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NPI Arctic Ocean Cruise II

IMR Cruise ID [2023007014]

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Haakon Hop, Anette Wold and Ole Arve Misund (Editors).
Norwegian Polar Institute, 9296 Tromsø, Norway

Cruise overview

The purpose of the cruise was to conduct research on the pelagic ecosystem on the slope of the Nansen Basin of the Arctic Ocean and to promote capacity and network building among international students from circumpolar nations with Arctic connections. The cruise was carried out using RV *Kronprins Haakon* and was organized by the Norwegian Polar Institute.

The financing of the cruise was through the ordinary allocation of funds from the Royal Norwegian Ministry of Climate and Environment to the Norwegian Polar Institute and from a project issued by the Royal Norwegian Ministry of Foreign Affairs to the Norwegian Polar Institute.

The Arctic Ocean has been estimated to warm twice the global mean rate in the upper 2000 m. The blue waters are expanding into the currently ice-covered area of the Nansen Basin, which forms together with the Amundsen Basin the Eurasian part of the Central Arctic Ocean. The Arctic amplification is predicted to accelerate with increased transport of warm and saline Atlantic water into the CAO (Atlantification). The Arctic Ocean is in fast transit towards an ice-free condition with ongoing climate change. Svalbard, northern Barents Sea and the Nansen Basin are the areas that are experiencing the largest changes. A selected area of the Arctic Ocean North East of Svalbard into the Nansen Basin was the focus of the research cruise.

International students were invited to participate on this cruise. On board they were cooperating with scientists and their research in the fields of physical and biological oceanography, sea ice, pelagic ecosystem and contaminants. They participated in the data acquisition and will also have the opportunity to use the collected material and data in their own research. An interactive series of talks and discussions on Arctic changes, issues, strategies and policies were important parts of the cruise.

Data availability

Data collected during the cruise are made available through the Norwegian Polar Data Centre (https://data.npolar.no/). Measurements from different disciplines are contained in separate datasets with separate DOIs, but all measurements from the cruise are linked with the tag: NPI-AO-2023-2.

Acknowledgements

Thanks to captain Hallgeir M. Johansen ship's crew of RV Kronprins Haakon, and the international students from USA, Canada, Greenland, Iceland, Sweden, Finland and Norway.

Contents

Participants

1. Ole Arve Misund (NPI)-EK80 Hydroacoustics-Cruise Leader
2. Haakon Hop (NPI)-Fish trawling, zooplankton-Chief Scientist
3. Anette Wold (NPI)-Zooplankton-Ass. Chief Scientist
4. Nalan Koc (NPI)-Student Responsible Leader
5. Cecilie von Quillfeldt (NPI)-Phytoplankton, ice algae, env. management
6. Marika Marnela (NPI) - Oceanography
7. Lucie Goraguer (NPI) – Chlorophyll *a*, water samples
8. Vegard Stürzinger (NPI) - Fish trawling, zooplankton
9. Rupert Krapp (NPI-OLA)- Logistics, polar bear safety
10. Jacob M. Christensen (UiT-SUDARCO) - Fish genetics, University of Tromsø, Norway
11. Juni Bjørneset (NPI-Norge) - Fish trawling, zooplankton
12. Sofie Hauge Andersen - International student, Aarhus University, Denmark
13. Einar Pétur Jónsson-International student, Marine and Freshwater Research Institute (MFRI), Iceland
14. Flore Wijnands - International student, Stockholm University, Sweden
15. Sonja Gindorf - International student, Stockholm University, Sweden
16. Matias Uusinoka - International student, Aalto University, Finland
17. Concepcion (Connie) Melovidov - International student, University of Alaska Fairbanks, USA
18. Emily Stidham - International student, University of Alaska Fairbanks, USA
19. Per-Henning Mathisen - International student, University of Tromsø, Norway
20. Aurora Heim - International student, University of Tromsø, Norway
21. Malou Platou Johansen - International student (Greenland/Denmark), University of Tromsø, Norway
22. Bryan Vandenbrink - International student, University of Guelph, Canada
23. Sean Mack - International student, Aleut International Association (AIA), Alaska, USA
24. Jessica Cook (AC-Norway) - Outreach
25. Mario Acquarone (AMAP-Norway) - Marine mammals
26. Elizabeth McLanahan (PAME-USA)

Instrument engineers

Roy Robertsen (IMR)

Hans Christian Eide (IMR)

Transects from Svalbard shelf to the deep Nansen Basin

Initially, the cruise followed the outlined plan, with CTD and biological stations with plankton nets and trawling along Western Transect 1 (Figure 1). From the end of this transect we continued north-east to the location of the Nansen 1 mooing (N83°56' E22°15') in the Nansen Basin. An Ice station with sampling was performed on a suitable floe north of this location. Subsequently we proceeded southward along the Nansen transect which constituted our Transect 2 with denser stations involving biological sampling as we approached the continental slope.

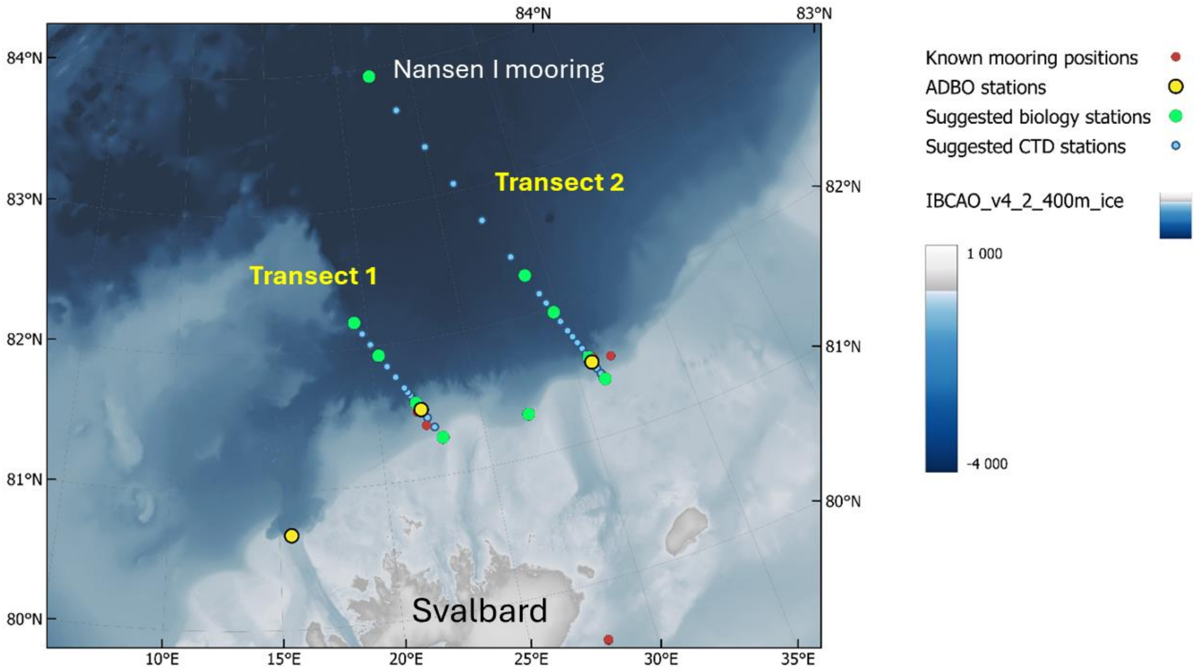

Figure 1. Arctic Ocean Cruise track with CTD and net stations related to latitude-longitude positions. ADBO = Arctic Distributed Biological Observatory stations for monitoring.

Shipboard CTD measurements

Contact: Marika Marnela (Marika.Marnela@npolar.no), NPI

General approach

The CTD used was an SBE911+ unit. The T, S and O_2 ducts were flushed with Triton-X and freshwater between stations or kept dry to avoid problems with icing (Table 1). At the beginning of stations, the CTD was lowered to 10 dbar and allowed to soak until the pump started and sensors stabilized. The CTD was brought to the surface and then lowered to within 10 m of seabed as determined using the altimeter. Data acquisition was generally initiated just before deployment with the CTD on deck and allowed to run until the CTD was back on deck at the end of the cast. The CTD was lowered over the side of the ship. Niskin bottles were closed using the bottle fire command within the Sea-Bird acquisition software so that a .bl file was created for each deployment. NMEA time and position information were fed to the acquisition computer and added to each scan line of the data files. Cast positions and starting times were also automatically added to the header of all data files. Note that the first station completed during Arctic Ocean 2 in 2023 has the number 179 and not 001. The vessel operators specify numbers assigned to CTD stations. The first cast each year has the number 1 and subsequently casts are numbered sequentially. Stations 179-192 and 215-221 were taken with a big rosette with 24 Niskin bottles from the main CTD hangar and the in between stations 193, 195-214 from the smaller adjacent room with a small rosette with 12 Niskin bottles. The rosette and winch were changed due to a failure on winch cable in the main hangar. After the problem was fixed, the big rosette was taken back into use. The CTD and sensors were the same throughout the cruise. On the deep biological stations two casts were made when using the smaller rosette to obtain all the water samples. First a shallow cast to 400 m and then the deep one. During biology stations, 5 Niskin bottles were typically bleached and the order of the bottle firing was non-sequential.

CTD Sections

Two CTD sections were taken. The sections were designed to reach from the Svalbard shelf edge well into the deep basin. They were also designed to contain two suggested ADBO (Atlantic-Arctic Distributed Biological Observatory) stations and other previously visited locations and to run parallel. Station times and positions are shown in Table 2 and positions in Figure 2 as well. In total, 39 stations were completed between 81 °N and 84 °N (station 16 was skipped so the numbering goes to 40), 38 of these with CTD measurements. The densest station spacing was at the Svalbard shelf slope to cover the slope current with the Atlantic Water core. The first section is lacking a CTD cast at the end due to a later solved winch problem in the main CTD hangar. Potential temperature and salinity at transects 1 and 2 from uncalibrated data are presented in Figure 3.

