quantities.

A third bottom trawl (no 47) at 300 m was quite similar to these two. The total catch of 136 kg consisted of 128 kg of fish, totally dominated by cod, and 8 kg was benthos, mainly deep water prawns.

At a bottom depth of about 500 m, three hauls were made; an 0-group haul (no 48), a bottom trawl (no 49) and then a deep pelagic haul with Åkratrawl (no 50). The catch of about 3 kg in the 0-group haul consisted of various 0-group fish species and some jellyfishes. The bottom trawl haul consisted of 47 kg of fish and 18 kg of benthos. The fish catch was dominated by cod and Greenland halibut, while the benthos was dominated by sponges. The deep pelagic trawl (fishing depth 450 m) was totally dominated by cod, together with some jellyfishes (Perifylla).

Further out, at about 800 m depth, a bottom trawl (no 51) and a deep pelagic trawl (no 52) were deployed. The catch from the bottom trawl contained 546 kg of sponges and 23 kg of fish, mainly blue whiting. The deep pelagic trawl, fishing in the mesopelagic layer at 400-450 m, mainly caught 11 kg of cod, and 4 kg of jellyfishes (Perifylla).

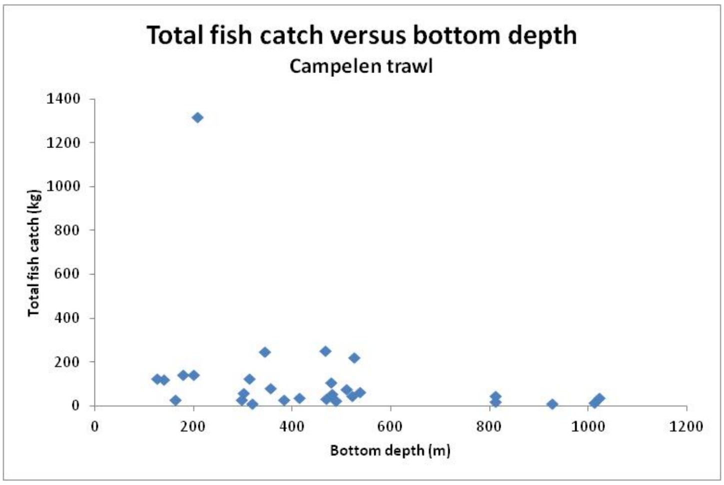
The next bottom trawl (no 53) was set at 1023 m depth, and caught 40 kg of fish and 115 kg of benthos. The fish catch mainly consisted of Arctic skates and Greenland halibut, while the benthos was dominated by brittle starts (53 kg), sponges (26 kg) and sea stars (20 kg). A deep pelagic haul nearby (no 54), set at 330-430 m fishing depth, caught two cod weighing about 6 kg together, and a small amount of plankton organisms.

It was not possible to deploy the bottom trawl at deeper waters because of limited amount of wire, so the last three hauls were made with Åkra trawl. These were set at 450 m fishing depth over 1500 m bottom depth (no 55), at 430 m fishing depth over 2000 m bottom depth, and finally at 820 m fishing depth at 2300 m bottom depth (no 57).

The first of these hauls gave a very small catch (about 0.5 kg) and consisted mainly of plankton and some few lanternfishes. Some 0-group fishes in the catch probably entered the trawl when this was hauled through the upper layer. The second haul also had a small catch consisting of various plankton organisms including cnidarians and jellyfishes, in addition to some lanternfishes. The final trawl station, fishing at 820 m, yielded 6 Black seasnails and one capelin, but the capelin had probably entered the trawl at shallower depth than the main fishing depth. In addition some few plankton organisms were found.

Trends in fish biomass caught in the Campelen trawl versus depth

There is seemingly no clear trend in amount of fish caught in the Campelen trawl by depth (Figure 16 upper panel). However, one catch, trawl no 16, where 1.3 tonnes of cod were caught, is masking any signals in the scatterplot. When this catch was removed from the dataset, a clear downward trend with bottom depth was seen (Figure 16 lower panel). However, the relationship between catch and depth is not statistically significant at the 5% level (p=0.07) and only 13% of the variation in catch is accounted for by the regression.



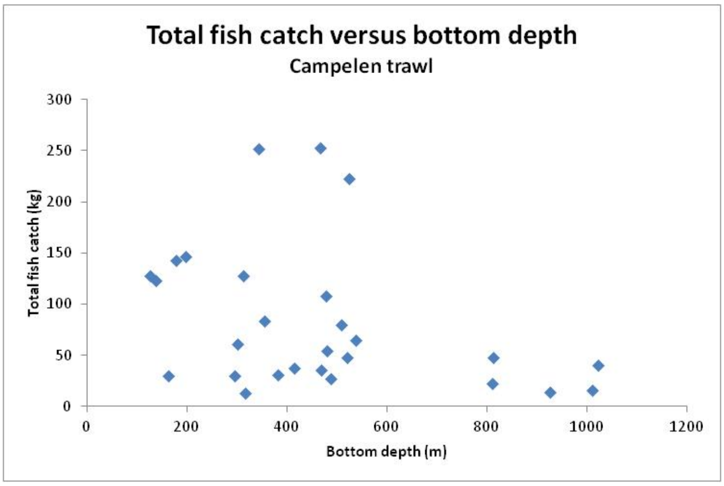


Figure 16. Total fish catch versus bottom depth (upper). Lower figure show the same excluding the haul where 1.3 tonnes of cod were caught.

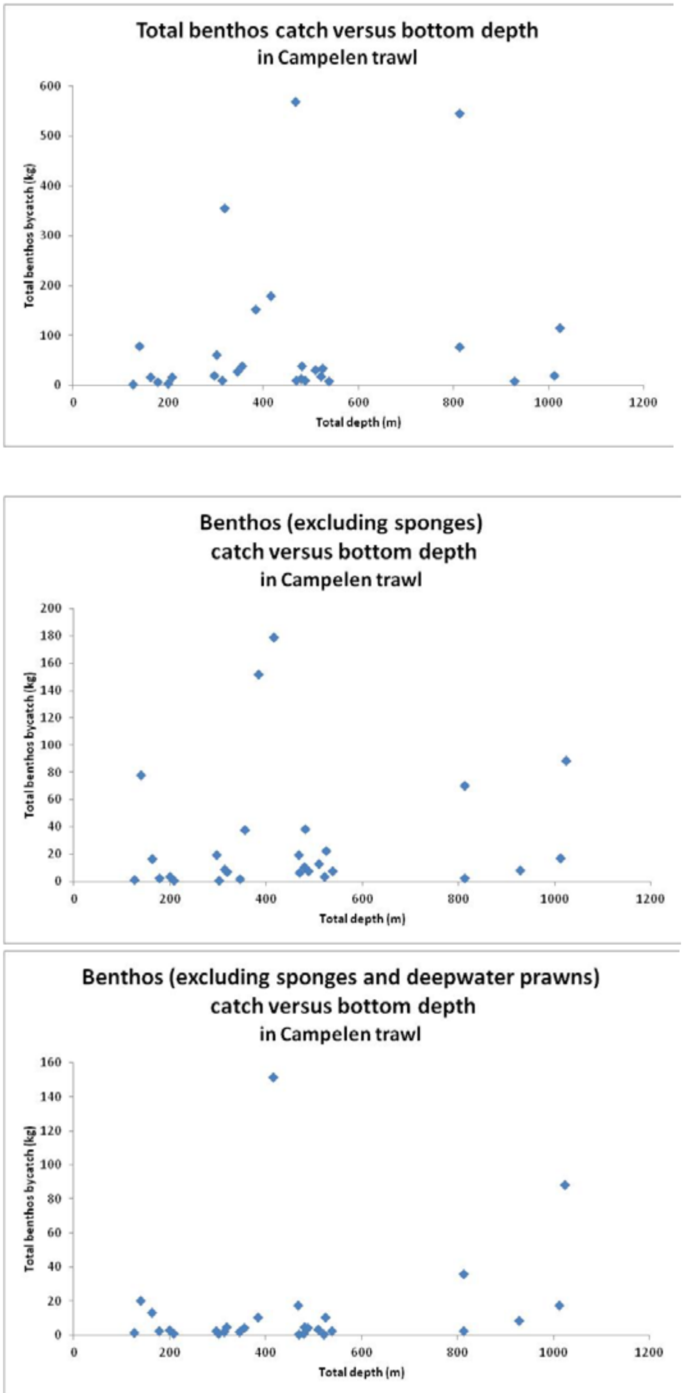


Figure 17. Total benthos catch versus bottom depth in Campelen trawl (upper). Midle figure show the same excluding sponges and lower figure show the same excluding sponges and deepwater prawns.

<u>Trends in the benthos biomass caught in the Campelen trawl versus depth</u>

A similar analysis was conducted for the benthos bycatch data. No trend can be seen for these data (Figure 17 upper panel). Since sponges made up a very large proportion of some of the catches, the sponges were removed from the catches and the data plotted again (Figure 17 middle panel). This had some effect on the data but still no clear trends could be seen. Then all deep sea prawn catches was also removed (in addition to the sponges) since also deep sea prawn is very dominating in some catches (Figure 17 lower panel). A possible weak positive trend with depth can now be seen. Still there is one outlier in the plot, (trawl no 31). This haul was characterized by a very large catch (150 kg) of Hyas crabs, a species hardly seen in any other catch. If this haul had been removed from the dataset, a positive trend with depth would probably emerge. However, this exercise has not been done.

Trends in the fish biomass caught in the Campelen trawl versus bottom temperature

When the total fish catch is plotted versus the temperature at the bottom, a positive trend is seen (Figure 18 upper panel). However, also in this case the big cod catch is an outlier. Removing this, point makes a clear trend visible (Figure 18 lower panel). A linear regression analysis was ran on this reduced dataset, and it was highly significant (N= 26, p = 0.002), suggesting that there is a positive relationship between bottom temperature and catch rates of fish in this area.

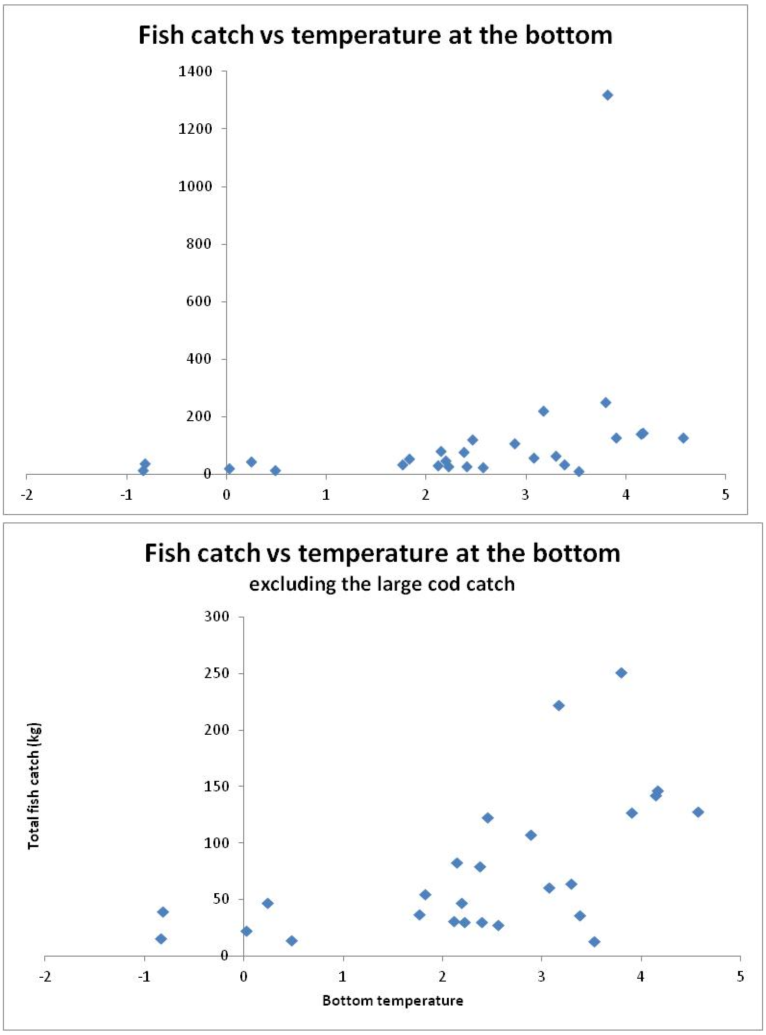


Figure 18. Fish catch versus temperature at bottom (upper). Lower figure show the same excluding the haul where 1.3 tonnes of cod were caught.