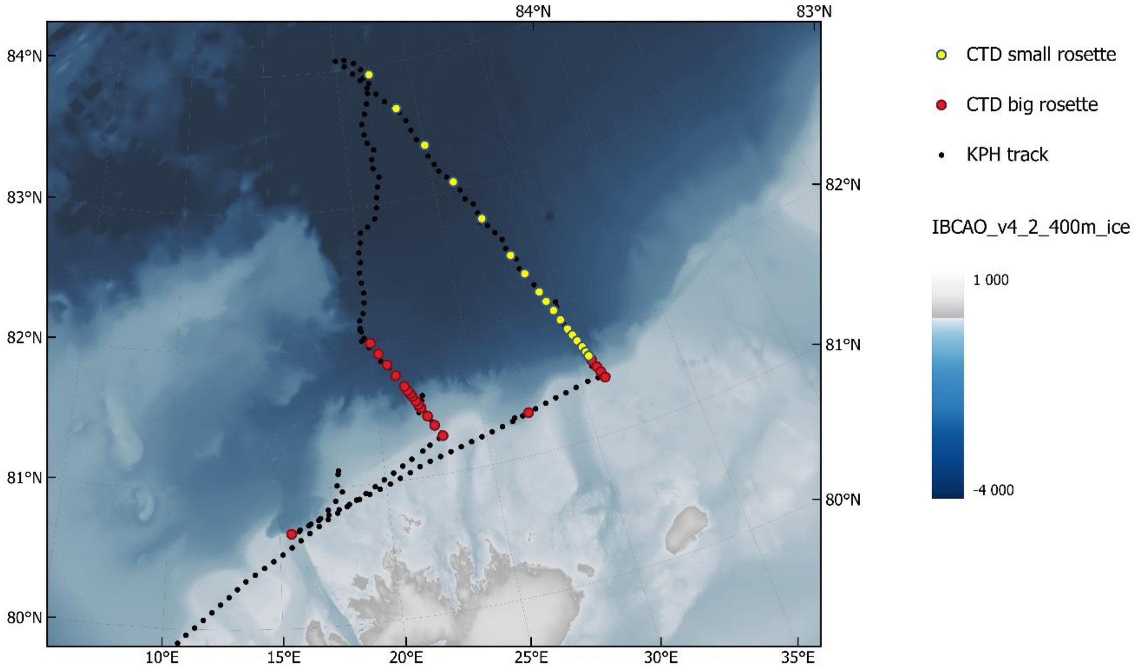

Figure 2. Location of cruise track with CTD profiles.

Salinity calibration

Laboratory salinity measurements are used to validate and (if necessary) calibrate conductivity sensors on the CTD. Salinity samples were collected on all deeper casts of a station, mostly from the bottom. 250 ml glass sample bottles were filled from Niskin bottles and 2 out of 5 of the crates containing the sample bottles were analysed onboard using a Guildline Portasal salinometer (8410A, SN 74176). The air temperature remained at 19 +- 1 °C for the start of the cruise and the bath temperature was set at 21 degrees for the analysis. Samples were stored next to the salinometer for at least 24 h before analysis and the salinometer was standardized with OSIL P-series standard seawater with reference salinity 34.995 before and after each batch of 23 samples. After room temperature rise, the salinometer bath temperature was changed to 22 °C, but it did not remain stable. The salinometer read values that were 4-5 units too low and unstable. REF and ZERO did not solve the problem. The salinometer was switched off and on again, but due to a large fluctuation in the room temperature (22-24 °C) possibly due to a radiator issue in the room, it was not attempted again to analyse the remaining bottles while steaming toward Longyearbyen. It was after the cruise found out that the drive belt for the stirrer had snapped which meant that the water bath was not stirred, and the salinometer did not maintain a stable temperature needed to make measurements. This was fixed ashore by replacing the drive belt. The last 3 crates with salinity samples were analyzed in the NPI lab in Tromsø after the cruise at 25 °C bath temperature and 23 °C room temperature. The data will be processed at NPI.

Table 1. CTD Package configuration

Channel	Sensor	Serial Number	Last Calibration
Frequency	Temperature 1	5884	14-Oct-2022
Frequency	Conductivity 1	2860	18-Oct-2022
Frequency	Pressure	141612	19-Dec-2017
Frequency	Temperature 2	6504	12-Oct-2022
Frequency	Conductivity 2	3123	18-Oct-2022
A/D Voltage 0	Oxygen, SBE43	3785	29-Nov-2022
A/D Voltage 1	Altimeter	73084	24-Dec-2017
A/D Voltage 2	Fluorometer, WET Labs ECO-AFL/FL	FLRTD-6506	18-Sep-2020
A/D Voltage 3	(Free)	N/A	N/A
A/D Voltage 4	Transmissometer, WET Labs C-Star	CST-2003DR	2019-10-01
A/D Voltage 5	Fluorometer, WET Labs ECO CDOM	FLCDRTD-4531 NPI	12/05/2023

Table 2. CTD station dual indexing, positions, times and max pressure.

Station	Lat	Lon	Max press	Date	Time	Local stati
st01	81.2759	22.9721	185	12.08.23	17:43:20	179
st02	81.3604	22.6584	390	13.08.23	01:09:45	180
st03	81.4341	22.4056	597	13.08.23	02:30:38	181
st04	81.5007	22.1597	880	13.08.23	03:56:48	182
st05	81.5271	22.0499	993	13.08.23	17:33:53	183
st06	81.5524	21.9556	1525	13.08.23	18:43:22	184
st07	81.5936	21.8304	1981	14.08.23	12:10:23	185
st08	81.6125	21.7304	2505	14.08.23	14:02:24	186
st09	81.6393	21.6209	3018	14.08.23	16:12:34	187
st10	81.6740	21.4855	3219	14.08.23	18:30:02	188
st11	81.7601	21.1348	3370	14.08.23	21:20:22	189
st12	81.8394	20.8155	3471	15.08.23	00:34:39	190
st13	81.9249	20.4322	3489	15.08.23	04:48:57	191
st14	82.0154	19.9900	3625	16.08.23	01:04:32	192
st17	83.9469	22.1835	400	17.08.23	19:15:11	193
st17	83.9452	22.1614	20	17.08.23	20:23:54	194
st17	83.9438	22.1420	4092	17.08.23	21:17:42	195
st18	83.6672	23.6610	4093	19.08.23	02:27:12	196
st19	83.3687	24.9855	4079	19.08.23	11:35:56	197
st20	83.0571	26.1842	4062	19.08.23	18:17:33	198
st21	82.7446	27.4275	3973	20.08.23	01:18:02	199
st22	82.4626	28.3970	3833	20.08.23	08:14:30	200
st23	82.2754	28.8860	400	20.08.23	13:20:27	201
st23	82.2689	28.8829	3704	20.08.23	14:44:48	202
st24	82.1317	29.3071	3557	21.08.23	04:52:05	203
st25	82.0530	29.5314	3461	21.08.23	08:24:12	204
st26	81.9740	29.7720	400	21.08.23	14:24:35	205
st26	81.9728	29.8115	3272	21.08.23	15:34:27	206
st27	81.8934	29.9645	3357	22.08.23	03:51:33	207
st28	81.8131	30.1761	3152	22.08.23	08:35:00	208
st29	81.7646	30.2872	3054	22.08.23	11:15:06	209
st30	81.7155	30.4658	2967	22.08.23	13:57:22	210
st31	81.6601	30.6080	2535	22.08.23	16:39:48	211
st32	81.6159	30.7043	1992	22.08.23	18:37:30	212
st33	81.5840	30.7799	400	22.08.23	22:28:59	213
st33	81.5840	30.7801	1493	22.08.23	23:39:47	214
st34	81.5598	30.8300	1027	23.08.23	09:22:05	215
st35	81.5463	30.8564	870	23.08.23	10:35:50	216
st36	81.4918	30.9953	656	23.08.23	19:38:17	217
st37	81.4481	31.1077	384	23.08.23	20:39:14	218
st38	81.4003	31.2219	186	23.08.23	21:30:46	219
st39	81.3090	27.2068	376	24.08.23	11:17:18	220
st40	80.6853	15.5320	527	25.08.23	09:21:08	221

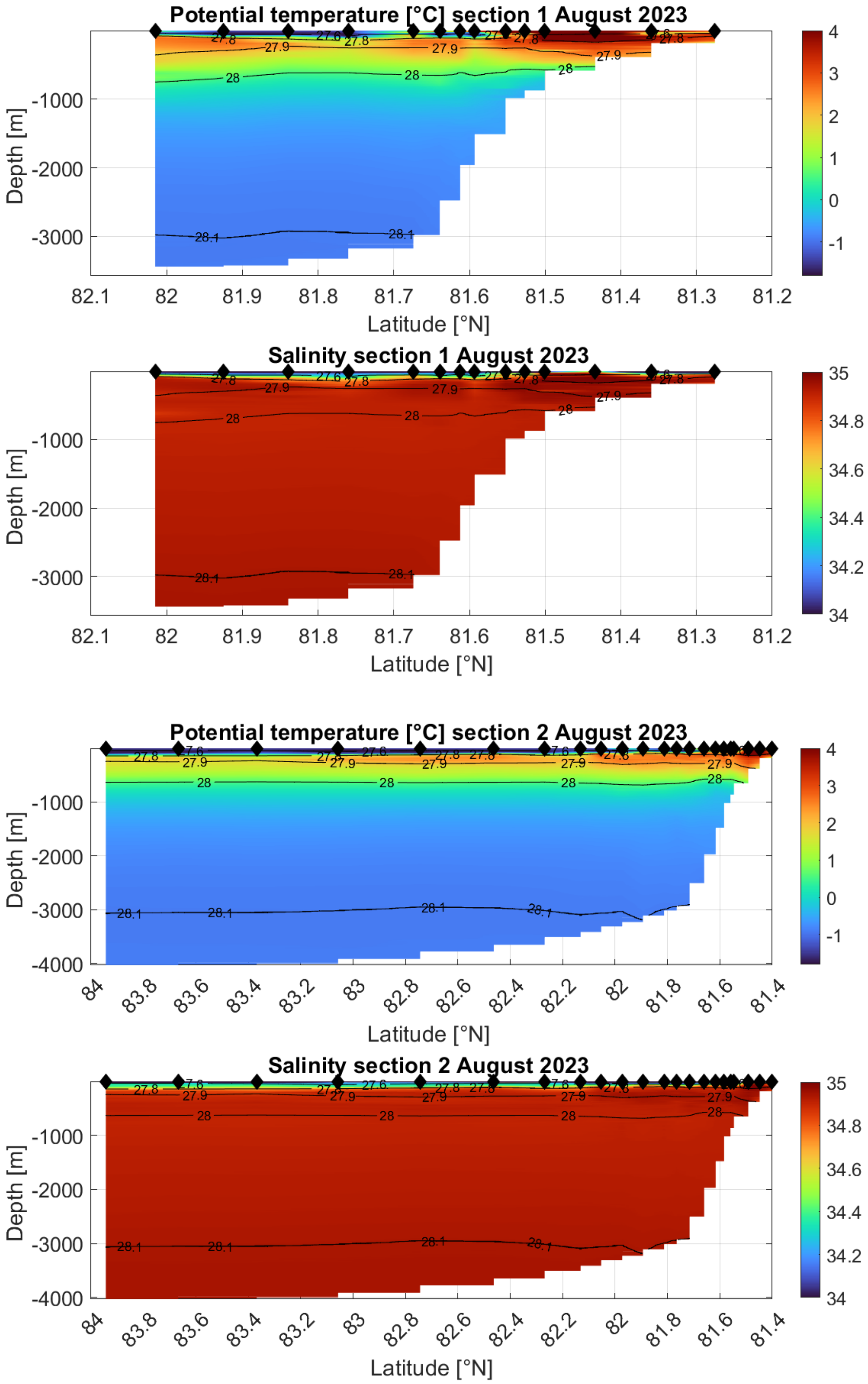

Figure 3. Potential temperature and salinity at Transects 1 and 2 from uncalibrated data.

Phytoplankton/microscopy/Chlorophyll *a* /POC/PON

Contacts: Lucie Goraguer (Lucie.Goraguer@npolar.no), Philip Assmy (Philipp.Assmy@npolar.no), NPI

Water sampling

Parameters: Phytoplankton microscopy, Chlorophyll *a*/Phaeopigments, Particulate Organic Carbon/Nitrogen (POC/PON) and nutrients

Water was sampled at 8 standard depths (5, 10, 25, 50, 75, 100, 200 and 400 m, see Table 3) in addition to the depth of deep chlorophyll *a* maximum (DCM) using Niskin bottles attached to a rosette combined with CTD.

Chlorophyll *a* was sampled for different size fractions with different filter type:

GF/F >0.7 µm: for Chl *a* total, 3 µm and 20 µm: for larger Chl *a* size fraction. Concentrations were determined on board using a Turner Trilogy fluorometer. Overall, the total chlorophyll *a* concentration was low (<1.6 µg L-1) for both transects (Figure 4).

For the samples for chlorophyll *a*, POC/PON, and nutrients, volumes of (250 to 1400 ml) were filtered for triplicates onto pre-combusted GF/F filters. At the last two stations (St. 39 and St. 40), only 1 filter was used per each depth (no triplicate). Filters were dried at 60˚C for approx. 24 h and packed either in the plastic cup or aluminium foil for further analysis.

The nutrient samples were fixed with 200 µL of Chloroform: Trichloromethane and stored in 20-mL vials in a cool room (4 °C).

Phytoplankton samples (190 mL) were fixed with 0.8 ml GLA 25% + 10 ml hexamine-buffered formaldehyde 20%. The taxonomy samples were packed for further microscopic analysis at the Institute for Oceanology (IOPAN, Sopot, Poland).

Table 3. Biological parameters sampled during the main water stations.

Stn	Depth (m)	Phytoplankton net	Chl. *a*	Microscopy (Phytoplankton/ice algae)	POC/PON	Nutrients
Water station						
	5		x	x	x	x
	10		x	x	x	x
	25		x	x	x	x
	50		x	x	x	x
	75		x	x	x	x
	100		x	x	x	x
	200		x	x	x	x
	400		x	x	x	x
	DCM		x	x	x	x
	0-50 m	x				
Ice st.						
			x	x		

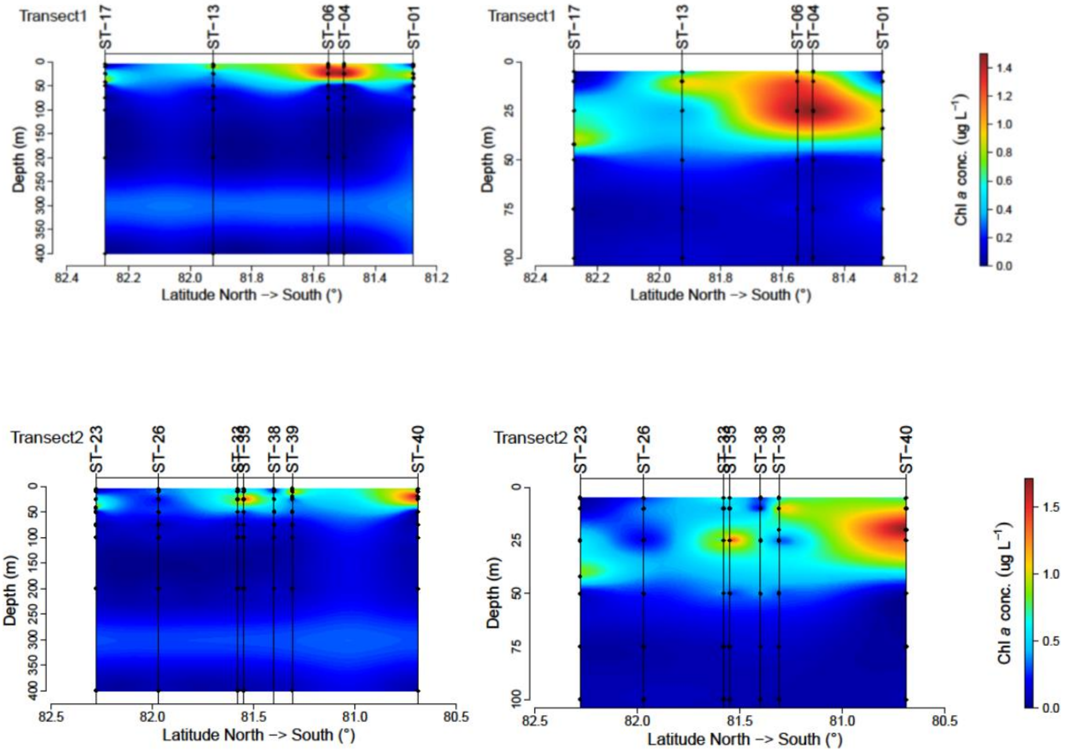

Figure 4. Chlorophyll a concentration along Transect 1 (top) and Transect 2 (bottom), from north to south, with upper 400 to the left and upper 100 m to the right.

Ice sampling work:

Parameters: biological: phytoplankton microscopy and Chl *a*/Phaeo, physical: temperature and salinity

A short ice station was sampled with scientific and teaching purposes. Several ice cores were taken (Table 4) for biological parameters such as: Chl *a*/phaeopigments, ice algae, and physical parameters, such as temperature and salinity (Figure 5).

The total chlorophyll a was measured by GF/F filter (1 filter per ice section) for the following ice sections: 0-3, 3-10, 10-20, 20-30 cm and every 20 cm sections, by pooling 3 ice core bio bulk together. Overall the total Chl *a* concentration was very low at all stations with < 0.03 µg L^{-1} (Figure 6)

Sea-ice algae samples were taken from 3 cores for the sections 0-3 and 3-10 cm. The samples (90 mL) were fixed with 0.4 mL of glutaraldehyde (0.1 % final concentration) and 10 mL of hexamine-buffered formaldehyde (1% final concentration) and packed for further microscopic analysis at IOPAN.

Table 4. Ice cores sampled for the different parameters.

#core	Core name	Parameter
1	Physic 1	Temperature (*in situ*)
2	Physic 2	Salinity
3	Bio-bulk 1	Chl a
4	Bio-bulk 2	Chl a
5	Bio-bulk 3	Chl a
6	Ice algae	Taxonomy
7	Ice algae	Taxonomy
8	Ice algae	Taxonomy

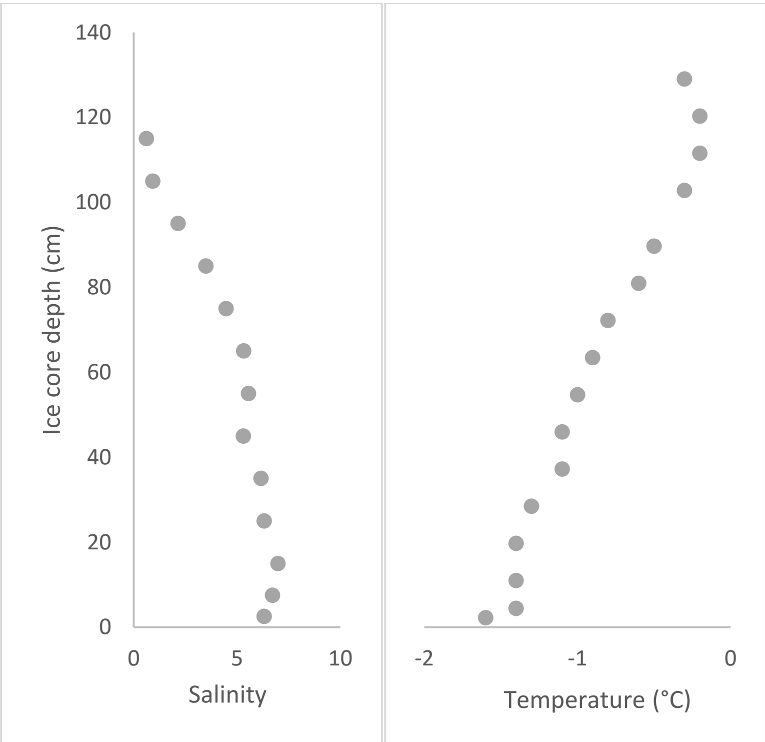

Figure 5. Ice core salinity and temperature (°C).

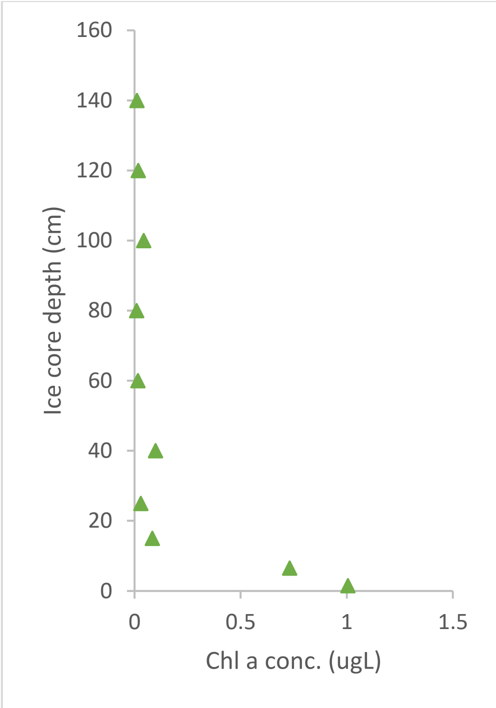

Figure 6. Ice core total chlorophyll a concentration (ug L^{-1})

Phytoplankton taxonomy

Contact: Cecilie H. von Quillfeldt (Cecilie.von.Quillfeldt@npolar.no), NPI

Introduction

A suite of environmental variables (e.g. sea ice, nutrients, light, water stratification, salinity, temperature) determine abundance, biomass, primary production and taxonomic composition through time (Poulin et al. 2011)[1]. Changes in these variables as a result of climate change may have substantial effects on primary producers (Figure 7).

Net and water samples for phytoplankton taxonomy were taken to study the community composition of phytoplankton. The aim was to:

1) Give an introduction to the protists[2] north of Svalbard.
2) Investigate how the species composition and abundance of protists vary at different sites and how this is related to physical parameters (e.g. dominant water masses) and season.
3) Investigate how different size fractions contribute to primary production.

[1)] Poulin, M., Daugbjerg, N., Gradinger, R., Ilyash, L., Ratkova, T., & von Quillfeldt, C. H. 2011. The pan-Arctic biodiversity of marine pelagic and sea-ice unicellular eukaryotes: A first-attempt assessment. *Marine Biodiversity* 41, 13–28.

[2)] Protist, any member of a group of diverse eukaryotic, predominantly unicellular microscopic organisms.