Benthos

Location of the Campelen stations is shown in Figure 4. The Fram Strait south section (section 6) from 126 m to 2023 m depth (from the shallowest st.2044, 2045, 2046, 2049, 2051, to the deepest station 2053) showed relative low abundances and biomass at the shallowest station, a strong increase in abundance at 187 m and a increase of both abundance and biomass on the two deepest stations (Figure 19). The shallow station 2046 (187 m depth) had high abundances of Ascidiaceans, brittle stars (*Ophiopholis aculeata*) and sea urchins (*Strongylocentrotus pallidus*). In the deeper parts of the transect (Station 2051 at 804 m), the *Geodia* sponges dominated in biomass (catch of 540kg) and in abundance, while by *Gorgonocephalus* basket stars in biomass. Station 2053 (1023 m) was dominated in biomass by the basket star (*Gorgonocephalus ecnemis* and *G. acticus*), the *Haliclona* sponge and the seastar *Bathybiaster vexillifer*. In abundance the seastars *Pontaster tenuispinus* and *Bathybiaster vexillifer*, the brittlestar *Ophioscolex glacialis*, sea spiders, prawns (*Pasiphaea* sp) and large amphipods (*Cleippides quadricuspis*) dominated. A total of 32 individuals of sea pen *Umbellula encrinus* were taken at this station. These individuals measured up to 210 cm high.

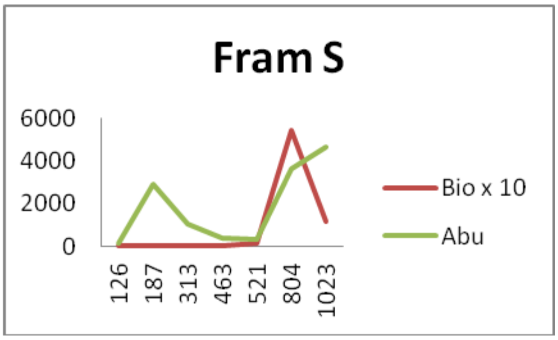


Figure 19. Fram Strait south section. Benthos (*Pandalus borealis* excluded) biomass and abundance of 15 minutes Campelen trawling in the southern Fram transect from 126 to 1023 meter depth.

Figure 19 stations:

Station	Depth	Sp no	Biomass	Abun.
2045	126	43	1,24	198
2046	187	37	3,29	3189
2047	313	37	8,71	2304
2044	463	52	10,19	1491
2049	521	33	18,04	937
2051	804	40	**545,72**	3623
2053	1023	40	115,16	4653

Samples from deep station 2051 at 804m depth.

Geodia sponges.

Gorgonocephalus basket stars.

Catch of the brightly red prawn *Pasiphaea* sp, amphipoda, sea cucumber, sponges, arms of sea star and *Gorgonocephalus*.

The Fram Strait north section (section 2) showed high biomass and abundances on the shallow station (station 2005, 298 m). The biomass was totally dominated by sponges (particularly *Geodia*) while the abundance by the brittle star *Ophiopholis aculeata*, the crangonid crustacean *Sabinea septemcarinata*, the small sponge *Tethya norvegica* and the sea star Henrisia sp. The brittle star *Ophioscolex glacialis*, the crangonid crustacean *Sclerocrangon ferox*, the sea star *Pontaster tenuispinus*, the sea cucumber *Molpadia borealis* and the prawn *Bythocaris* sp dominated the abundance (Figure 20). At the deeper stations (2009 and 2011) the *Gorgonocephalus arcticus* dominated the biomass at the 800 m, while the sea star *Bathybiaster vexillifer* at 1000 m depth. The same species dominated in abundances as on the 800 m station in addition to sea spiders and ascidiaceans.

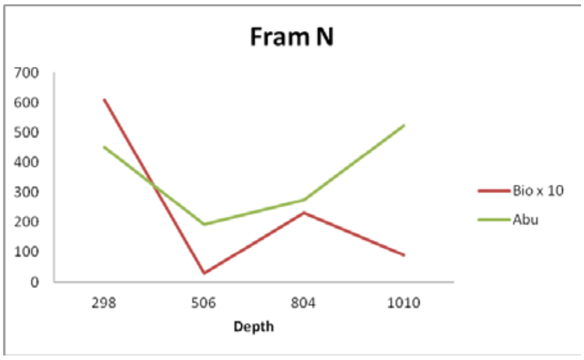


Figure 20. Fram Strait north section. Benthos (*Pandalus borealis* excluded) biomass and abundance of 15 minutes Campelen trawling in the Fram Strait north section from 298 to 1010 meter depth

Figure 20 stations:

Station	Depth	Sp no	Biomass	Abun.
2005	298	52	64,74	910
2007	506	53	5,29	661
2009	804	63	23,98	274
2011	1010	43	9,44	523

At the North-West depth transect (from 200 to 500 m) the sponges either dominated totally (station 2016) or was a major contributor to the dominant biomass together with ascidians (st 2017 at 487 m), or the brittle star *Ophiura sarsi* and the sea lilies *Poliometra prolixa* (the shallowest station 2037) (Figure 21). The abundances were dominated by Ophiura sarsi, Poliometra prolix, the sea anemone *Hormathia digitata* and *Strongylocentrotus pallidus* at the shallow St 2037, while by *Ophiopholis aculeata*, *Tethya norvegica* and ascidians at 2016 and by ascidians (and *Pandalis borealis* = excluded from the data treatment) on st 2017.

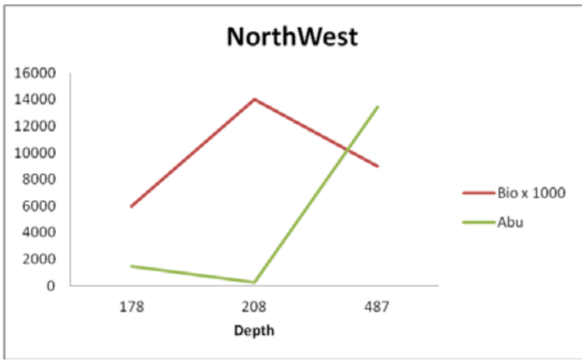


Figure 21. The North Western shelf transect. Benthos (*Pandalus borealis* excluded) biomass and abundance of 15 minutes Campelen trawling in the North Western transect from 178 (station 2037), 208 (st 2016) and 487 (st 2017) meter depth.

Figure 21 stations:

Station	Depth	Sp no	Biomass	Abun.
2037	178	57	6,41	1527
2016	208	41	14,55	279
2017	487	34	16,30	14768

The outer part of Wijdefjorden was dominated by the sea urchin *Strongylocentrotus pallidus*, (*Pandalus borealis*) and ascidians, and small *Ophiura sarsi* (st 2033 at 162 m) (Figure 22). The inner part of the fjord was dominated by (*Pandalus borealis*) the echinoderms *Ctenodiscus crispatus* and *Gorgonocephalus* basket stars. At the shelf break north of Wijdefjorden at 313 meter depth, sponges totally dominated the biomass while three species of prawns and 4 species of brittle stars dominated the abundances.

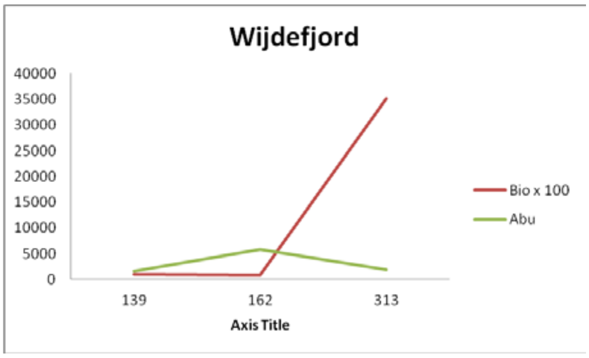


Figure 22. Wijdefjorden section. Benthos (*Pandalus borealis* excluded) biomass and abundance of 15 minutes Campelen trawling in the Vidjefjorden section from 139 to 313 meter depth.

Figure 22 stations (including Pandalus borealis)

Station	Depth	Sp no	Biomass	Abun.
2035	139	27	38,85	8901
2033	162	42	12,25	6353
2036	313	23	354,51	2286

A typical catch from "shallow" waters with *Ophiura* brittelestars, *Ctenodiscus seastars*, sea anemons.

All, except one, stations in, and north of, the Hinlopen strait were dominated by *Pandalus borealis* (>50% of the biomass) followed by the sea star *Ctenodiscus crispatus* and the brittle star *Ophiura sarsi* (Figure 23). In the central deeper part of the strait the catch was dominated by *Hyas* crabs. On the slope north of Hinlopen at stations 2027 (317m) and 2025 (297 m) and at the continental slope-break at 400 m, beside the dominants of *Pandalus borealis*, there was a high standing stock of the echinoderms *Ophiura sarsi* at the shelf stations while *Ophiopholis aculeata* on the deep slope (st 2021) facing toward the Arctic Ocean, *Ctenodiscus crispatus* and *Strongylocentus sps*, and many individulas of sea spiders were other dominant benthic animals (Figures 24-28).

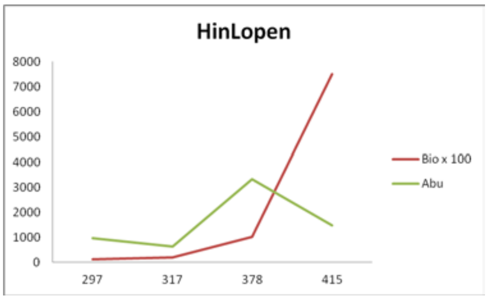
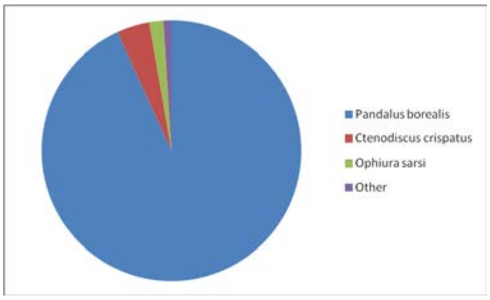


Figure 23. Hinlopen section. Benthos (*Pandalus borealis* excluded) biomass and abundance of 15 minutes Campelen trawling in the Hinlopen transect from 139 to 313 meter depth.

Figure 23 Hinlopen stations:

Station	Depth	Sp no	Biomass	Abun.
2025	297	45	12	2163
2027	317	62	15	3281
2029	378	29	152	28039
2031	415	16	90	3792



Figue 24. The quantitative distribution of the species at station 2029 in Hinlopen.

Hyas crabs from inner Hinlopen strait.

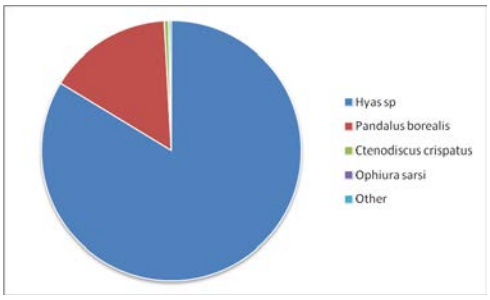


Fig 25. Quantitative distribution of benthos (in biomass) in the innermost station 2031 (415m) of the Hinlopen strait.

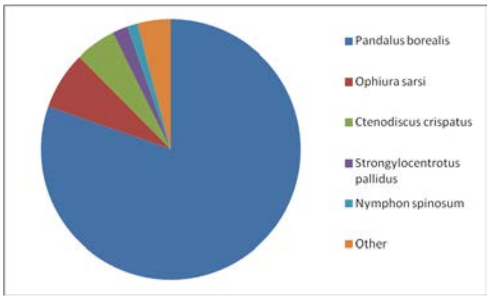


Figure 26. Quantitative distribution of benthos (in abundance) at the shelf station 2027 (317 m depth), north of Hinlopen.

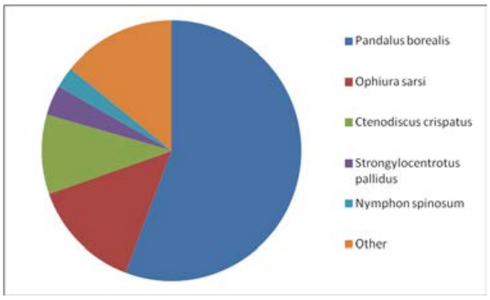


Figure 27. Quantitative distribution of benthos (in abundance) at the shelf station 2025 (297 m depth), north of Hinlopen.

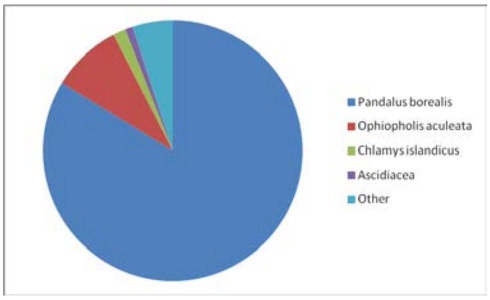


Figure 28. Quantitative distribution of benthos (in abundance) at the shelf break station 2021 (422 m depth), north of Hinlopen.

South (~78,5º) to north (~79,5º) shallow (187-344m) transect. At the transect from south to northern part of west Svalbard the highest abundances was recorded in the south (Ascidiacea, *Ophiopholis aculeata* and *Chlamys islandicus*), while the largest biomass in the north (totally dominated by sponges, see description of Fram N). (Figure 29).

South (78º) to north (~79,5º) medium depth (463-539 m) transect. Excepth for station "5" (st 2043 at 539 m depth) dominated in biomass by sponges and many individuals of *Ophiupholis aculeata*, the abundances and biomass was relatively even along the transect (Figure 30).