Figure 7. Altered light conditions (due to thickness and structure of the ice, amount of snow on top of the ice, thawing/freezing, i.e. length of season with open water, will affect primary producers in the water column (and in the ice). Photo: Cecilie H. von Quillfeldt (NPI).

Methods

Sampling

Niskin bottles: Seawater from six standard depths (5, 10, 25, 50, 75 and 100 m) in addition to the depth of the Chl *a* maximum was collected using a Niskin bottle rosette at type A CTD casts (Figure 8). 190 mL of sample was fixed with 0.8 mL of 25% glutaraldehyde and 10 mL of 20% hexamine-buffered formalin solution at final concentrations of 1% respectively and stored dark.

Phytoplankton net hauls: Phytoplankton net haul sampling were used for qualitative collection of protists. A phytoplankton net (10 µm mesh size) attached to a metallic frame (Figure 8) was used to filter water from 50 m to the surface. Each sample of 90 mL was fixed with 3.0 mL of strontium chloride stock solution and 10 mL of 20% hexamine-buffered formalin solution at final concentrations of 2% and stored dark.

In addition, a handheld phytoplankton net (20 µm mesh size) (Figure 8) was used to collect phytoplankton from below Chl *a* maximum to the surface. When large diatoms and dinoflagellates are present, in addition to colonies of some other groups, this net often provides more material than a 10 µm net, but most small organisms are lost. Thus, it may be useful to document live material on board to get an impression of dominant species in the water column.

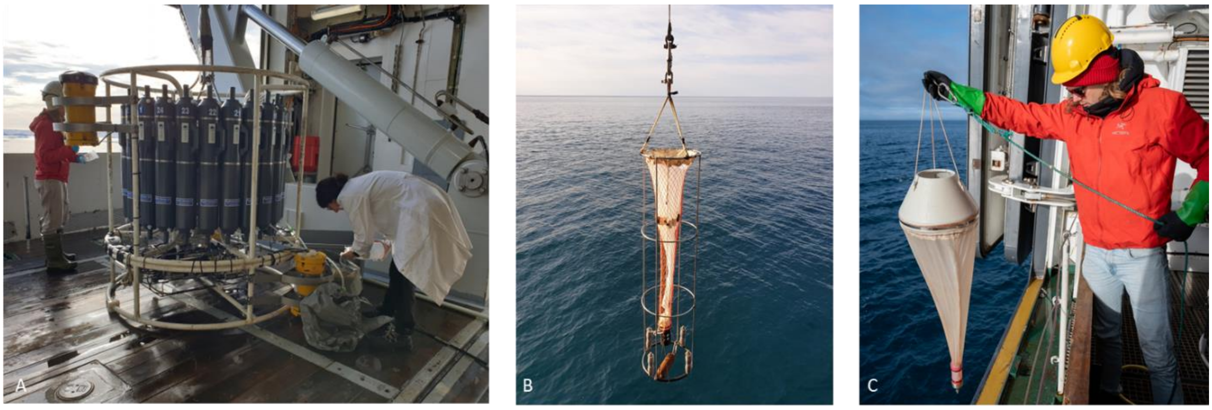

Figure 8. Niskin bottle rosette (A) and phytoplankton net, 10 µm (B) and 20 µm (C), respectively. Photo: C.H. von Quillfeldt (A & B), J. Cook (C).

Sample locations for the 20 µm net hauls are in Appendix 3. Except for station 15, the 10 µm net was used at the same stations. At station 1 and 40 (A-DBO) only 10 µm phytoplankton net hauls were taken. Sea water for absolute abundances were taken at the same stations as the 10 µm phytoplankton net. Fixed samples were later shipped to IOPAN (Sopot, Poland) for microscopic identification and analysis.

Analyses on board

Light microscopy (LM) was used to investigate the species composition of protists in the 20 um net hauls (Figure 9). As many groups and species as possible were identified and their relative abundance at each locality estimated.

a) b)

Figure 9. Microscope work on board RV Kronprins Haakon. Photo: C.H. von Quillfeldt (a), J. Cook (b).

Preliminary results

All stations showed a typical summer situation, but with variable blooming stages and species composition. A combination of location and ice cover and, thus, stage of the bloom, explains the differences.

Large diatoms were among the dominant or common ones (Figures 10, 11), but with an increasing relative abundance of smaller species (e.g. *Chaetoceros brevis*) at the northernmost stations. A few spring species, often with resting spores (Figure 12) occurred indicating that the spring bloom was over. Dinoflagellates were always present but increasing in diversity and abundances towards the end of the cruise (Figures 10, 11). *Dinobryon balticum*, a common golden alga during summer and autumn in the Arctic, was among the dominant or common ones at some stations, but absent or in low number at other stations (Figure 10). Some of the species had identifiable resting spores (Figure 12). *Nitzschia frigida*, a typical ice alga, occurred together with species common in ice covered waters and remains of ice algal communities at several of the stations, but never in high abundances and often in bad conditions, except for a few times at high sea ice concentrations (Figure 13). Representatives of several groups of organisms other than protists, often in high abundances, also occurred in the net samples (Figure 14). Faecal pellets were present at all stations, often in high abundances (Figure 15). Some of them had evidence of ice algal grazing, e.g. on *Polarella glacialis* and *N. frigida*. The last station (A-DBO) had a somewhat different species composition with a higher relative abundance of species typical for more southern, Atlantic communities, e.g. *Dactyliosolen fragilissimus.*

Figure 10. Typical dominant species (both diatoms and dinoflagellates) from some stations. Photos: Cecilie H. von Quillfeldt.

Figure 11. Examples of other species found regularly, or a few times. Photos: Cecilie H. von Quillfeldt.

Figure 12. Typical spring species with resting spores (arrow). Photos: Cecilie H. von Quillfeldt.

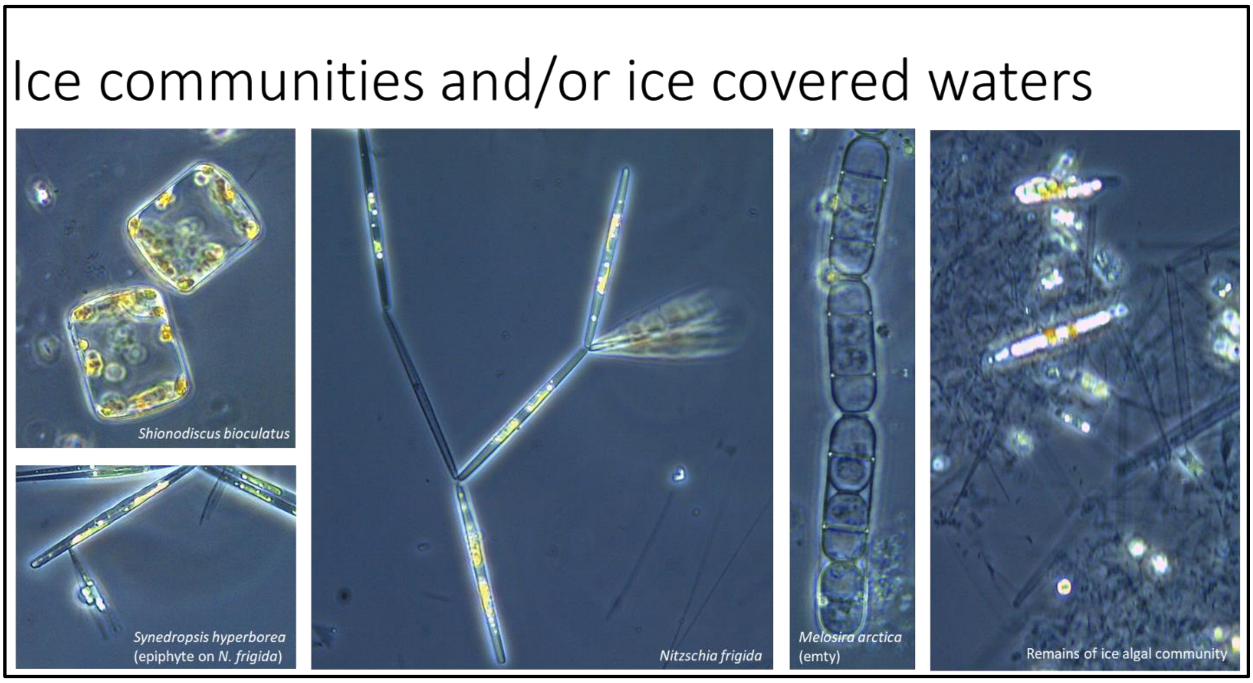

Figure 13. Typical ice algal species (or remains of ice algal communities) that may occur in net samples taken in ice covered waters, or in areas which was recently ice covered. Shionodiscus bioculatus *can also occur in phytoplankton spring blooms. Photos: Cecilie H. von Quillfeldt.*

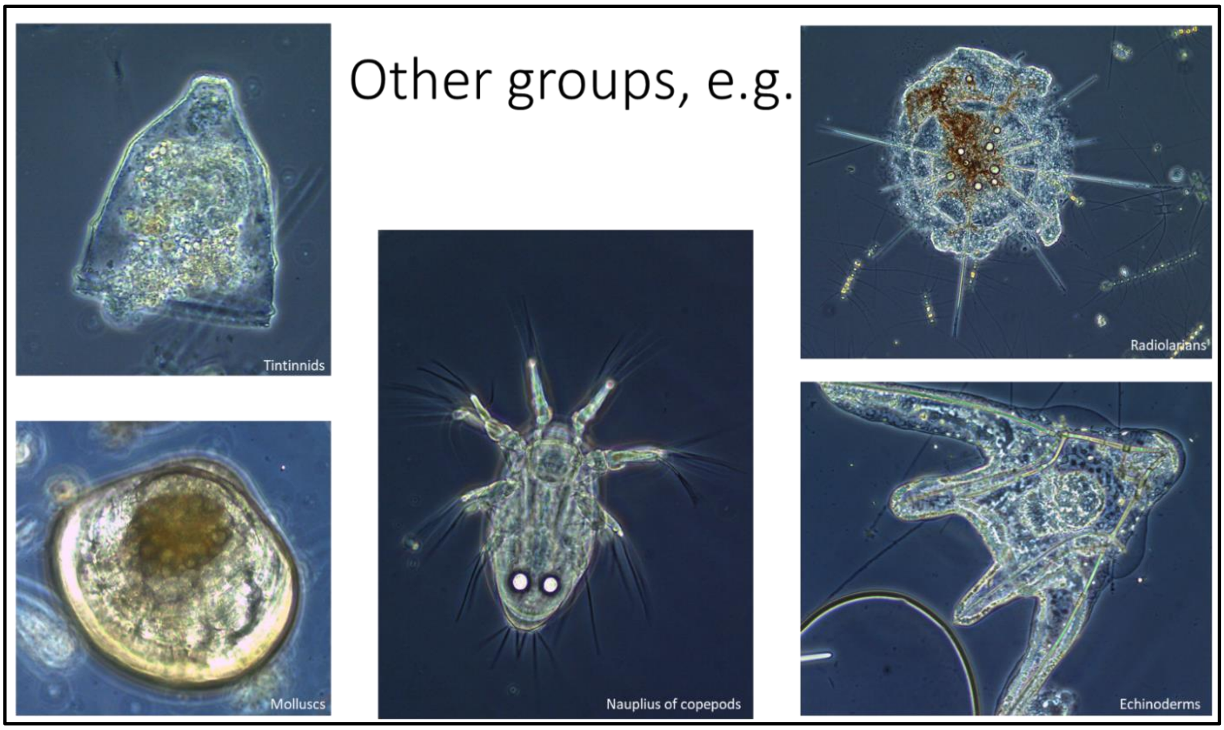

Figure 14. Zooplankton from many different groups occurred in the phytoplankton net. Photos: Cecilie H.von Quillfeldt

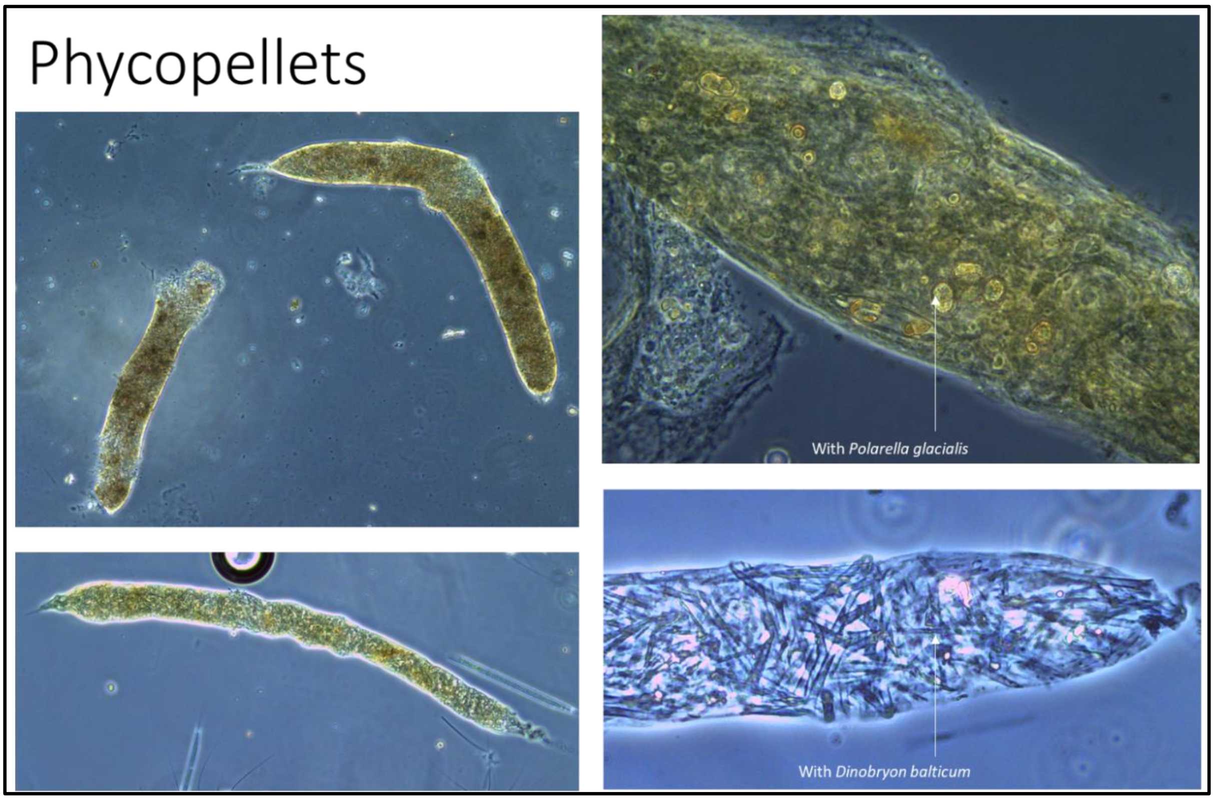

Figure 15. Faecal pellets of many types and sizes occurred at all stations, sometimes quite abundant. Some showed grazing on ice communities (with for example Polarella glacialis *and* Nitzschia frigida*) others on phytoplankton (with for example* Dinobryon balticum*). Photos: Cecilie H. von Quillfeldt.*

Phytoplankton collection for experimental cultures

Contact: Einar Pétur Jónsson (einar.petur.jonsson@hafogvatn.is), Marine and Freshwater Research Institute (MFRI), Iceland

Phytoplankton samples were collected with the intention of establishing monocultures of select species from the Arctic phytoplankton community in order to study their response to changes in temperature and pH. Increased attention is given to multi-stressor studies and these monocultures form part of the multi-stressor experimental plan at the Marine and Freshwater Research Institute of Iceland.

Water samples were taken from the DCM at the stations indicated in Table 5, and from the bottom 15 cm of the ice core station. After filtering through 64 µm to filter out zooplankton, the phytoplankton concentration was increased by filtering water through a 0.22 µm G/FF filter. A small (50 mL) sample was then placed in a culture chamber at 4°C with 25-50 photon light.

In order to choose appropriate stressor levels for subsequent experiments, water samples for total alkalinity were taken alongside the plankton samples from Niskin bottles. Total alkalinity information gives the pH level and both temperature and salinity were measured by the CTD parallel to the water collection.

Filtered seawater was collected from the transects to gently transition the organisms into other seawater when establishing the monocultures.

Table 5. Water samples were taken from the DCM at the stations indicated and from the bottom 15 cm of the ice core station.

Station	Sample depth	Bottom depth	DMO	Lat	Lon	Ice status
6	25	1499	25	81.5524	21.9556	Visible, few chunks
13	12	3430	12	81.9249	20.4322	Ice all around
13	12	3430	12	81.9249	20.4322	Ice all around
17	25	4023	25	81.9249	22.1835	Ice 2 m thick
Ice	0	NA		84.0898	20.0730	Ice 1.5 m thick
Ice	0	NA		84.0898	20.0730	Ice 1.5 m thick
23	42	3737	42	82.2754	28.8860	Ice >1 m thick
26	50	3313	50	81.9728	29.8115	70% ice < 1 m thick
33	25	1952	25	81.5840	30.7799	No ice
35	25	868	25	81.5463	30.8564	30% ice
38	25	193	18	81.4090	31.2219	No ice
39	18	379	18	81.3090	27.2068	No ice
40	20	527	20	80.6853	15.5322	No ice

Mesozooplankton and macrozooplankton sampling

Contact: Anette Wold (Anette.Wold@npolar.no), Norwegian Polar Institute

Introduction

The main objective of the work was to collect samples to study the zooplankton community in terms of taxonomic composition, abundance and biomass, with sampling along the transects (Figure 16).

Sampling Methods

Mesozooplankton was sampled with Multiple Plankton Sampler MultiNet type Mammoth (Hydro-Bios Kiel, 9 nets, opening: 1.0 m^2, net length: 550 cm, mesh size: 180 µm, Figure 17). Macrozooplankton was sampled with MIK net (Midwater Ring Net, opening: 3.14 m^2, net length: 13 m, mesh size: 1.6 mm µm and 500 µm (last metre).

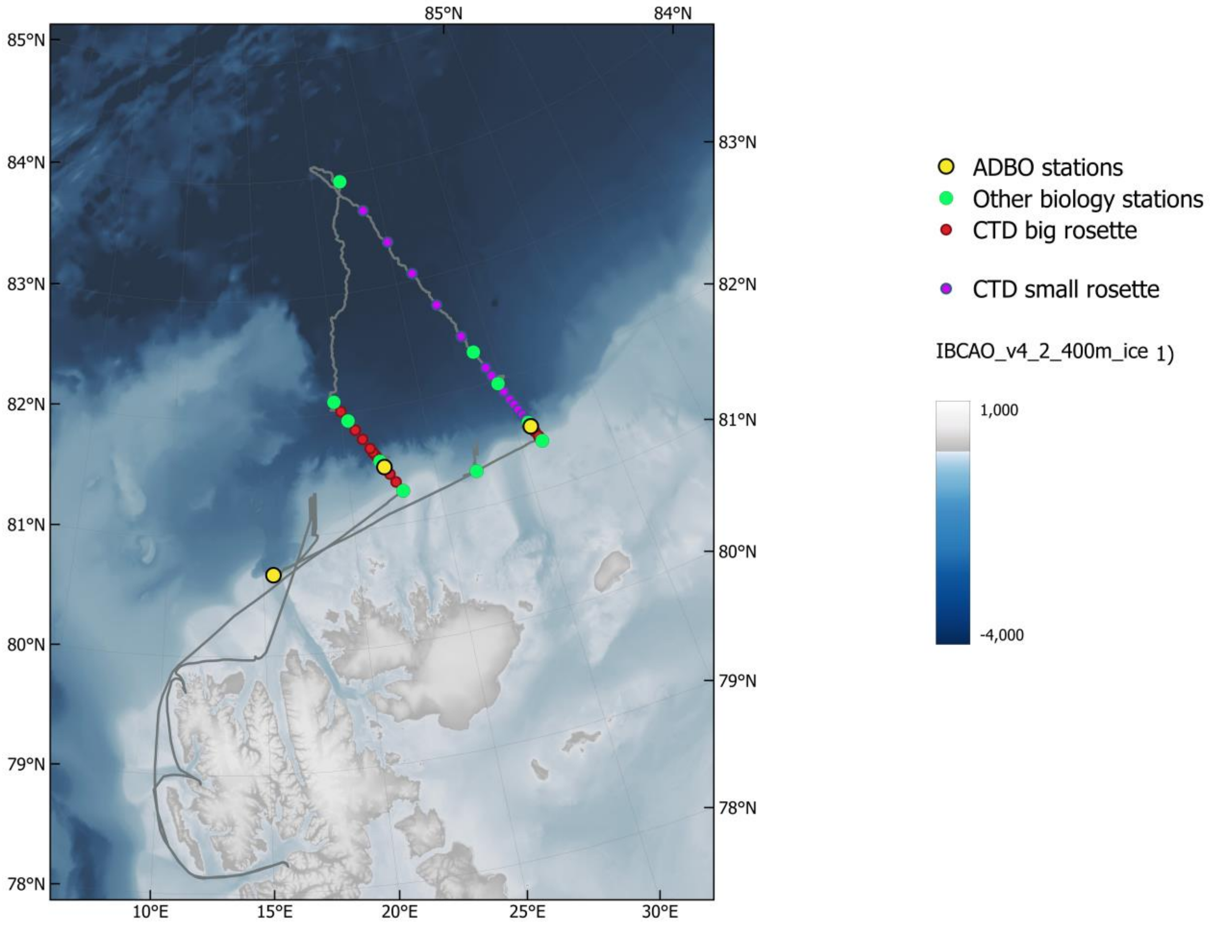

Figure 16. Biological sampling stations during the Arctic Ocean cruise.