South (~78,5º) to north (~79,5º) deep (804-1010 m) transect. The southern stations had higher biomass and abundances compared to the northern stations. *Geodia* sponges, octo-corals (*Drifa glomerata*) and crangonid crustaceans (*Sclerocrangon ferox*) dominated in abundance while sponges, *Gorgonocephalus*, sea stars (*Tylaster willey*) and cephalopods (*Bathypolypus arcticus*) dominated the biomass at the most southern station (st 2051 at 804 m depth), while the seastars *Pontaster tenuispinus*, *Bathybiaster vexillifer* and sea spiders and amphipods dominated in abundance at the next station toward the north (st 2053 at 1023 m depth) together with *Gorgonacephalus* and sponges in biomass (Figure 31).

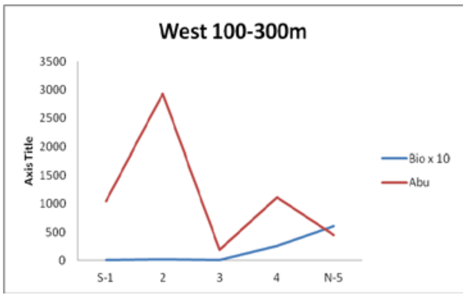


Figure 29. Transect from south (~78,5º) to north (~79,5º) for shallow (187-344m) areas (*Pandalus borealis* excluded). S-1 = st 2047, 2 = st 2046, 3 = st 2045, 4 = st 2042, and N-5 = st 2005.

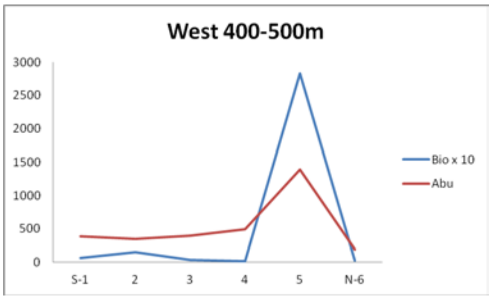


Figure 30. Transect from south (78º) to north (~79,5º) for intermedian depth (463-539 m) areas (*Pandalus borealis* excluded). S-1 = st 2001, 2 = st 2049, 3 = st 2044, 4 = st 2043, 5 = st 2004 and N-6 = 2007.

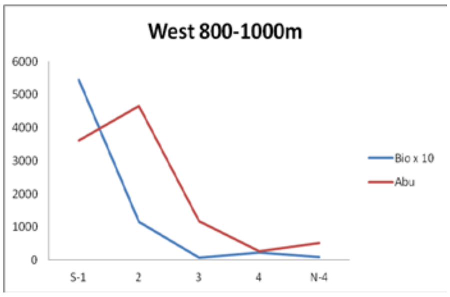


Figure 31. Transect from south (~78,5º) to north (~79,5º) for the deepest depths covered (804-1010 m) areas (*Pandalus borealis* excluded). S-1 = st 2051, 2 = st 2053, 3 = st 2039, 4 = st 2009, N-4 = 2011.

Deep station catch: *Gorgoncephalus* (orange), fish (Greenland halibut among other fish), sponge, sea cucumber and the giant carnivorous club sponge *Chondrocladia gigantea* with deflated “clubs”.

Marine mammals

During the survey all together 37 blue whales, 37 fin whales, 21 humpback whales, 22 minke whales, 7 unidentified large whales (including sperm whales), 1 killer whale, 42 white-beaked dolphins, 61 small unidentified delphinidae, 10 harp seals, 5 bearded seals, 1 ringed seal were observed. The spatial distribution of these sightings is shown in Figure 32.

The general picture is that observations were more frequently made in the northern, partly ice covered area than in open water (Figure 32), and with different species present in the marginal ice zone compared with in open water. Also evident are two “hot spots” north of Svalbard (shown by circles in the figure) where numerous marine mammals were observed.

The northernmost of the “hot spots” was located on the shelf break on the north of Hinlopen. In this region 17 blue whales, 2 humpback whales, 3 minke whales, 2 fin whales and 1 harp seal were observed. All these observed mammal species are known to feed intensively on zooplankton, krill in particular, during summer and autumn. The location was partly ice covered but with intense life in leads and openings in the ice. The acoustic backscatter showed a layer of high zooplankton concentration in this region between 300 and 500 m depth (Figure 11D) and the plankton net hauls confirmed the presence of large amounts of zooplankton in the region. The high concentrations of zooplankton (and consequently) mammals are likely linked to topography and ocean currents. The “hot spot” was located in a pronounced topographic feature (called Magdalenadjupet). In this region the topography forms an underwater ridge towards north-east on the shelf-slope which steers the Atlantic current and is likely to both possibly form eddies and give retention of the water masses. In addition the slope (within Magdalenadjupet) is extremely steep and there is a canyon cutting into the shelf-break. The canyon continues southward (southeastwards) into Hinlopen. Due to the complex topography the region is likely influenced by strong currents with pronounced lateral gradients, different water masses and possibly upwelling along the shelf-break.

The other “hot spot” was located at the same section but further to the south at the mouth and within Hinlopen (Figure 32). In this area we observed 5 blue whales, 9 humpback whales, 2 minke whales, 4 fin whales and 2 unidentified large whales. There was no ice in the area. The acoustic backscattering showed moderate amounts of plankton mostly in the upper 50 m with scattered patches of moderate zooplankton amounts also occurring in the 200 to 350 m depth zone (Figure 11D).

Table 3 shows all sightings sorted into three different regions. Most animals were found in the southern Fram Strait (south of 79^{o}N), and the dominating species in this region were the white-beaked dolphin and small unidentified delphinidae. These species occurs in groups giving a high number of animals despite a moderate number of sightings. Individuals of all other observed whale species were also present, with the fin whale. No seals were observed in this region.

Few sightings were made in northern Fram Strait (79^{o}N-80^{o}N), primarily fin whales.

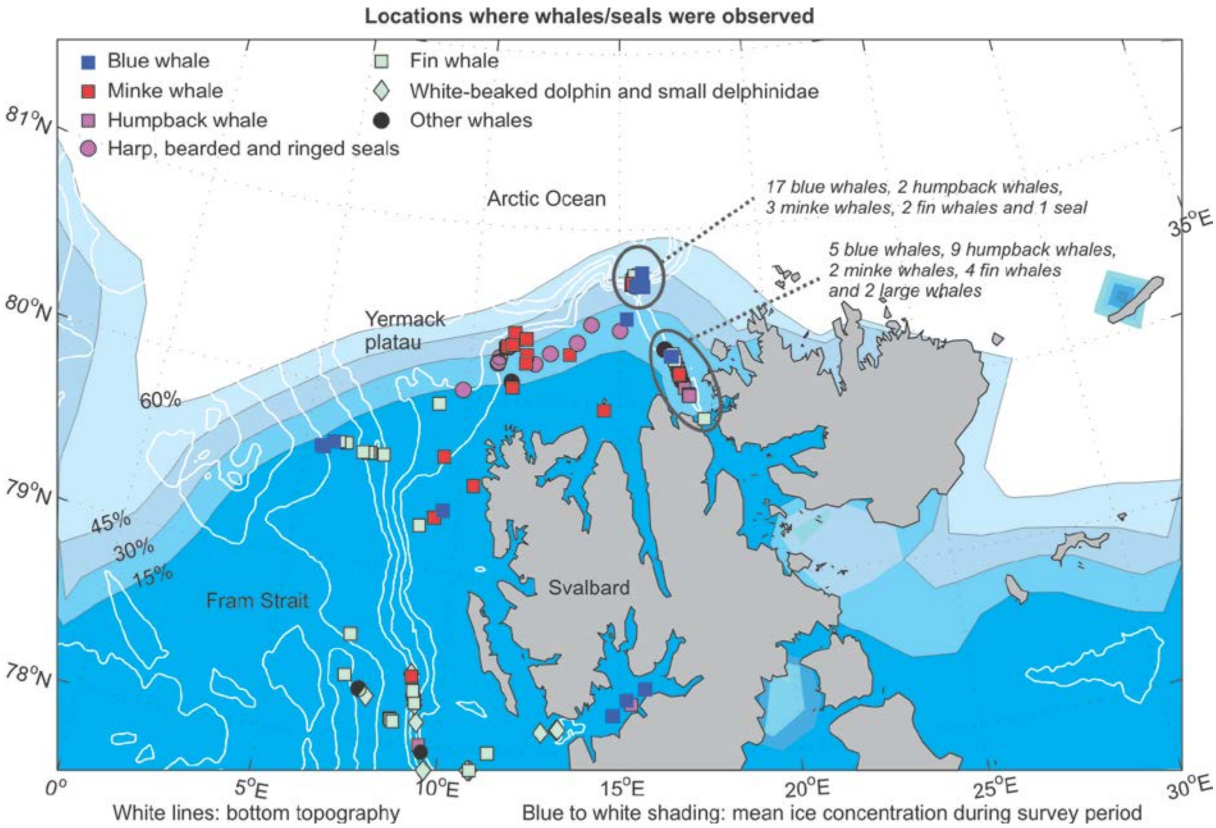


Figure 32. Locations where groups of whale and seal species were observed. Each location denotes a sighting. For some of the sightings several animals were part of the observation.

Table 3. Visual observations of marine mammals sorted by three regions, to the south of 79°N, between 79-80°N and to the north of 80°N.

Species	**South of 79°N**		**79°N-80°N**		**North of 80°N**	
	Sightings (#)	Animals (#)	Sightings (#)	Animals (#)	Sightings (#)	Animals (#)
Blue whale	3	3	4	5	19	29
Minke whale	2	2	4	4	16	16
Fin whale	9	16	10	13	5	8
Humpback whale	2	2			11	19
Other whales	2	2			5	6
White-beaked dolphin	7	42				
Small delphinidae	8	61				
Harp seal					7	10
Bearded seal					4	5
Ringed seal					1	1
Total	**33**	**128**	**18**	**22**	**68**	**94**

There were a substantially more sightings in the partly ice covered region north of 80^{o}N than further south (Figure 32 and Table 3). All whale species were observed, with blue whale dominating, but there was also a substantial amount of minke whales and humpback whales. This is also the only region where we observed seals (in the marginal ice zone). No white-beaked dolphins nor small delphinidae were observed in the northern region.

Sea birds

In 2014, a total of 22 966 birds belonging to 18 different species were counted (Table 4). Similar to previous surveys, the three most common auk species were found in a gradient from the coast: Atlantic puffin mostly inshore or close to the coast, Brünnich's guillemots further offshore and Little auks far offshore into the West-Spitsbergen Current (Figure 33). The density of auks was considerably higher in 2014 than the previous years (Table 4). Notably, Ivory gull and Glacous Gull were also more common in 2014. Arctic tern was relatively rare in 2014. As in previous years the ship-followers were dominated by Northern fulmars, with a relatively uniform distribution (Figure 33). Kittiwakes have a more eastern distribution and are generally found in high densities east of Spitsbergen. Accordingly, the number of Kittiwakes observed in 2014 was relatively low, possibly due to the lack of coverage in the eastern areas.

Table 4. List of species encountered during the surveys in 2012, 2013 and 2014.

English name	Scientific name	2012	2013	2014
Little auk	*Alle alle*	315	89	546
Purple sandpiper	*Calidris maritima*	0	1	5
Black guillemot	*Cephus grylle*	37	33	190
Atlantic puffin	*Fratercula arctica*	50	136	404
Northern fulmar*	*Fulmarus glacialis*	15671	20150	19551
Glaucous gull*	*Larus hyperboreus*	896	226	1362
Great black-backed gull*	*Larus marinus*	1	0	13
Ivory gull	*Pagophila eburnea*	2	1	110
Black-legged kittiwake	*Rissa tridactyla*	1056	506	228
Long-tailed skua	*Stercorarius longicaudus*	0	1	2
Arctic skua	*Stercorarius parasiticus*	11	6	9
Pomarine skua	*Stercorarius pomarinus*	7	28	4
Great skua	*Stercorarius skua*	4	6	4
Unident. Skua	*Stercorarius sp.*	0	0	2
Arctic tern	*Sterna paradisaea*	245	203	16
Common guillemot	*Uria aalge*	0	0	1
Brünnich's guillemot	*Uria lomvia*	465	246	516
Unspec. guillemot	*Uria* spp.	0	0	3
Total		18760	21632	22966