Mesozooplankton - Mammoth multinet

Depth stratified samples were taken with the MultiNet Mammoth (from the following depths Bottom-2000-1500-1000-600-200-100-50-20-0 m, but at the stations shallower than 2000 m less than 9 nets were used (Table 6). Samples from MultiNet Mammoth were preserved in buffered 4% formaldehyde for mesozooplankton abundance/taxonomy (community samples; Table 7). Examination of these samples will be conducted at Plankton Ecology Laboratory at the Institute of

Oceanology (IO PAN) in Sopot, Poland, as a part of long term collaboration in Arctic zooplankton ecology studies. During the first transect samples from the second Mammoth deployment were preserved in 96% EtOH and stored at -20 °C. The genetic samples will be used for metabarcoding analysis, the results of which will then be compared with the results of the community-sample analysis based on morphology to compare the faunal findings of between these two methods. For the deep station (st15 and 17), we only did one deployment of the Multinet Mammoth and the samples were split into two, one sample for taxonomy and one for metabarcoding. During the second transect, we only took samples for taxonomy.

Figure 17. MultiNet Mammoth, sampling capacity: 9 depth strata, opening area: 1 m^2. Photo: Anette Wold (NPI)

Macrozooplankton - MIK (method Isaac Kidd) net

The MIK net was deployed down to the bottom or to a maximum depth of 1000 m only at the deep stations. All gelatinous species from the net catch were removed, sorted to taxa/taxonomic groups and stored at 3 °C for later identification (see below). The remaining sample was split into two parts. One part was preserved in buffered 4% formaldehyde for abundance/taxonomy, and the other part was preserved in EtOH for metabarcoding.

Gelatinous zooplankton

Each gelatinous organism selected from the MultiNet deployment dedicated to metabarcoding and the MIK deployment was measured and photographed on a light table. Individuals were picked up using a metal spoon with holes and excess water was removed by blotting using a paper towel under the spoon. The individuals were then weighed and afterwards stored in 96% EtOH at -20°C for genetic analysis by Sanna Majaneva at Akvaplan-niva/NTNU.

Brief observations of the mesozooplankton community from MultiNet and MIK net sampling

Below is a brief description of the zooplankton community based on visual observations of the samples during processing and not based on thorough observations under stereomicroscope. It only includes observation of the larger specimens and not the smaller specimens.

Shallow(st01, st38)

The shallow stations were dominated by smaller copepods like *Pseudocalanus* spp. and copepodid stages of *Calanus finmarchicus* and *Calanus glacialis* with high numbers in the surface layers as well as high numbers of appendicularia *Oikopleura vanhoffeni* especially at st38. Fewer amphipods and krill were caught at the shallow stations than at the deeper ones.

Table 6. Overview of sampling depths for different zooplankton nets

Gear	Stations	Sampling depth
MultiNet 180 µm	Shelf (st01, 38)	Bottom-150-100-50-20-0m
MultiNet 180 µm	Slope (st04, 35,39 & 40)	Bottom-200-150-100-50-20-0m
MultiNet 180 µm	Slope (st06,33)	Bottom-600-200-150-100-50-20-0m
MultiNet 180 µm	Deep (st13, 15, 17, 23, 26)	Bottom-2000-1500-1000-600-200-100-50-20-0m
MIK 1500 µm	All stations	Bottom/ 1000-0m

Table 7. Overview of mesozooplankton and macrozooplankton community samples

Gear	Sample type	Stations	Number of samples
MultiNet 180µm	Mesozooplankton Taxonomy	1,4,6,13,15,17,23,26,33,35,38,39,40	95
	Mesozooplankton Metabarcoding	1,4,6,13,15,17	47
MIK net 1.6mm	Macrozooplankton Taxonomy	1,4,6,13,15,17,23,26,33,35,38,39,40	13
	Macrozooplankton Metabarcoding	1,4,6,13,15,17,23,26,33,35,38,39,40	13

Slope (st04, st06, st33, st35)

There was a higher concentration of *Calanus finmarchicus* especially in the surface end intermediate layers. Concentrations of chaetognaths and the amphipod *Themisto abyssorum* were also high.

Deep stations (st13, 15, 17, 23, 26)

At all deep stations, the zooplankton community within the upper 50 m water layer was dominated by calanoid copepod *Calanus hyperboreus*, in addition to cyclopoid copepod *Oithona similis* and calanoid *Metridia* (most probably *M. longa*). At st15 and 17 in the ice, we observed high numbers of appendicularia (*Oikopleura vanhoffeni*) in surface waters. The houses of this appendicularian were visibly covered by brownish spots, most likely algal cells. The intermediate depths were characterized by higher abundance of *Metridia* (*M. longa*), *Microcalanus* spp. and *Triconia borealis.*

The deeper layers had a higher diversity with several large-sized Arctic copepods at depths, the most dominant were *Paraeuchaeta* spp. *Gaetanus brevispinus* and *G. tenuispinus*. Among other noticeable large zooplankton were the amphipod *Cyclocaris guilelmi*, the decapod *Hymenodora glacialis* and the chaetognath *Eukrohnia hamata*.

Gelatinous zooplankton

Gelatinous zooplankton had relatively low abundance at all stations (Table 8).

Table 8. Overview of number of individuals of gelatinous zooplankton (single individuals) sampled at each station from the MIK nets. All species belong to the Phylum Cnidaria (except for one Ctenophora)

Station	Species	# ind.
st01	*Mertensia ovum*	6
	Beroe spp.	1
st04	*Beroe* spp.	1
	Mertensia ovum	1
	Botrynema brucei ellionora	2
st06	Beroe spp.	3
	Botrynema brucei ellionora	1
st13	*Beroe* spp.	1
st15	*Beroe* spp.	2
	Botrynema brucei ellionora	7
st17	Siphonophore nectophore	15
	Botrynema brucei ellionora	7
st23	*Botrynema brucei ellionora*	6
	Beroe spp.	1
st26	*Botrynema brucei ellionora*	3
	Aglantha digitale (pink)	6
	Siphonophore nectophore (w/amphipod inside)	1
st33	*Beroe* spp.	1
	Botrynema brucei ellionora	1
st35	*Mertensia ovum*	1
	Botrynema brucei ellionora	1
	Beroe spp.	1

Calanus genetics

Contacts: Janne Søreide (Janne.Soreide@unis.no), University Centre in Svalbard (UNIS), and Vegard Stürzinger, NPI

Calanus samples were collected for genetic study. The samples were sorted from Multinet and MIK nets at the following stations. *Calanus* was sorted under stereomicroscope and immediately added RNALater and stored at -80 °C.

Station 23
Calanus hyperboreus (20 ind.) were collected from MIK net.

Station 39
Calanus finmarchicus (20 ind.) was collected from the two upper multinet samples (0-50m)
Calanus glacialis (20 ind.) were collected from MIK net.

Calanus glacialis haplotype study

Kohei Matsuno, Hokkaido University, Anette Wold, NPI

At stations 39 we picked individual *Calanus* for a study on *Calanus* haplotypes (Table 9). Twenty individuals were placed individually in cryovials and preserved in EtOH. Their prosome length was measured prior to fixation or a picture was taken and prosome length was measured based on the image. In addition, five individuals were frozen at -80 °C for fatty acid (FA) analysis, and 3×5 individuals were pooled and frozen for stable isotope analysis. The samples will be analysed by Kohei Matsuno at Hokkaido University, Japan, who received them this autumn.

Table 9. *Calanus* haplotype samples.

Station	Gear	Sample depth (m)	Species	Stage	# ind. Halotype	# ind. FA	# ind. SI
St39	Multinet	0-50m	*Calanus glacialis/ C. finmarchicus*	CV	20	5	3×5

Acoustic fishery survey with SIMRAD EK80 echo sounder

Contacts: Ole Arve Misund (Ole.Arve.Misun@npolar.no), Norwegian Polar Institute,
Roy Robertsen (Roy.Robertsen@hi.no), Institute of Marine Research

RV *Kronprins Haakon* is equipped with state-of-the-art instruments for acoustic surveying of the water column along the ship track. With the chosen survey track from Longyearbyen – west and north of Svalbard – to Transect 1 – the Nansen I mooring – south-east to Transect 2, the Distributed Biological Observatories (DBO's) and return to Longyearbyen. This gave the opportunity to survey the pelagic ecosystem on the shelf and slope of the Atlantic sector of the Polar Ocean. This was done by continuous recordings of the hull-mounted transducers of the Simrad EK80 echo sounder (Table 10) The back scatter (s_v) at the 18, 38, 70, 120, 200 and 333 kHz frequencies was recorded from surface to 500 m depth and stored for subsequent post processing.

Table 10. Operational characteristics of the hull mounted Simrad ES80 echo sounder onboard RV *Kronprins Haakon* during the Arctic Ocean survey, July – August 2022.

Channel	Frequency (kHz)	Beam width (°)	Pulse type	Pulse duration (ms)	Power (W)	Ramping
ES18	18	11°	cw	1.024	1600	fast
ES38B	38	7°	cw	1.024	2000	fast
ES70	70	7°	cw	1.024	750	fast
ES120	120	7°	cw	1.024	250	fast
ES200	200	7°	cw	1.024	150	fast
ES333	333	7°	cw	1.024	50	fast

The echo sounder recordings were post processed using the LSSS software. The 38 kHz recordings were chosen as the main source for the post processing. The post processing was done by setting a lower detection threshold to a volume back scattering strength (s_V) of – 82 dB as recommended for traditional fisheries acoustic surveys. The recordings were integrated to obtain an area back scattering strength (s_A). This was done over distances of five nautical miles using adequate depth layers from surface to 500 m depth. During this process, a nautical area back scattering coefficient for each five nautical mile sailed (nasc/5 nm) was obtained.

Allocation of the recorded nautical area back scattering coefficients to fish species (capelin, cod, mesopelagic species, redfish) or plankton was done based on catches from pelagic trawl stations with the Harstad (in open and ice-covered waters) pelagic trawl, and the MIK or MultiNet plankton samplers hauled vertically. Recordings from the other frequencies were also used in the scrutinizing process when appropriate. Especially the 18 kHz recordings were useful to identify and sort out recordings of false bottom, and the 70, 120, and 200 kHz recordings were used to distinguish plankton recordings from near-surface noise.

When sailing in ice covered waters, RV *Kronprins Haakon* was navigated manually to take advantage of open leads as much as possible along the planned cruise tracks. Often the ship hit the ice at the sides of the leads, and regularly ice breaking was necessary to progress along the planned cruise tracks. In such situations, much noise and vibrations in the hull were detected by the echo sounder.

During the cruise, 1000 nautical miles were post processed using the LSSS system. Noise recordings were removed using the convenient removal functions of the LSSS system. For distances where heavy ice conditions were encountered, there were a few five-nautical-miles sailed where the recordings had to be removed completely because of continuous noise recordings. But for most five-nautical-miles sailed, there were sections with representative recordings, generally when the ship was navigated to take advantage of open leads in ice covered waters. Then allocation of area back scattering coefficients to the recording categories was possible (Figure 18).

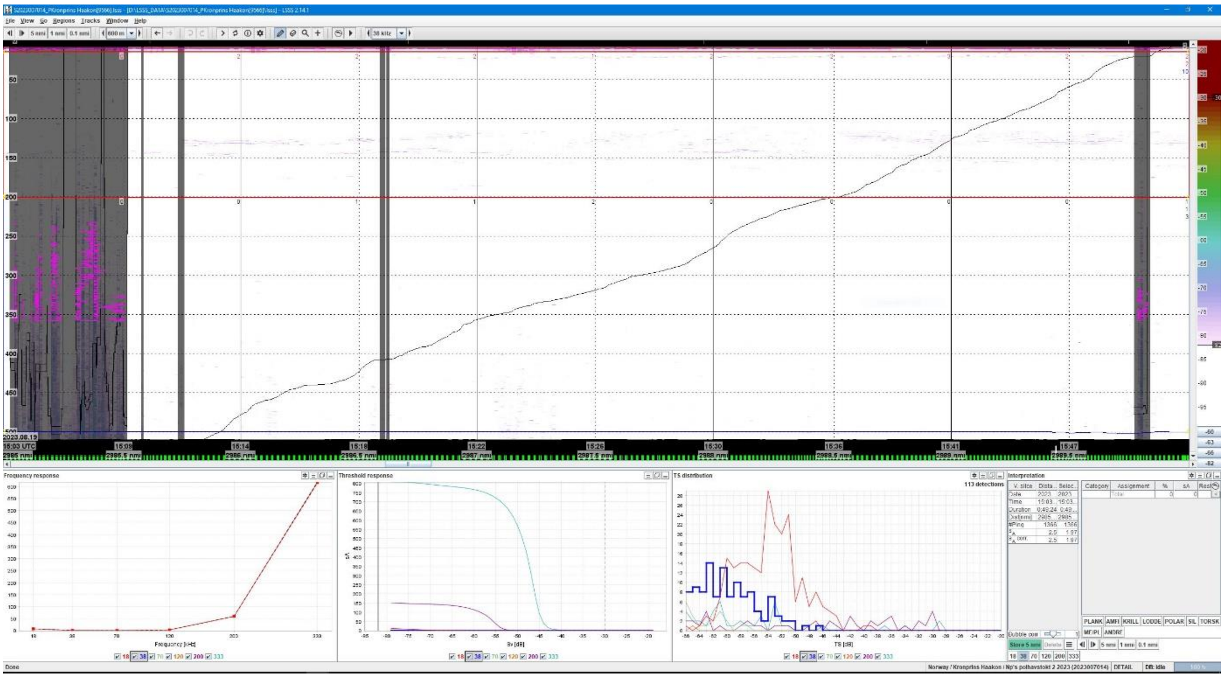

Figure 18. Scrutinizing of the 38 kHz Simrad E80 recordings using the LSSS post processing software. Screen dump from the LSSS after post processing of a five nautical mile distance along the Nansen Transect 2, sailed distance 2985 – 2990 from N83,30° - N83,20°. Shaded areas are removed because of noise. Allocation of s_A – values recorded to the different species groups (here plankton in the upper 200 m layer and mesopelagic/plankton in the deeper layer).

Initial Results

Quite dense recordings were made north along the west coast of Svalbard, and on the continental shelf north of Svalbard. Trawl catches identified substantial amounts of O – group fishes (juvenile capelin, cod, haddock, redfish and polar cod) near the surface in these waters (Figure 19).

Along the coast west and north of Svalbard, there were good recordings of capelin (*Mallotus villosus*) in a layer near surface and of demersal species like cod (*Gadus morhua*) in a layer from about 200 m depth to bottom (Figure 20). At the western transect at about E20°, capelin was recorded north to about N81° 30'. At the eastern transect, capelin was recorded at about E30° from N81° 45' and to the shelf.

In the ice-covered areas north of N82°, a more or less continuous weak mesopelagic layer was recorded at depths from about 300 m to 500 m. Species like krill (*Thysanoessa longicaudata*), pelagic amphipods (*Themisto libellula*, and *T. abyssorum*), ctenophores lantern fish (*Benthosema glacialis*), and arrow worms were caught in the mesopelagic layer. There were no distinct fish recordings in this layer.

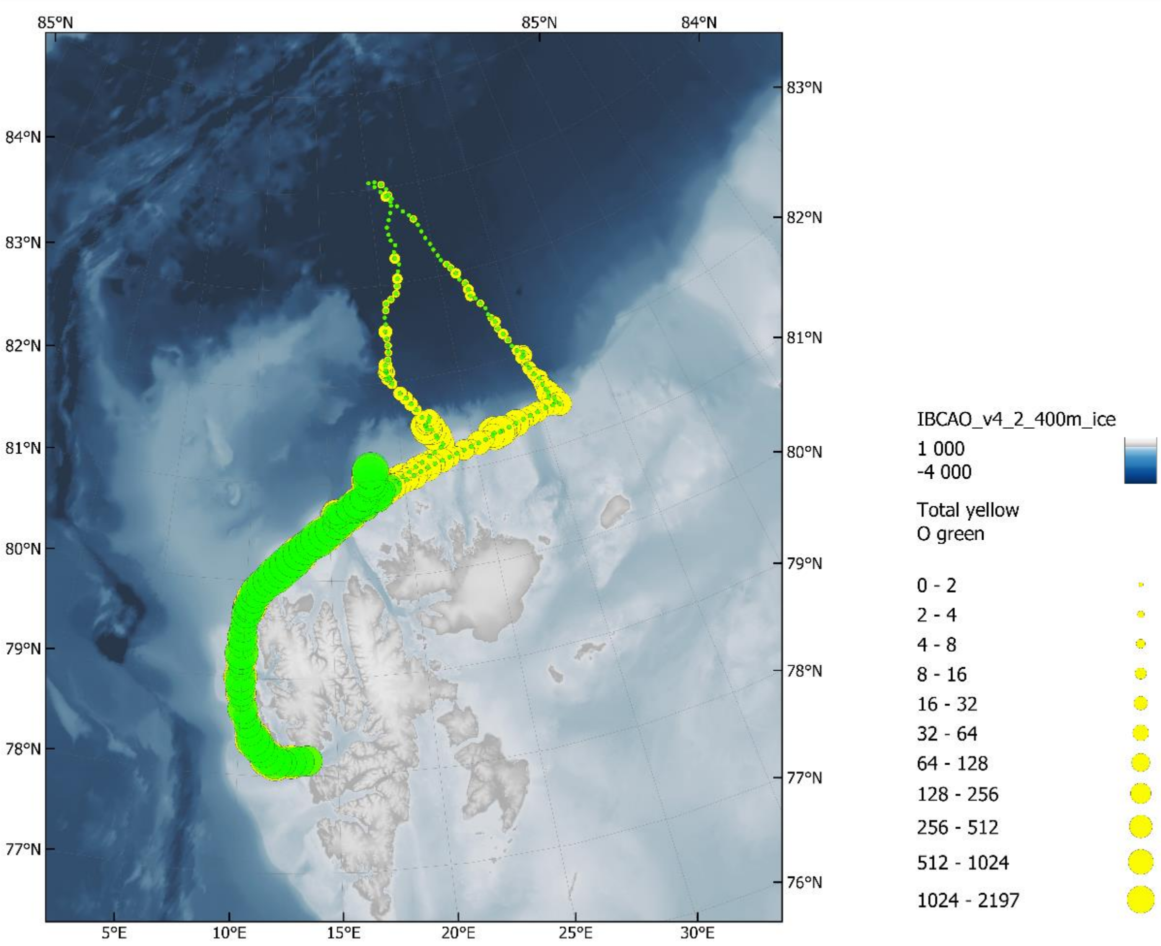

Figure 19. Total and O-group (juvenile fishes) recordings (Nautical Area Scattering Coefficients/5 nautical mile) made by the Simrad EK80 echo sounder and post processed in LSSS during the Arctic Ocean cruise 2023.

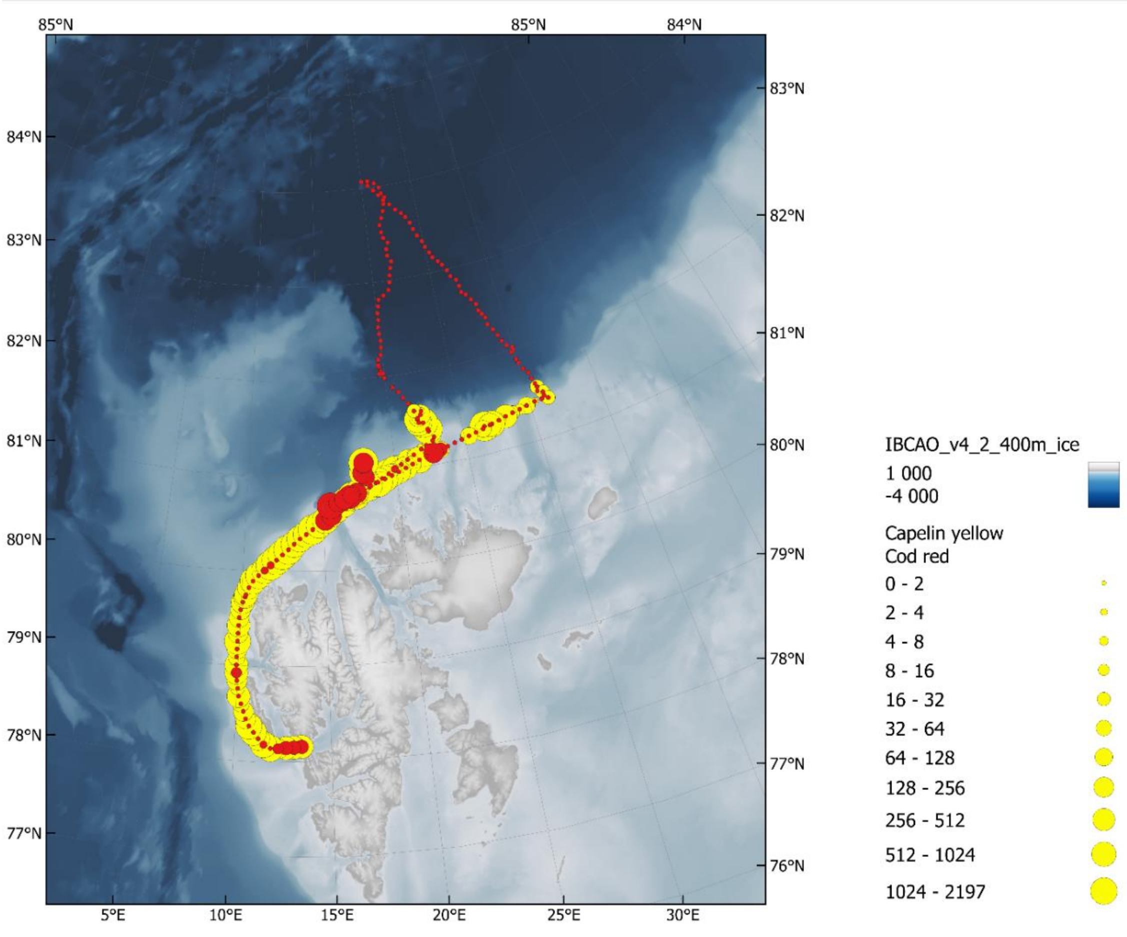

Figure 20. Recordings (Nautical Area Scattering Coefficients/5 nautical mile) of capelin and cod made by the Simrad EK80 echo sounder and post processed in LSSS during the Arctic Ocean cruise 2023.