*Ship-follower

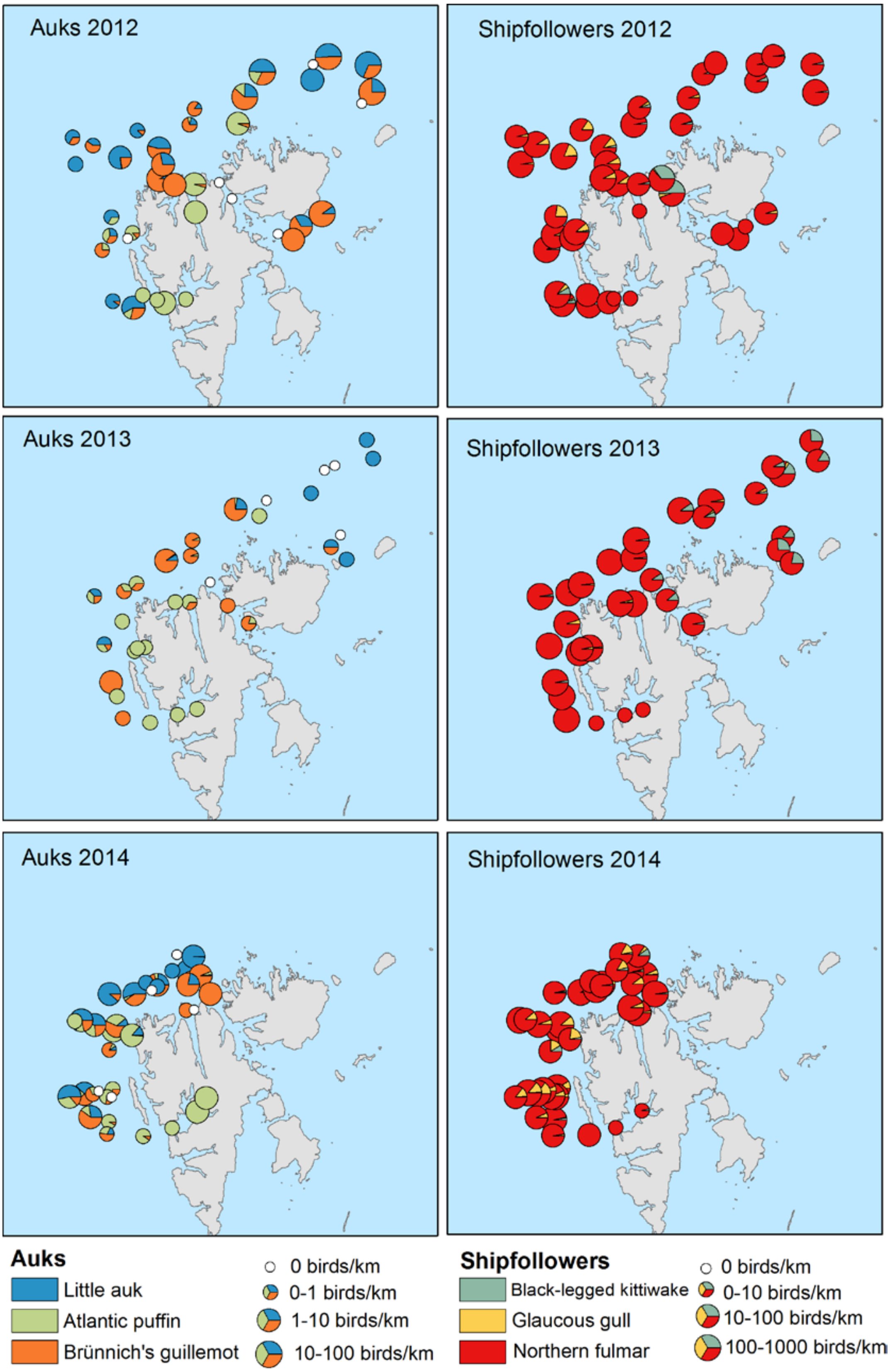


Figure 33. Seabird observations in 2012, 2013 and 2014. Left panel; distribution of the most common auks, right panel; distribution of the most common ship-followers.

Discussion

The first SI_ARCTIC survey was conducted with R/V Helmer Hanssen 19 August-7 September 2014. The survey covered the region west and north of Svalbard in open and party ice covered waters. Due to heavy ice conditions the survey coverage on the northern side of Svalbard was less than planned. During the survey all parts of the marine ecosystem was sampled including physical, chemical and biological oceanography (temperature, salinity, currents, fluorescence, oxygen, nutrients and chlorophyll). Phytoplankton and zooplankton (species abundance and biomass), fish (species abundance, biomass, age and stomach samples, and benthic organisms (species abundance and biomass) were sampled using a multitude of different gear. Underway acoustic registration of fish and plankton (eco sounder) and ocean currents (ADCP), underway measurements of surface layer temperature, meteorology and sea state, and visual observations of marine mammals and birds were also conducted.

The results from the survey showed interesting differences between eastern Fram Strait and the region north of Svalbard regarding plankton, fish and marine mammals. The main results showed:

- Clear differences in physical environment and the species between eastern Fram Strait and the region north of Svalbard.
- Eastern Fram Strait was dominated by fish in the east and plankton in the west. There were not much whales or seals in this region.
- The region north of Svalbard was dominated by plankton (smaller animals than in Fram Strait), seals and whales. A number of blue whales were observed north of Svalbard.
- Cod was the dominant fish species (in the survey region). This was clearly influenced by the limited survey coverage.

The 2014 SI_ARCTIC survey was the first survey in ice covered waters with the combined aim of conducting both annual monitoring (the Barents Sea Ecosystem survey) and exploratory studies (SI_ARCTIC). While the annual monitoring approach calls for covering a predefined region with sufficient station grid and predefined gear in a synoptic way, process studies/exploratory studies calls for more detailed sampling with different gear, more time spend on station work (thus being less synoptic). Combining these two efforts in one survey turned out to be challenging. Other issues that was found to nessessary to focus on for future SI_ARCTIC surveys was 1) a need to improve sampling for fish in ice covered waters, 2) a need to reduce the number of pelagic trawls, and 3) a need to be able to sample deeper in the water column.

Acknowledgements

We gratefully acknowledge the assistance provided by the Captain and Crew of the R/V Helmer Hanssen. We are also grateful to Marit Reigstad, UiT, for borrowing the LADCP and Ilker Fer, UiB, and Angelika Renner, IMR, for their assistance with the LADCP data processing. The Research Council of Norway is thanked for the financial support through the projects “The Arctic Ocean Ecosystem” – (SI_Arctic, RCN 228896). The work is a contribution to the Barents and Norwegian Sea Ecosystem Programmes at IMR.

References

Beitsch, A., L. Kaleschke and S. Kern (2013), "AMSR2 ASI 3.125 km Sea Ice Concentration Data, V0.1", Institute of Oceanography, University of Hamburg, Germany, digital media (ftp-projects.zmaw.de/seaice/)

Bucklin, A., S.B. Smolenack, A.M. Bentley, and P.H. Wiebe, 1997. Gene flow patterns of the euphausiid, *Meganyctiphanes norvegica*, in the N. Atlantic based on DNA sequences for mitochondrial cytochrome oxidase I and cytochrome b. J. Plank. Res. 19:1763-1781.

Bucklin, A., P.H. Wiebe, O.S. Astthorsson, A. Gislason, L.D. Allen, and S.B. Smolenack, 2000. Population genetic variation of *Calanus finmarchicus* in Icelandic waters: preliminary evidence of genetic differences between Atlantic and Polar populations. ICES J. Mar. Res. 57:1592-1604.

Bucklin, A., Hopcroft, R.R., Kosobokova, K.N., Nigro, L.M., Ortman, B.D., Jennings, R.M., Sweetman, C.J.,. 2010. DNA barcoding of Arctic Ocean holozooplankton for species identification and recognition. Deep-Sea Research II 57: 40-48.

Bucklin, A., Steinke, D., Blanco-Bercial, L., 2011. DNA barcoding of marine metazoa. Annu. Rev. Mar. Sci. 3: 471-508.

Chu, D., 2004. The GLOBEC kriging software package—EasyKrig3.0, July 15, 2004. <http://globec.whoi.edu/software/kriging/easy_krig/easy_krig.html>.

Kaleschke, L., C. Lüpkes, T. Vihma, J. Haarpaintner, A. Bochert, J. Hartmann, G. Heygster. 2001. "SSM/I Sea Ice Remote Sensing for Mesoscale Ocean-Atmosphere Interaction Analysis", Can. J. Rem. Sens., 27(5), 526-537.

MacLennan, D. N., Fernandes, P. G., and Dalen, J. 2002. A consistent approach to definitions and symbols in fisheries acoustics. – ICES Journal of Marine Science, 59: 365–369.

Parent, G. J., S. Plourde, and J. Turgeon, 2011. Overlapping size ranges of Calanus spp. off the Canadian Arctic and Atlantic coasts: Impact on species’ abundances. J. Plankton Res. 33: 1654–1665, doi:10.1093/plankt/fbr072

Spreen, G., L. Kaleschke, G. Heygster (2008), "Sea Ice Remote Sensing Using AMSR-E 89 GHz Channels", J. Geophys. Res., 113, C02S03, doi:10.1029/2005JC003384.

Appendix A. Tables.

Table A1. Stations with all equipment conducted during the SI_ARCTIC 2014 survey. Position and bottom depth are averaged over position and bottom depth for each equipment deployment. Station number for the different equipment is given. More details for the equipment, isotop and genetic sampling are given in tables A3-A8.

Location	Date when starting	Latitude (average)	Longitude (average)	Bottom depth (m)	Ice cover	CTD with fluorescence and oxygen	LADCP	Nutrients and phytoplankton (water samples)	Phytoplankton net (0-30m)	WP2/Juday (twice, to bottom)	MIK	Multinet	Plankton trawl	Harstad trawl	Åkra Trawl	Campelen trawl	Beam trawl	Grab	Isotop samples (#)	Genetic samples zooplankton	Comment
Case 1	20.08	78,0038	9,4698	509	0	539		539	539	539			2002 (234m)	2003 (0-40m)		2001	2001 (3 replicates)	2001 (3 replicates)*	92	WP2, Plankton trawl	* Grab conducted when returing to position at 04.09
Along shelf break in Fram Strait	21.08	79,4856	8,0776	467	0											2004			10		
Fram Strait north section	21.08	79,6763	9,7289	302	0	540	540	540	540	540	540			2006 (55m)		2005			29	WP2, MIK, Harstad trawl	Arctic ecosystem station
	21.08	79,6629	9,0870	397	0	541	541	541													
	21.08	79,6695	8,5192	495	0	542	542	542	542	542	542			2008 (357m)		2007	2007		16	WP2, Juday, MIK	
	22.08	79,6682	7,9548	690	0	543	543	543													
	22.08	79,6803	7,5198	797	0	544	544	544	544	544	544			2010 (411m)		2009			15	WP2, Juday, MIK	
	22.08	79,6898	6,5122	1054	0	545	545	545	545	545				2012 (0-40m)		2011	2011		7	WP2, Juday	
	23.08	79,6517	5,5035	1581	0	546	546	546													
	23.08	79,6331	5,4088	2422	Ice/2	547	547	547	547	547		547			2013 (1086m)				8	WP2, Juday	
Along ice edge	24.08	79,9594	9,0401	476	Ice/1	548	548	548	548	548	548			2015 (0-40m)		2014	2014	2014	5	WP2, Juday, MIK	Arctic ecosystem station
	24.08	80,3354	11,4547	208	Ice/5	549	549	549	549	549						2016	2016		1		
	25.08	80,4089	11,4362	473	Ice/5	550	550	550	550	550				2018 (0-40m)		2017	2017			WP2	
Hinlopen section	25.08	80,8158	11,4362	1814	Ice/5	551	551	551	551		551	551	2020 (1185m)	2019 (0-40m)					9	MIK	
	26.08	80,7195	15,5072	1000	Ice/5	552	552	552													
Case 2	26.08	80,6873	15,5583	534	Ice/6	553	553	553	553	553		553	2022 (408m)	2023 (0-40m), 2024 (194m)		2021	2021 (3 replicates)	2021		WP2, Plankton trawl	
	27.08	80,5524	15,8997	309	Ice/6	554	554	554	554	554				2026 (0-40m)		2025					
	27.08	80,2896	16,7588	314	0	555		555	555	555				2028 (0-40m)		2027				WP2	
	27.08	80,0418	17,3814	388	0	556	556	556	556	556	556	556		2030 (0-40m)		2029			1	WP2, Juday, MIK	
	27.08	79,8034	18,0539	421	0	557	557	557	557	557				2032 (272m)		2031				WP2, Juday	
Wijdefjorden section	28.08	79,8974	15,3941	158	0	558	558	558	558	558				2034 (0-40m)		2033				WP2	
	28.08	79,6709	15,3965	135	0	559	559	559	559	559						2035				WP2	
	28.08	80,1702	15,4806	180	0	560	560	560	560	560										WP2	
	28.08	80,3018	15,0677	28	0	561		561													
	28.08	80,5021	14,5833	136	0	562	562	562	562	562										WP2	
	28.08	80,6303	14,2423	177	0	563	563	563	563	563										WP2	
	28.08	80,7128	14,1274	299	0	564	564	564	564	564						2036				WP2, Juday	
	29.08	80,7459	14,2133	494	0	565	565	565	565	565											
	29.08	80,7645	14,1914	644	6	566	566	566													
	29.08	80,7616	14,0306	730	Ice/6	567	567	567	567	567										Juday	
	29.08	80,7621	13,6034	1010	Ice/6	568	568	568		568										WP2	

Table A1 continues

Location	Date when starting	Latitude (average)	Longitude (average)	Bottom depth (m)	Ice cover	CTD with fluorescence and oxygen	LADCP	Nutrients and phytoplankton (water samples)	Phytoplankton net (0-30m)	WP2/Juday (twice, to bottom)	MIK	Multinet	Plankton trawl	Harstad trawl	Åkra Trawl	Campelen trawl	Beam trawl	Grab	Isotop samples (#)	Genetic samples zooplankton	Comment
14h CTD and LADCP station	29.08	80,7596	13,5989	1000	Ice/6	569	569														
	29.08	80,7627	13,6151	1005	Ice/6	570	570														
	29.08	80,7637	13,6855	962	Ice/6	571	571														
	29.08	80,7682	13,7581	941	Ice/6	572	572														
	29.08	80,7609	13,8461	846	Ice/6	573	573														
	29.08	80,7552	13,5888	984	Ice/6	574	574														
	29.08	80,7359	13,6135	876	Ice/6	575	575														
	29.08	80,7440	13,5598	954	Ice/6	576	576														
	30.08	80,7325	13,5255	922	Ice/6	577	577														
	30.08	80,7295	13,5201	912	Ice/6	578	578														
	30.08	80,7288	13,5542	880	Ice/6	579	579														
Along ice edge/Case 3	30.08	80,2299	11,8034	167	Ice/4	580	580	580	580	580	580			2038 (0-40m)		2037	2037 (3 replicates)	2037 (2 replicates)	56	WP2, MIK	
	30.08	80,0510	11,2053	215	Ice/4	581	581	581	581	581	581									WP2, MIK	
	30.08	80,2071	11,8601	281	0	582	582	582	582	582										WP2	
Along shelf break in Fram Strait	31.08	79,1071	8,1582	916	0	583	583	583	583	583				2040 (419m), 2041 (0-40m)		2039				WP2	Arctic ecosystem station
	01.09	79,0533	8,6041	315	0	584	584	584	584							2042					Arctic ecosystem station
	01.09	78,7957	8,6273	495	0	585	585	585	585							2043					Arctic ecosystem station
	01.09	78,7011	9,1314	471	0	586	586	586	586							2044			4		Arctic ecosystem station
	01.09	78,6908	9,7741	122	0	587	587	587	587							2045			1		Arctic ecosystem station
Fram Strait south section	01.09	78,5798	9,6228	189	0	588	588	588	588	588						2046				WP2	Arctic ecosystem station
	01.09	78,5987	9,4929	316	0	589	589	589	589	589	589					2047	2047	2047	1	WP2, MIK	Arctic ecosystem station
	01.09	78,5985	9,3812	413	0	590	590	590													
	01.09	78,5836	9,1680	515	0	591	591	591	591	591		591		2048 (0-40m)	2050 (449m)	2049	2049	2049		WP2	Arctic ecosystem station
	02.09	78,6042	8,7957	707	0	592	592	592													
	02.09	78,5832	8,7443	814	0	953	953	953	953	953					2052 (446m)	2051				WP2, Juday	
	02.09	78,5918	8,2645	1039	0	594	594	594	594	594	594				2054 (429m)	2053	2053	2053	1	WP2, MIK	
	03.09	78,6056	7,3625	1485	0	595	595	595	595	595					2055 (452m)					WP2	
	03.09	78,6117	6,6572	2083	0	596	596	596	596	596					2056 (430m)					WP2	
	03.09	78,6161	5,4057	2216	0	597	597	597	597	597	597				2057 (821m)					WP2, MIK	

Table A2.Participation list.

Name	Expertise	Institution
Randi Ingvaldsen	Cruise leader	IMR
Lars Johan Naustvoll	Phytoplankton	IMR
Tor Knutsen	Zooplankton	IMR
Peter Wiebe	Zooplankton – acoustics	WHOI
Ann Bucklin	Zooplankton – genetics	University of Connecticut
Harald Gjøsæter	Fish	IMR
Thomas de Lange Wenneck	Fish	IMR
Hildegunn Mjanger	Fish	IMR
Gunnar Langhelle	Fish – taxanomi	Bergen Museum
Lis L. Jørgensen	Benthos	IMR
Denis Zakharov	Benthos – taxanomi	PINRO
Raquel Pereria	Benthos - sponges	University of Bergen
Gunnar Rikhardsen	Marine mammals observer	IMR
Ole Dyping	Marine mammals observer	IMR
John Ford	Sea birds observer	NINA
Magnar Mjanger	Instrumentation	IMR
Gunnar Lien	Instrumentation	IMR

Table A3. Zooplankton genetics samples

Responsible Person	Date	Station	Net System	Depth Interval sampled (m)	Species/sample description	Number of Individuals or vials	Bottle Type	Preservation	Tow Start Time GMT	Tow End Time GMT	Start Latitude	End Latitude	Start Longitude	End Longitude	Station	Comments
Bucklin	20.aug.14	2002	Plankton Trawl	0 - 234	Meganyctiphanes	5	CV	-80C	232,358356	232,383669	78,02332	78,05018	9,4423846	9,3965024	2002	
Bucklin	20.aug.14	2002	Plankton Trawl	"	Meganyctiphanes	34	PB-100	ETOH	"	"	"	"	"	"	2002	
Bucklin	20.aug.14	2002	Plankton Trawl	"	Thysanoessa inermis	13	SV	ETOH	"	"	"	"	"	"	2002	
Bucklin	20.aug.14	2002	Plankton Trawl	"	Meganyctiphanes	2	SV	ETOH	"	"	"	"	"	"	2002	
Bucklin	20.aug.14	539	WP2 (2)	0 - 450	sample (1/2)	entire	PB-100	ETOH	232,510596	232,550775	77,99555	77,99054	9,499677	9,4882368	539	
Bucklin	20.aug.14	539	WP2 (2)	"	sample (2/2)	entire	PB-100	ETOH	"	"		"	"	"	539	
Bucklin	21.aug.14	540	WP2 (2)	0 - 295	sample (1/2)	entire	PB-100	ETOH	233,360035	233,378229	79,67456	79,6755	9,718295	9,7227342	540	Note WP (2) refers to second WP2/Juday tow
Bucklin	21.aug.14	540	WP2 (2)	"	sample (2/2)	entire	PB-100	ETOH	"	"	"	"	"	"	540	
Bucklin	21.aug.14	540	WP2 (2)	"	Themisto libellula	3 (#1-3)	CV	LN2 -80C	"	"	"	"	"	"	540	
Bucklin	21.aug.14	540	WP2 (2)	"	Themisto abyssorum	5 (#4-8)	CV	LN2 -80C	"	"	"	"	"	"	540	
Bucklin	21.aug.14	540	MIK	0 - 250	sample (1/2)	1/8 split	PB-100	ETOH	233,441910	233,465833	79,68413	79,69761	9,7220989	9,7399393	540	
Bucklin	21.aug.14	540	MIK	"	sample (2/2)	1/8 split	PB-100	ETOH	"	"	"	"	"	"	540	
Bucklin	21.aug.14	540	MIK	"	Themisto abyssorum	10(#9-19)	CV	LN2 -80C	"	"	"	"	"	"	540	
Bucklin	21.aug.14	540	MIK	"	Themisto libellula	10(#20-29)	CV	LN2 -80C	"	"	"	"	"	"	540	
Bucklin	21.aug.14	540	MIK	"	Calanus hyperboreus	10(#30-39)	CV	LN2 -80C	"	"	"	"	"	"	540	
Bucklin	21.aug.14	2006	Harstad Trawl	0 - 55	Sebastes cf mentella	20	Foil	LN2 -80C	233,48443	233,50626	79,67842	79,65252	9,7351226	9,7222818	2006	
Bucklin	21.aug.14	2006	Harstad Trawl	"	Sebastes cf mentella	20	Foil	LN2 -80C	"	"	"	"	"	"	2006	
Bucklin	21.aug.14	542	WP2 (2)	0 - 485	sample (1/3)	entire	PB-100	ETOH	233,733351	233,759699	79,66759	79,66372	8,5106282	8,5079265	542	This subsample is now in two PB-100's
Bucklin	21.aug.14	542	WP2 (2)	"	sample (2/3)	entire	PB-100	ETOH	"	"	"	"	"	"	542	
Bucklin	21.aug.14	542	WP2 (2)	"	sample (3/3)	entire	PB-100	ETOH	"	"	"	"	"	"	542	
Bucklin	21.aug.14	542	Juday (2)	"	Thysanoessa longicaudata	4 (#40-43)	CV	LN2 -80C	"	"	"	"	"	"	542	Note WP (2) refers to second WP2/Juday tow
Bucklin	21.aug.14	542	Juday (2)	"	Calanus glacialis	4 (#44-48)	CV	LN2 -80C	"	"	"	"	"	"	542	
Bucklin	21.aug.14	542	Juday (2)	"	Paraeuchaeta sp.	1(#49)	CV	LN2 -80C	"	"	"	"	"	"	542	
Bucklin	21.aug.14	542	Juday (2)	"	Thysanoessa longicaudata	1 (#50)	CV	LN2 -80C	"	"	"	"	"	"	542	
Bucklin	21.aug.14	542	Juday (2)	"	Themisto abyssorum	5 (#51-55)	CV	LN2 -80C	"	"	"	"	"	"	542	
Bucklin	21.aug.14	542	MIK	0 - 472	Meganyctiphanes	11(#56-66	CV	LN2 -80C	233,797280	233,858090	79,6619	79,70023	8,4968077	8,5246507		
Bucklin	21.aug.14	542	MIK	"	Calanus glacialis F	30(#67-96)	CV	LN2 -80C	"	"	"	"	"	"		Excellent condition, all females (N=30?)
Bucklin	21.aug.14	542	MIK	"	Thysanoessa longicaudata	18(#97-114)	CV	LN2 -80C	"	"	"	"	"	"		OK condition (N=14?)
Bucklin	21.aug.14	542	MIK	"	sample (1/3)	1/32 split	PB-100	ETOH	"	"	"	"	"	"	542	
Bucklin	21.aug.14	542	MIK	"	sample (2/3)	1/32 split	PB-100	ETOH	"	"	"	"	"	"	542	
Bucklin	21.aug.14	542	MIK	"	sample (3/3)	1/32 split	PB-100	ETOH	"	"	"	"	"	"	542	
Bucklin	21.aug.14	542	MIK	"	Limacina sp.	100's	PB-100	ETOH	"	"	"	"	"	"	542	Note the Harstad trawl here is duplicated above - top entries are right, this c
Bucklin	21.aug.14	2006	Harstead Trawl		Sebastes (redfish)	40	FP	LN2 -80C	233,985845	233,008391	79,67004	79,64373	8,5766764	8,5568766		FP = foil pack; small sebastes cf mentella removed from Hastead Trawl LN@
Bucklin	22.aug.14	544	WP2 (2)	0 - 790	sample (1/2)	entire	PB-100	ETOH	233,276730	233,316701	79,67379	79,67263	7,5113743	7,5267674	544	
Bucklin	22.aug.14	544	WP2 (2)	"	sample (2/2)	entire	PB-100	ETOH	"	"	"	"	"	"	544	Also SV/Fish vertebrae (ETOH)
Bucklin	22.aug.14	544	Juday (2)	"	Paraeuchaeta sp.	3	SV - 1	ETOH	"	"	"	"	"	"	544	Good condition
Bucklin	22.aug.14	544	Juday (2)	"	Thysanoessa longicaudata	17	SV - 1	ETOH	"	"	"	"	"	"	544	Good condition
Bucklin	22.aug.14	544	MIK	0 - 742	Meganyctiphanes	7 (#115-121)	CV	LN2 -80C	233,405949	233,454572	79,70853	79,74166	7,5170038	7,5198152	544	
Bucklin	22.aug.14	544	MIK	"	Paraeuchaeta sp.	30	SV - 1	ETOH	"	"	"	"	"	"	544	
Bucklin	22.aug.14	544	MIK	"	sample (1/3)	1/64 split	PB-100	ETOH	"	"	"	"	"	"	544	MIK had a large Greenland Halibut with squid in mouth
Bucklin	22.aug.14	544	MIK	"	sample (2/3)	1/64 split	PB-100	ETOH	"	"	"	"	"	"	544	MIK packed with chaetognaths
Bucklin	22.aug.14	544	MIK	"	sample (3/3)	1/64 split	PB-100	ETOH	"	"	"	"	"	"	544	1/64 split preserved in ETOH for UCONN
Bucklin	23.aug.14	545	WP2 (2)	0 - 1072	sample (1/2)	entire	PB-100	ETOH	233,924537	233,980324	79,68668	79,68664	6,4789381	6,4970618	545	
Bucklin	23.aug.14	545	WP2 (2)	"	sample (2/2)	entire	PB-100	ETOH	"	"	"	"	"	"	545	
Bucklin	23.aug.14	545	Juday (2)	"	Thysanoessa longicaudata	7 (#122-128)	CV	LN2 -80C	"	"	"	"	"	"	545	
Bucklin	23.aug.14	547	WP2 (1)	0 - 2000	Thysanoessa longicaudata	11	SV - 1	ETOH	234,560255	234,679873	79,64407	79,64891	5,5207386	5,5188054	547	
Bucklin	23.aug.14	547	WP2 (1)	"	Paraeuchaeta sp.	4	SV - 1	ETOH	"	"	"	"	"	"	547	
Bucklin	23.aug.14	547	WP2 (1)	"	Calanus sp.	20 (#129-148)	CV	LN2 -80C	"	"	"	"	"	"	547	Probably C. hyperboreus(F), Good not excellent Condition
Bucklin	23.aug.14	547	WP2 (2)	0 - 2000	sample (1/2)	1/2 split	PB-100	ETOH	234,679873	234,716146	79,64891	79,64048	5,5188054	5,4916035	547	Phytoplankton; sieved in 333 um
Bucklin	23.aug.14	547	WP2 (2)	"	sample (2/2)	1/2 split	PB-100	ETOH	"	"	"	"	"	"	547	Phytoplankton; sieved in 333 um
Bucklin	23.aug.14	547	WP2 (2)	"	Themisto abyssorum	2	SV - 1	ETOH	"	"	"	"	"	"	547	Excellent condition
Bucklin	23.aug.14	547	Juday (2)	"	Thysaonoessa inermis	#149	CV	LN2 -80C	"	"	"	"	"	"	547	Excellent condition
Bucklin	23.aug.14	547	Juday (2)	"	Paraeuchaeta barbata	3(#150-152)	CV	LN2 -80C	"	"	"	"	"	"	547	Excellent condition
Bucklin	23.aug.14	547	WP2 (2)	"	Calanus hyperboreus F	5(#153-157)	CV	LN2 -80C	"	"	"	"	"	"	547	females - VG condition
Bucklin	23.aug.14	547	WP2 (2)	"	Thysanoessa longicaudata	17(#158-175)	CV	LN2 -80C	"	"	"	"	"	"	547	Good condition

Bucklin	24.aug.14	548	WP2 (2)	0 - 450	sample	1/2 split	PB-100	ETOH	296,424797	236,450532	79,9488	79,94611	9,0368469	9,0201133	548	Phytoplankton! Rinsed sample on 333 um sieve.
Bucklin	24.aug.14	548	Juday (2)	"	Themisto libellula	1	SV - 1	ETOH	"	"	"	"	"	"	548	Excellent condition
Bucklin	24.aug.14	548	MIK	0 - 450	Meganyctiphanes	11 (#198-208)	CV	LN2 -80C	236,539063	236,573854	79,96319	79,96304	9,0341676	8,9783314	548	Excellent condition
Bucklin	24.aug.14	548	MIK	"	Themisto libellula	30	SV - 1	ETOH	"	"	"	"	"	"	548	Very good condition
Bucklin	24.aug.14	548	MIK	"	sample (1/2)	(1/16 split)	PB-100	ETOH	"	"	"	"	"	"	548	
Bucklin	24.aug.14	548	MIK	"	sample (2/2)	(1/16 split)	PB-100	ETOH	"	"	"	"	"	"	548	
Bucklin	24.aug.14	548	MIK	"	Paraeuchaeta sp.	25	SV - 1	ETOH	"	"	"	"	"	"	548	Good condition
Bucklin	24.aug.14	548	MIK	"	Clione limacina	8	SV - 1	ETOH	"	"	"	"	"	"	548	Very good condition
Bucklin	24.aug.14	548	MIK	"	Calanus glacialis??	~25	SV - 1	ETOH	"	"	"	"	"	"	548	Poor condition
Bucklin	24.aug.14	548	MIK	"	Thysanoessa longicaudata	18 (#209-226)	CV	LN2 -80C	"	"	"	"	"	"	548	Excellent-> good condition
Bucklin	24.aug.14	549	MIK	0 - 60	Meganyctiphanes	21(#227-247)	CV	LN2 -80C	236,916921	236,936979	80,33361	80,33607	11,473339	11,441432	549	Shallow tow (30-0m); all excellent condition
Bucklin	24.aug.14	549	MIK	"	Thysaonoessa inermis	20(#248-267)	CV	LN2 -80C	"	"	"	"	"	"	549	Excellent condition
Bucklin	24.aug.14	549	MIK	"	Meganyctiphanes	45	SV - 1	ETOH	"	"	"	"	"	"	549	Excellent condition
Bucklin	24.aug.14	549	MIK	"	Thysaonoessa inermis	20	SV - 1	ETOH	"	"	"	"	"	"	549	Excellent condition
Bucklin	24.aug.14	549	MIK	"	Themisto libellula	100	SV - 1	ETOH	"	"	"	"	"	"	549	Excellent condition
Responsible Person	Date	Station	Net System	Depth Interval sampled (m)	Species/sample description	Number of Individuals or vials	Bottle Type	Preservation	Tow Start Time GMT	Tow End Time GMT	Start Latitude	End Latitude	Start Longitude	End Longitude	Station	Comments
Bucklin	25.aug.14	550	WP2 (2)	0 - 490	Sample (1/2)	no split	PB-100	ETOH	238,164803	238,191238	80,41628	80,41628	11,426908	11,432502	550	
Bucklin	25.aug.14	550	WP2 (2)	"	Sample (2/2)	no split	PB-100	ETOH	"	"	"	"	"	"	550	
Bucklin	26.aug.14	551	MIK	0 - 1000	Thysanopoda acutifrons??	1	SV-1	ETOH	238,965359	239,054352	80,81956	80,81981	15,613922	15,441439	551	Very interesting find
Bucklin	26.aug.14	551	MIK	"	Thysaonoessa inermis	65	SV-1	ETOH	"	"	"	"	"	"	551	Good condition
Bucklin	26.aug.14	551	MIK	"	Thysanoessa longicaudata	21	SV-1	ETOH	"	"	"	"	"	"	551	Good condition
Bucklin	26.aug.14	551	MIK	"	Paraeuchaeta	25	SV-1	ETOH	"	"	"	"	"	"	551	Good condition
Bucklin	26.aug.14	551	MIK	"	Meganyctiphanes	14	SV-1	ETOH	"	"	"	"	"	"	551	Alive when put into ETOH
Bucklin	26.aug.14	2022	PlankTrawl	0 - 408	Meganyctiphanes	14 (#268-283	CV	LN2 -80C	239,487454	239,517674	80,67972	80,68554	15,526256	15,526256	2022	
Bucklin	26.aug.14	2022	PlankTrawl	"	Paraeuchaeta babata	13	SV-1	ETOH	"	"	"	"	"	"	2022	dead
Bucklin	26.aug.14	2022	PlankTrawl	"	Meganyctiphanes	21	SV-1	ETOH	"	"	"	"	"	"	2022	Subdivided catch on 29Aug2014
Bucklin	26.aug.14	2022	PlankTrawl	"	Meganyctiphanes	30	SV-1	ETOH	"	"	"	"	"	"	2022	dead
Bucklin	26.aug.14	2022	PlankTrawl	"	Sample (1/3)	random bit	PB-100	ETOH	"	"	"	"	"	"	2022	
Bucklin	26.aug.14	2022	PlankTrawl	"	Sample (2/3)	random bit	PB-100	ETOH	"	"	"	"	"	"	2022	Another PB100 (3/3) prep for IMR very dead opaque
Bucklin	26.aug.14	2022	PlankTrawl	"	Sample (3/3)	random bit	PB-100	ETOH	"	"	"	"	"	"	2022	Added split 29 Aug 2014 - was 2/2
Bucklin	26.aug.14	2022	PlankTrawl	"	Nematoscelis megalops	1	SV-1	ETOH	"	"	"	"	"	"	2022	
Bucklin	26.aug.14	553	WP2 (2)	0 - 660	Sample (1/1)	no split	PB-100	ETOH	299,938142	239,974502	80,69674	80,69354	15,601266	15,601266	553	
Bucklin	26.aug.14	555	WP2 (2)	"	Sample (1/1)	no split	PB-100	ETOH	"	"	"	"	"	"	555	
Bucklin	27.aug.14	556	WP2 (2)	0 - 660	Sample (1/2)	no split	PB-100	ETOH	239,436389	239,631852	80,04111	80,05288	17,387249	17,315841	556	
Bucklin	27.aug.14	556	WP2 (2)	"	Sample (2/2)	no split	PB-100	ETOH	"	"	"	"	"	"	556	
Bucklin	27.aug.14	556	Juday(2)	"	Calanus hyperboreus	10(#284-293)	CV	LN2 -80C	"	"	"	"	"	"	556	
Bucklin	27.aug.14	556	MIK	0 - 350	Thysaonoessa inermis	10(#294-303)	CV	LN2 -80C	239,636690	239,674468	80,0548	80,04915	17,321016	17,461173	556	
Bucklin	27.aug.14	556	MIK	"	Meganyctiphanes	13	SV	ETOH	"	"	"	"	"	"	556	
Bucklin	27.aug.14	556	MIK	"	Thysaonoessa inermis	40	PB-100	ETOH	"	"	"	"	"	"	556	
Bucklin	27.aug.14	557	WP2 (2)	0 - 390	Sample (1/2)	no split	PB-100	ETOH	239,946950	239,979838	79,79728	79,83704	18,062005	18,008235	557	
Bucklin	27.aug.14	557	WP2 (2)	"	Sample (2/2)	no split	PB-100	ETOH	"	"	"	"	"	"	557	
Bucklin	27.aug.14	557	Juday(2)	"	Calanus hyperboreus	15(#304-318)	CV	LN2 -80C	"	"	"	"	"	"	557	
Bucklin	27.aug.14	558	WP2 (2)	0 - 156	Sample (1/2)	no split	PB-100	ETOH	240,292778	240,308542	79,8937	79,89748	15,427884	15,378556	558	
Bucklin	27.aug.14	558	WP2 (2)	"	Sample (2/2)	no split	PB-100	ETOH	"	"	"	"	"	"	558	
Bucklin	27.aug.14	559	WP2 (2)	"	Sample (1/1)	no split	PB-100	ETOH	240,453443	240,466991	79,66756	79,67598	15,382635	15,34924	559	
Bucklin	28.aug.14	560	WP2 (2)	0 - 165	Sample (1/1)	no split	PB-100	ETOH	240,679711	240,693600	80,16953	80,16984	15,484275	15,492365	560	Few F C.hyper boreus, many chyp CIII/CIV; Oithona/Oncea
Bucklin	28.aug.14	562	WP2 (2)	0 - 130	Sample (1/1)	no split	PB-100	ETOH	240,815046	240,823252	80,50226	80,50226	14,584271	14,601257	562	
Bucklin	28.aug.14	563	WP2 (2)	0 - 165	Sample (1/1)	no split	PB-100	ETOH	240,889769	240,897859	80,63173	80,63023	14,24174	14,262759	563	
Bucklin	29.aug.14	564	WP2 (2)	0 - 290	Sample (1/1)	no split	PB-100	ETOH	241,066950	241,090845	80,71391	80,71848	14,156194	14,172275	564	
Bucklin	29.aug.14	564	Juday(2)	"	Thysanoessa longicaudata	10(#319-328)	CV	LN2 -80C	"	"	"	"	"	"	564	Tiny, very lively-uncertain species ID/excl-cond /in the ice
Bucklin	29.aug.14	565	WP2 (2)	0 - 500	Sample (1/1)	no split	PB-100	ETOH	241,215301	241,236030	80,75107	80,74926	14,215156	14,289288	565	
Bucklin	29.aug.14	567	Juday(1)	0 - 150	Sample (1/1)	no split	PB-100	ETOH	241,380440	nan	80,76105	nan	14,082147	nan	567	Tow aborted by bridge-Ice problem-0-150m, so Lars put WP2 into ETOH an
Bucklin	29.aug.14	567	Juday(2)	0 - 741	Sample (1/2)	no split	PB-100	ETOH	241,408113	241,445093	80,75936	80,75012	13,924288	13,962747	567	
Bucklin	29.aug.14	567	Juday(2)	"	Sample (2/2)	no split	PB-100	ETOH	"	"	"	"	"	"	567	
Bucklin	29.aug.14	567	Juday(2)	"	Thysanoessa longicaudata	10(#329-338)	CV	LN2 -80C	"	"	"	"	"	"	567	10 Ind picked alive and kicking out of Juday(2) before alcohol preservation
Bucklin	29.aug.14	568	WP2(2)	0 - 500	Sample (1/2)	no split	PB-100	ETOH	241,578241	241,600359	80,76019	80,76189	13,596333	13,602625	568	We assigned CTD#568 to this tow even though CTD#569 was taken before t

Bucklin	29.aug.14	568	WP2(2)	"	Sample (2/2)	no split	PB-100	ETOH	"	"	"	"	"	"	568	
Bucklin	30.aug.14	580	WP2(2)	0 - 160	Sample (1/1)	no split	PB-100	ETOH	242,573015	242,578727	80,22599	80,22714	11,752586	11,757461	580	
Bucklin	30.aug.14	580	MIK	0 - 160	Themisto libellula	20	SV	ETOH	242,625938	242,653009	80,23565	80,2415	11,819392	11,831754	580	all alive when preserved in ETOH
Bucklin	30.aug.14	580	MIK	"	Thysanoessa inermis	5	SV	ETOH	"	"	"	"	"	"	580	"
Bucklin	30.aug.14	580	MIK	"	Meganyctiphanes	2	SV	ETOH	"	"	"	"	"	"	580	"
Bucklin	30.aug.14	580	MIK	"	Paraeuchaeta sp.	25	SV	ETOH	"	"	"	"	"	"	580	"
Bucklin	30.aug.14	580	MIK	"	Themisto abyssorum	31	SV	ETOH	"	"	"	"	"	"	580	"
Bucklin	30.aug.14	581	WP2(2)	0 - 200	Sample (1/1)	no split	PB-100	ETOH	242,901730	242,915671	80,05117	80,04624	11,227591	11,23662	581	lots of Phytoplankton-very green!
Bucklin	30.aug.14	581	MIK	0 - 160	Sample (1/2)	1/8 split	PB-100	ETOH	242,929630	242,954907	80,03965	80,03633	11,205617	11,099645	581	lots of Paraeuchaeta(IV?),Themisto, few Meg/Thysanoessa/Cgla??
Bucklin	30.aug.14	581	MIK	"	Sample (2/2)	1/8 split	PB-100	ETOH	"	"	"	"	"	"	581	
Bucklin	30.aug.14	581	MIK	"	Meganyctiphanes	8(#339-346	CV	LN2 -80C	"	"	"	"	"	"	581	Needs species confirmation, ID? Good condition/alive @ln2
Bucklin	30.aug.14	581	MIK	"	Thysanoessa longicaudata	1(#347)	CV	LN2 -80C	"	"	"	"	"	"	581	
Bucklin	31.aug.14	582	WP2(2)	0 - 250	Sample (1/1)	no split	PB-100	ETOH	243,004167	243,035023	79,95778	79,95779	10,742134	10,758167	582	Tiny copepods, Lots of phytoplankton!
Bucklin	31.aug.14	583	WP2(1)	0-870	Paraeuchaeta norvegica	18	SV	ETOH	243,796215	243,796458	79,12518	79,12515	8,139968	8,1599714	583	Recently dea (cond=good) F and mostly CIV-V; Tor species ID
Bucklin	31.aug.14	583	WP2(1)		Meganyctiphanes	1(#348)	CV	LN2 -80C	"	"	"	"	"	"	583	
Bucklin	31.aug.14	583	WP2(2)	0 - 870	Sample (1/3)	no split	PB-100	ETOH	243,842691	243,888924	79,12515	79,11973	8,1599714	8,1763399	583	Paraeuchaeta VIV-V other small copepods, many ostracods, amphipods
Bucklin	31.aug.14	583	WP2(2)	"	Sample (2/3)	no split	PB-100	ETOH	"	"	"	"	"	"	583	
Bucklin	31.aug.14	583	WP2(2)	"	Sample (3/3)	no split	PB-100	ETOH	"	"	"	"	"	"	583	
Bucklin	31.aug.14	583	WP2(2)	"	Paraeuchaeta norvegica	22	SV	ETOH	"	"	"	"	"	"	583	
Bucklin	01.sep.14	588	WP2(2)	0 -167	Sample (1/1)	no split	PB-100	ETOH	244,467396	244,479120	78,57551	78,57259	9,6385075	9,6365345	588	Nothing to pick - all small stuff
Bucklin	01.sep.14	589	WP2(2)	0 - 315	Sample (1/2)	no split	PB-100	ETOH	"	"	"	"	"	"	589	"
Bucklin	01.sep.14	589	WP2(2)	"	Sample (2/2)	no split	PB-100	ETOH	"	"	"	"	"	"	589	"
Bucklin	01.sep.14	589	MIK	"	Meganyctiphanes	8(#349, 351-357	CV	LN2 -80C	244,641400	244,672859	78,60498	78,61345	9,4988341	9,4277428	589	
Bucklin	01.sep.14	589	MIK	"	Thysanoessa inermis	6(#358-363)	CV	LN2 -80C	"	"	"	"	"	"	589	
Bucklin	01.sep.14	589	MIK	"	Sample	bit of sample	PB-100	ETOH	"	"	"	"	"	"	589	
Bucklin	01.sep.14	591	WP2(2)	0-500	Sample (1/3)	no split	PB-100	ETOH	244,877500	244,902905	78,57338	78,57458	9,1928475	9,2148426	591	Calanus spp CIII-IV; no phyto; no adults- curious
Bucklin	01.sep.14	591	WP2(2)	"	Sample (2/3)	no split	PB-100	ETOH	"	"	"	"	"	"	591	"
Bucklin	01.sep.14	591	WP2(2)	"	Sample (3/3)	no split	PB-100	ETOH	"	"	"	"	"	"	591	"
Responsible Person	Date	Station	Net System	Depth Interval sampled (m)	Species/sample description	Number of Individuals or vials	Bottle Type	Preservation	Tow Start Time GMT	Tow End Time GMT	Start Latitude	End Latitude	Start Longitude	End Longitude	Station	Comments
Bucklin	02.sep.14	593	WP2(1)	0-800	Thysanoessa longicaudata	n=4	SV	ETOH	245,372141	245,413374	78,56853	78,57775	8,8110823	8,747227	593	Most alive when preserved (taken from split of WP2(1)
Bucklin	02.sep.14	593	WP2(1)	"	Limacina	n=many	SV	ETOH	"	"	"	"	"	"	593	Many small , some large Limacina
Bucklin	02.sep.14	593	WP2(2)	"	Sample (1/2)	1/2 split	PB-100	ETOH	245,413374	245,454606	78,57775	78,58551	8,747227	8,6875285	593	
Bucklin	02.sep.14	593	WP2(2)	"	Sample (2/2)	1/2 split	PB-100	ETOH	"	"	"	"	"	"	593	
Bucklin	02.sep.14	593	Juday(2)	"	Thysanoessa longicaudata	n=17	SV	ETOH	"	"	"	"	"	"	593	
Bucklin	02.sep.14	594	WP2(2)	0-993	Sample (1/2)	1/2 split	PB-100	ETOH	245,764763	245,810856	78,61055	78,61761	8,2007521	8,2199501	594	
Bucklin	02.sep.14	594	WP2(2)	"	Sample (2/2)	1/2 split	PB-100	ETOH	"	"	"	"	"	"	594	
Bucklin	02.sep.14	594	WP2(2)	"	Thysanoessa longicaudata	34???	SV	ETOH	"	"	"	"	"	"	594	Mixture of living and recently dead. Conditioned mixed E->G
Bucklin	02.sep.14	594	MIK	0-1000	Thysanoessa spp	1/3	SV	ETOH	245,965347	246,040532	78,59804	78,57621	8,1071782	8,2865907	594	Early picks - recently dead/ cond Good
Bucklin	02.sep.14	594	MIK	"	Paraeuchaeta spp	2/3	SV	ETOH	"	"	"	"	"	"	594	Early picks - cond Good
Bucklin	02.sep.14	594	MIK	"	Thysanoessa spp	3/3	SV	ETOH	"	"	"	"	"	"	594	Late picks - Thysanoessa sp and Paraeuchaeta spp - dea cond -> fair
Bucklin	02.sep.14	594	MIK	"	Meganyctiphanes	10(#364-373)	CV	LN2 -80C	"	"	"	"	"	"	594	
Bucklin	02.sep.14	594	MIK	"	Sample (1/2)	Unknown Fraction	PB-100	ETOH	"	"	"	"	"	"	594	Lots of chaetognaths! Picked 10 Meg LN2; Thysanoessa, Paraeuchaeta
Bucklin	02.sep.14	594	MIK	"	Sample (2/2)	Unknown Fraction	PB-100	ETOH	"	"	"	"	"	"	594	spp. -> dying or dead into ETOH
Bucklin	03.sep.14	595	WP2(1)	0-1478m	Limacina	n=many	SV	ETOH	246,354201	246,437367	78,60703	78,60253	7,3468146	7,3563749	595	
Bucklin	03.sep.14	595	WP2(1)	"	Paraeuchaeta spp	5	SV	ETOH	"	"	"	"	"	"	595	2 large and 3 small individuals
Bucklin	03.sep.14	595	WP2(2)	0-1517	Sample (1/2)	1/4 split	PB-100	ETOH	246,437367	246,520532	78,60253	78,61203	7,3563749	7,3321214	595	
Bucklin	03.sep.14	595	WP2(2)	"	Sample (2/2)	1/4 split	PB-100	ETOH	"	"	"	"	"	"	595	
Bucklin	03.sep.14	595	WP2(2)	"	Paraeuchaeta spp	11	SV	ETOH	"	"	"	"	"	"	595	5 large & 6 small dudes
Bucklin	03.sep.14	595	WP2(2)	"	Meganyctiphanes	1	SV	ETOH	"	"	"	"	"	"	595	still alive when preserved
Bucklin	03.sep.14	595	WP2(2)	"	Calanus hyperboreus	20	SV	ETOH	"	"	"	"	"	"	595	picked by Lars - not really kicking, but fresh
Bucklin	03.sep.14	596	WP2(2)	0-1000	Sample (1/2)	no split	PB-100	ETOH	246,767483	246,826458	78,62362	78,62075	6,596262	6,5973163	596	Sieved over 333um to remove dense/gooey phytoplankton
Bucklin	03.sep.14	596	WP2(2)	"	Sample (2/2)	no split	PB-100	ETOH							596	
Bucklin	04.sep.14	597	WP2(2)	0-1000	Sample (1/2)	1/2 split	PB-100	ETOH	247,108542	247,184630	78,61816	78,61726	5,4027012	5,2948798	597	To 1000 m/WP2(1) to 2000m;Resieved over 333um before preservation
Bucklin	04.sep.14	597	WP2(2)	"	Sample (2/2)	1/2 split	PB-100	ETOH	"	"	"	"	"	"	597	1/2 split
Bucklin	04.sep.14	597	WP2(2)	"	Calanus hyperboreus	n=30	SV	ETOH	"	"	"	"	"	"	597	All recently dead; Cond=Good

Bucklin	04.sep.14	597	MIK	0-1000	Paraeuchaeta barbata	n~=30	SV	ETOH	247,193646	247,284780	78,61858	78,58425	5,2915293	5,488264	597	All recently dead; Cond=Good
	04.sep.14	597	MIK	"	Paraeuchaeta barbata	n~=30	SV	ETOH	"	"	"	"	"	"	597	All recently dead; Cond=Good
Bucklin	04.sep.14	597	MIK	"	Sample (1/2)	1/32 split	PB-100	ETOH	"	"	"	"	"	"	597	
Bucklin	04.sep.14	597	MIK	"	Sample (2/2)	1/32 split	PB-100	ETOH	"	"	"	"	"	"	597	
Bucklin	04.sep.14	597	MIK	"	Paraeuchaeta norvegica	n~=20	SV	ETOH	"	"	"	"	"	"	597	All recently dead; Cond=Good
Bucklin	04.sep.14	597	MIK	"	Thysanoessa longicaudata	n~=100	SV	ETOH	"	"	"	"	"	"	597	All recently dead; Cond=Good
Bucklin	04.sep.14	597	MIK	"	Meganyctiphanes	2(#374, 378)	CV	LN2-80	"	"	"	"	"	"	597	
Bucklin	04.sep.14	597	MIK	"	Paraeuchaeta barbata	3(#375-377)	CV	LN2-80	"	"	"	"	"	"	597	
Bucklin	04.sep.14	597	MIK	"	Paraeuchaeta barbata	15(#379-393)	CV	LN2-80	"	"	"	"	"	"	597	

Table A4. Summary listing by species of LN2 flash-frozen identified individual specimens in cryovials.

LN2 Vial Log

Date	Station	Gear		Species	Vial #	N
21.aug.14	542	Juday (2)		Calanus glacialis	#44-48	5
21.aug.14	542	MIK		Calanus glacialis	#67-96	10
				Total		**15**
21.aug.14	540	MIK		Calanus hyperboreus	#30-39	10
27.aug.14	556	Juday (2)		Calanus hyperboreus (n=10)	#284-293	10
23.aug.14	547	WP2(1)		Calanus hyperboreus F	#129-148	10
23.aug.14	547	WP2(1)		Calanus hyperboreus F	D479-D486	N/A
27.aug.14	557	Juday (2)		Calanus hyperboreus F (n=15)	#304-318	15
23.aug.14	547	WP2 (2)		Calanus hyperboreus F (n=5)	#153-157	5
				Total		**50**
21.aug.14	542	MIK		Meganyctiphanes norvegica	#56-66	11
22.aug.14	544	MIK		Meganyctiphanes norvegica	#115-121	7
31.aug.14	583	WP2(1)		Meganyctiphanes norvegica (n=1)	#348	1
02.sep.14	594	MIK		Meganyctiphanes norvegica (n=10)	#364-373	10
24.aug.14	548	MIK		Meganyctiphanes norvegica (n=11)	#198-208	11
04.sep.14	597	MIK		Meganyctiphanes norvegica (n=2)	#374, 378	2
24.aug.14	549	MIK		Meganyctiphanes norvegica (n=21)	#227-247	21
27.aug.14	2022	PlankTrawl		Meganyctiphanes norvegica (n=21)	#268-283	18
30.aug.14	581	MIK		Meganyctiphanes norvegica (n=8)	#339-346	8
01.sep.14	589	MIK		Meganyctiphanes norvegica (n=8)	#349, 351-357	8
				Total		**97**
23.aug.14	547	Juday (2)		Paraeuchaeta barbata (n=3)	#150-152	3
04.sep.14	597	MIK		Paraeuchaeta barbata? (n=15)	#379-393	15
04.sep.14	597	MIK		Paraeuchaeta barbata? (n=3)	#375-377	3
				Total		**21**
21.aug.14	542	Juday (2)		Paraeuchaeta sp.	#49	1
24.aug.14	548	Juday (2)		Paraeuchaeta sp. norvegica? N=6	#184-189	6
24.aug.14	548	WP2 (2)		Paraeuchaeta sp. norvegica? N=14	#176-183	8
				Total		**15**
21.aug.14	2006	Harstad Trawl		Sebastes cf mentella (n=20)	Foil 1	20
21.aug.14	2006	Harstad Trawl		Sebastes cf mentella (n=20)	Foil 2	20
				Total		**40**
21.aug.14	540	WP2 (2)		Themisto abyssorum	#4-8	4
21.aug.14	540	MIK		Themisto abyssorum	#9-19	11
21.aug.14	542	Juday (2)		Themisto abyssorum	#51-55	5
				Total		**20**
21.aug.14	540	WP2 (2)		Themisto libellula	#1-3	3
21.aug.14	540	MIK		Themisto libellula	#20-29	10
				Total		**13**
23.aug.14	547	Juday (2)		Thysanoessa inermis (n=1)	#149	1
27.aug.14	556	MIK		Thysanoessa inermis (n=10)	#294-303	10
24.aug.14	549	MIK		Thysanoessa inermis (n=20)	#248-267	16
01.sep.14	589	MIK		Thysanoessa inermis (n=6)	#358-363	6
				Total		**33**

21.aug.14	542	Juday (2)	Thysanoessa longicaudata	#40-43	4
21.aug.14	542	Juday (2)	Thysanoessa longicaudata	#50	1
21.aug.14	542	MIK	Thysanoessa longicaudata	#97-114	18
23.aug.14	545	Juday (2)	Thysanoessa longicaudata	#122-128	7
30.aug.14	581	MIK	Thysanoessa longicaudata (n=1)	#347	1
29.aug.14	564	Juday (2)	Thysanoessa longicaudata (n=10)	#319-328	10
29.aug.14	567	Juday (2)	Thysanoessa longicaudata (n=10)	#329-338	10
23.aug.14	547	WP2 (2)	Thysanoessa longicaudata (n=17)	#158-175	8
24.aug.14	548	MIK	Thysanoessa longicaudata (n=18)	#209-226	16
24.aug.14	548	WP2 (2)	Thysanoessa longicaudata (n=2)	#196-197	2
24.aug.14	548	Juday (2)	Thysanoessa longicaudata (n=6)	#190-195	6
			Total		**83**

Table A5. Bottom trawl (Campelen) stations during the SI_Arctic survey 2014.

Trawl	Date - time	Trawl serial no	Latitude (dec)	Longitude (dec)	Ship log	Trawl condition	Fishing depth (m)
3271	20.08.2014 07:26	2001	78.000	9.469	1419.6	1	525
3271	21.08.2014 05:54	2004	79.461	8.018	1540.1	1	467
3271	21.08.2014 09:30	2005	79.672	9.727	1563.3	1	302
3271	21.08.2014 17:48	2007	79.666	8.488	1587.5	1	509
3271	22.08.2014 05:48	2009	79.664	7.524	1618.8	2	814
3271	22.08.2014 17:45	2011	79.673	6.683	1648.9	2	1013
3271	24.08.2014 10:38	2014	79.984	9.152	1784.4	1	481
3271	24.08.2014 22:49	2016	80.337	11.455	1829.1	1	209
3271	25.08.2014 03:36	2017	80.404	11.394	1842.2	1	488
3271	26.08.2014 12:35	2021	80.678	15.523	1968.7	1	480
3271	27.08.2014 02:50	2025	80.563	15.907	2000.9	1	297
3271	27.08.2014 09:23	2027	80.294	16.633	2029.2	1	355
3271	27.08.2014 14:38	2029	80.061	17.264	2052.6	1	383
3271	27.08.2014 22:29	2031	79.795	18.067	2078.9	1	415
3271	28.08.2014 07:29	2033	79.920	15.346	2126.0	1	163
3271	28.08.2014 11:28	2035	79.692	15.426	2142.6	1	140
3271	29.08.2014 01:25	2036	80.717	14.130	2226.2	1	318
3271	30.08.2014 13:28	2037	80.215	11.793	2319.7	1	178
3271	31.08.2014 19:04	2039	79.121	8.117	2443.3	1	928
3271	01.09.2014 02:43	2042	79.061	8.592	2464.8	1	346
3271	01.09.2014 05:50	2043	78.822	8.527	2481.8	1	539
3271	01.09.2014 08:16	2044	78.714	9.069	2491.2	1	469
3271	01.09.2014 10:28	2045	78.707	9.781	2501.2	1	126
3271	01.09.2014 12:03	2046	78.598	9.579	2508.7	1	199
3271	01.09.2014 13:56	2047	78.592	9.508	2513.1	1	314
3271	01.09.2014 21:14	2049	78.595	9.145	2528.3	1	521
3271	02.09.2014 09:09	2051	78.584	8.745	2557.6	1	812
3271	02.09.2014 16:38	2053	78.596	8.268	2576.3	1	1024

Table A6. Pelagic trawl stations during the SI_Arctic survey 2014. Trawl codes: 3513 = Harstad trawl, 3514 = Harstad trawl with extra floats on the headrope, 3532 = Åkra trawl, 3548 = Macroplankton trawl. Those fishing depths marked with 0-gr mean hauls designed for 0-group fish trawling. During these hauls the trawl is kept with the headrope in the surface for 10 minutes, then lowered to 20 m and kept there for 10 minutes, and finally lowered to 40 m and kept there for 10 minutes.

Trawl	Date - time	Trawl serial no	Latitude (dec)	Longitude (dec)	Ship log	Trawl condition	Fishing depth (m)
3513	21.08.2014 13:37	2006	79.678	9.735	1568.7	1	55
3513	22.08.2014 01:39	2008	79.670	8.577	1601.1	1	357
3513	22.08.2014 14:25	2010	79.681	7.487	1633.9	1	411
3513	26.08.2014 03:44	2019	80.803	15.447	1936.1	1	0-gr
3513	26.08.2014 19:33	2024	80.687	15.658	1985.7	1	194
3513	28.08.2014 01:32	2032	79.838	18.006	2085.2	1	272
3513	31.08.2014 23:52	2040	79.088	8.179	2453.8	1	419
3514	20.08.2014 16:17	2003	78.002	9.473	1438.8	1	0-gr
3514	23.08.2014 04:38	2012	79.703	6.554	1664.2	1	0-gr
3514	24.08.2014 16:59	2015	79.977	9.074	1793.1	1	0-gr
3514	25.08.2014 08:13	2018	80.393	11.458	1849.5	1	0-gr
3514	26.08.2014 18:26	2023	80.685	15.468	1981.6	1	0-gr
3514	27.08.2014 04:46	2026	80.554	15.822	2005.8	1	0-gr
3514	27.08.2014 10:59	2028	80.282	16.760	2032.5	1	0-gr
3514	27.08.2014 19:47	2030	80.033	17.465	2062.9	1	0-gr
3514	28.08.2014 09:24	2034	79.897	15.379	2130.2	1	0-gr
3514	30.08.2014 14:21	2038	80.185	11.649	2323.2	1	0-gr
3514	01.09.2014 01:00	2041	79.056	8.192	2456.9	1	0-gr
3514	01.09.2014 19:24	2048	78.582	9.160	2523.5	1	0-gr
3532	23.08.2014 12:06	2013	79.644	5.344	1690.7	1	1086
3532	02.09.2014 05:04	2050	78.602	9.123	2540.9	1	449
3532	02.09.2014 13:37	2052	78.616	8.610	2564.4	1	446
3532	03.09.2014 06:43	2054	78.562	8.521	2599.9	1	429
3532	03.09.2014 14:43	2055	78.603	7.381	2622.4	1	452
3532	03.09.2014 21:58	2056	78.617	6.615	2642.5	1	430
3532	04.09.2014 09:35	2057	78.619	5.332	2670.9	1	821
3548	20.08.2014 10:36	2002	78.023	9.442	1428.8	1	234
3548	26.08.2014 07:32	2020	80.800	15.672	1949.0	1	1185
3548	26.08.2014 13:41	2022	80.680	15.523	1971.5	1	408

Table A7. The total species number, the biomass and abundance of the catch taken per equipment (Beam trawl = 5 min trawling; Campelen trawl = 15 min trawling; grab = 0.1m^2), serial number per station, Case study-stations (C1-3) and dato for the sampling. Largest values in **bold**.

Dato	Station	Serial no	Depth	BottomTemp	Equipment	Sp. no	Bio (Equip)	No (Equip)
20.08.2014	C1	2001			Beam Trawl 1	27	0,10	135
					Beam Trawl 2	44	0,72	269
					Beam Trawl 3	30	3,61	675
			502	3,17	Campelen	64	17,00	1661
21.08.2014		2004	463	(blank)	Campelen	47	284,39	1704
	Fram N	2005	298	3,08	Campelen	52	64,74	910
		2007			Beam Trawl	30	2,36	93
22.08.2014	Fram N	2007	506	2,37	Campelen	53	5,29	661
	Fram N	2009	804	0,24	Campelen	63	23,98	274
		2011			Beam Trawl	12	0,04	34
23.08.2014	Fram N	2011	1010	-0,84	Campelen	43	9,44	523
		2013			Åkra pelagisk trål	12	2,08	348
24.08.2014		2014			Beam Trawl	25	1,09	**3164**
		2014	479	1,82	Campelen	37	19,29	3867
		2014			Grab	8	0,00	17
		2016			Beam Trawl	15	25,26	390
25.08.2014	NW	2016	208	3,81	Campelen	41	14,55	279
		2017			Beam Trawl	14	0,22	384
	NW	2017	487	2,56	Campelen	34	16,30	14768
26.08.2014	C2	2021			Beam Trawl 1	34	0,93	206
		2021			Beam Trawl 2	19	0,09	75
		2021			Beam Trawl 3	44	0,34	381
		2021	422	2,88	Campelen	42	9,16	1727
		2021			Grab	**5**	0,00	5
27.08.2014	Hinlopen	2025	297	2,22	Campelen	45	11,93	2163
	Hinlopen	2027	317	2,14	Campelen	62	14,65	3281
	Hinlopen	2029	378	2,11	Campelen	29	151,91	**28039**
	Hinlopen	2031	415	1,76	Campelen	16	89,53	3792
28.08.2014	WijdeF	2033	162	2,40	Campelen	42	12,25	6353
	WijdeF	2035	139	2,46	Campelen	27	38,85	8901
	WijdeF	2036	313	3,52	Campelen	23	354,51	2286
30.08.2014	C3 NW	2037			Beam Trawl 1	40	1,42	340
		2037			Beam Trawl 2	28	0,13	114
		2037			Beam Trawl 3	27	0,57	82
		2037	178	4,15	Campelen	57	6,41	1527
		2037			Grab 2	8	0,01	**42**
		2037			Grab 3	**12**	**0,02**	34
31.08.2014	NW	2039	923	0,48	Campelen	**66**	8,28	1178
01.09.2014	NW	2042	344	3,80	Campelen	52	26,91	1163
	NW	2043	539	3,29	Campelen	48	7,56	1651

	Fram S	2044	463	3,38	Campelen	52	10,19	1491
	Fram S	2045	126	4,57	Campelen	43	1,24	198
	Fram S	2046	187	4,17	Campelen	37	3,29	3189
	Fram S	2047	313	3,90	Beam Trawl	**55**	1,98	938
		2047			Campelen	37	8,71	2304
		2047			Grab	14	0,01	60
	Fram S	2049	521	2,19	Beam Trawl	23	**33,20**	1067
		2049			Campelen	33	18,04	937
		2049			Grab	9	0,00	17
02.09.2014	Fram S	2051	804	0,03	Campelen	40	**545,72**	3623
	Fram S	2053	1023	-0,82	Beam Trawl	24	4,29	247
		2053			Campelen	40	115,16	4653
		2053			Grab	7	**0,00**	7

Table A8. Collected samples for stable isotope analyses.

St.no.	Case study	Fisk (adult and juv)	Benthos	Pelagic	POM	Sediment	Stomachs/fish
2001	C1	11	14	14	1		4
2003		18	22	4		1	
2004		10					
2005		10	19				
2007		2	9				5
2009		4	9	1			1
2011			7				
2013				8			
2014			4			1	
2016			1				
2020				9			
2021	C2		5				
2029		1					
2037	C3	12	19	18	1	1	5
2044							4
2045		1					
2047						1	
2053						1	