A more or less continuous plankton layer, mostly consisting of *Calanus* spp., was recorder throughout the survey. The densest plankton recordings were encountered in layers from surface to 200 m depth along the coast west and north of Svalbard (Figure 21).

EK80 recordings of the mesopelagic layer at 300-400 m depth indicated pelagic fish with the 18 kHz transducer (Figure 22). Pelagic trawl catches verified that these were capelin. Below this layer, larger fishes can be seen, which are Atlantic cod feeding on the capelin and other mesopelagic organisms.

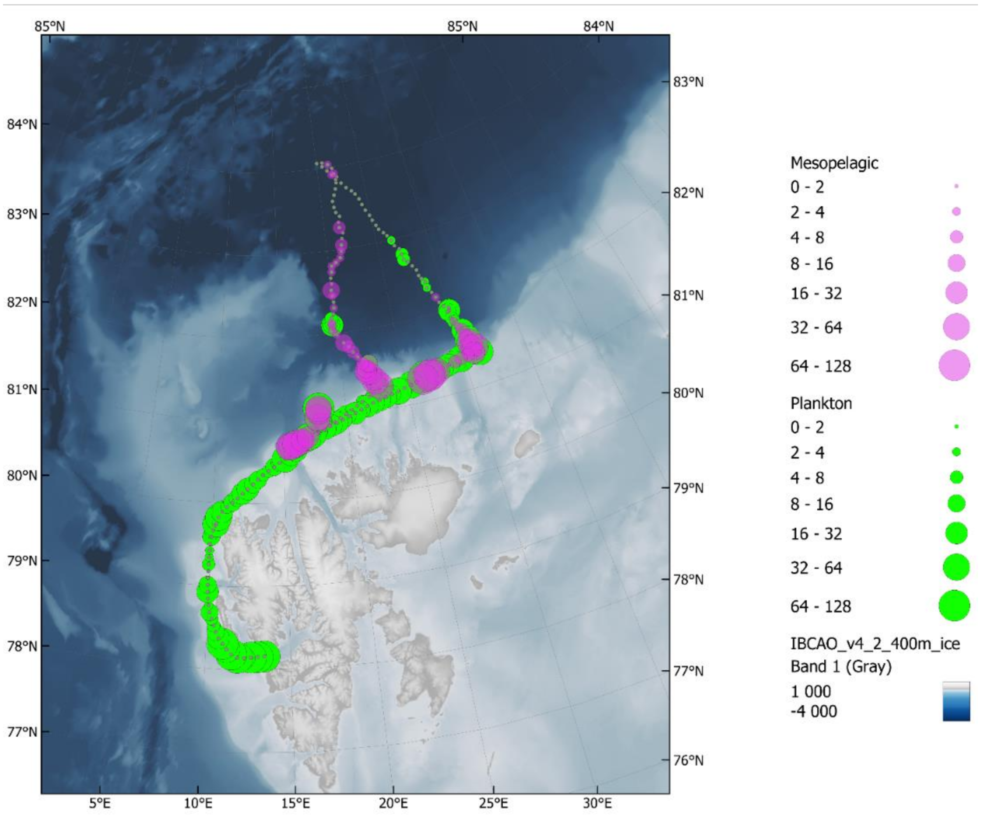

Figure 21. Recordings (Nautical Area Scattering Coefficients/5 nautical mile) of plankton and mesopelagic species made by the Simrad EK80 echo sounder and post processed in LSSS during the Arctic Ocean cruise 2023.

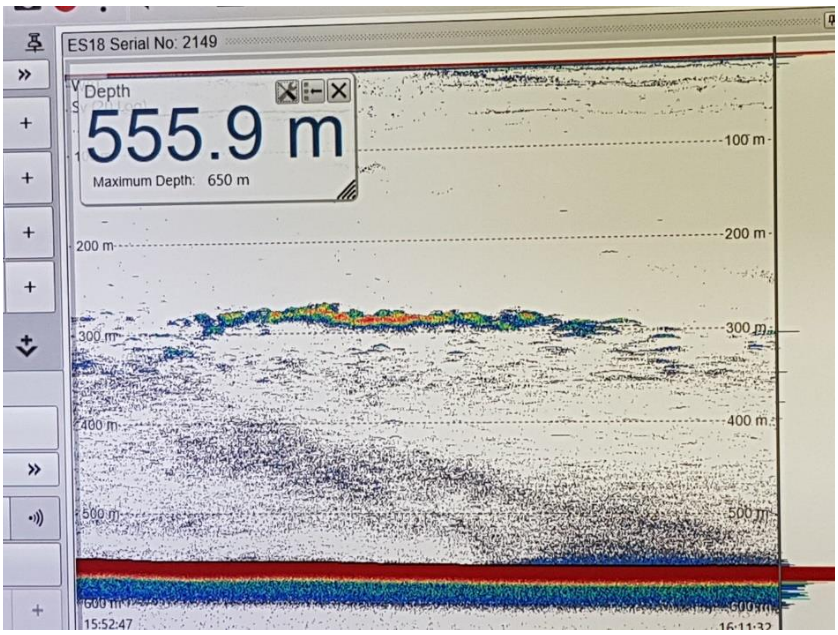

Figure 22. Mesopelagic layer on 24 August of mostly capelin near the benthic trawl station 40. The echo is strongest at about 280-300 m depth above the bottom at 556 m depth.

Pelagic and bottom trawling

Contacts: Ole Arve Misund (Ole.Arve.Misund@npolar.no) and Haakon Hop (Haakon.Hop@npolar.no), NPI, Aurora Heim (Aurora.Heim@uit.no), UiT The Arctic University of Norway

Pelagic trawl sampling was carried out to identify recordings on the Simrad EK80 echo sounder. Two types of pelagic trawls were used. In ice-free waters both the traditional Harstad pelagic trawl and the Vito pelagic trawl were used (Table 11). Both trawls were operated according to the procedures for scientific trawling at the Institute of Marine Research (KS&SMS-07-1-1-01), and rigged and used according to the procedures for the Harstad pelagic trawl (KS&SMS-07-1-2-2-2-03) and the Vito pelagic trawl (KS&SMS07-1-3-2-6-06). The Vito pelagic trawl replaced the Åkra pelagic trawl used by IMR since the mid nineteen nineties to identify and sample acoustic recordings of pelagic fish[1].

In ice-covered areas, an "ice rigged" Harstad pelagic trawl was used. On this version of the Harstad pelagic trawl, there were just four floats at the mid part of the headline, and chain weights of 150 kg were attached to each of the lower wings. A 25 kg weight was attached to the trawl bag. The upper wings on both sides were knitted together with a weak rope that broke when the trawl opened in the sea. The purpose of the adjusted rigging was to sink the trawl fast under ice floes in the wake of the vessel during shooting. When towing, the trawl gallows were lowered towards the trawl ramp so that the trawl warps were brough into the centre of the ship, and pointed downwards in the sea right behind the vessel. This enabled trawling without ice blocks coming under and lifting the trawl warps.

After leaving Longyearbyen on 10 August, and cruising west and north of Svalbard, pelagic trawling was conducted to identify acoustic recordings of fish, krill and planktonic organisms (TR stations, Figure 23). Entrances of fish and other organisms were recorded on the acoustic trawl eye on the Scanmar Scanbas trawl performance system during these tows.

Table 11. Rigging and operation of the Harstad and Vito pelagic trawls. Weight refers to the chains attached to the lower wing ends to open the trawl, data on warp length, warp tension, towing depth, towing speed and height were read from the Scanmar trawl performance system of the vessel.

Trawl type	Floats	Weight (kg)	Warp length (m)	Warp tension (tons)	Towing depth (m)	Towing speed (kn)	Vertical opening (m)
Harstad pelagic trawl	90 × 9.5''	100	301 - 1051	5.1 – 12.0	69 - 416	2.9 -3.4	10 - 14
Harstad pelagic trawl ice rigged	4 × 9.5''	150 x 2	210 – 1002	6.3 – 11.4	81 - 458	2.7 – 3.1	6 - 9
Vito pelagic trawl	30 × 9.5''	150 x 2	776 – 850	8.9 – 15.3	305 - 337	3.0 – 3.5	11 - 20

[1)]Valdemarsen, J. W., and Misund, O. A. 1995. Trawl designs and techniques used by Norwegian research vessels to sample fish in the pelagic zone. Proceedings of the sixth IMR-PINRO Symposium, Bergen, 14 – 17 June, 1994: , pp. 135-144.

When sailing in ice pelagic trawling was carried out occasionally in open leads of minimum 3 nautical miles long. The ice gallows of the vessel were then used to lower the warps close to the trawl ramp of the vessel to lower the probability for getting ice floes under the trawl warps. After spooling the trawl nets on the net drum during hauling, they were driven down on deck and carefully spooled on the net drum again while manually shaking the net to obtain samples of juvenile fish, squid, medusae, krill, and arrow worms hanging in the meshes.

Pelagic trawl - sampling

Contacts: Haakon Hop, Vegard Stürzinger, Juni Bjørneset, Norwegian Polar Institute

Representative catches of capelin (*Mallotus villosus*), juvenile redfish (*Sebastes mentella*), and cod (*Gadus morhua*) were obtained by the regular Harstad trawl on the three first trawl stations on Transect 1 when towing at depths from 50 – 400 m (TR-1-3, Table 12). In the ice covered Polar Ocean, only marginal catches of arrow worms (*Eukrohnia hamata*), ctenophore (*Mertensia ovum*), krill and pelagic amphipods were taken at depth from 200 m to 350 m (TR-4-7) with the ice-rigged Harstad trawl. Many of the arrow worms were carefully picked from the meshes of the trawl when hauling. The helmet jelly (*Periphylla periphylla*) were caught in several of the trawl hauls and seem to have expanded in to the Central Arctic Ocean (Figure 24). Southwards along the Nansen transect, three trawl stations (TR-8-10) gave catches of capelin both adults and larvae, Greenland halibut larvae, pelagic amphipods and krill. Some juvenile redfish and cod were caught in addition at TR-10 near the edge of the continental slope.

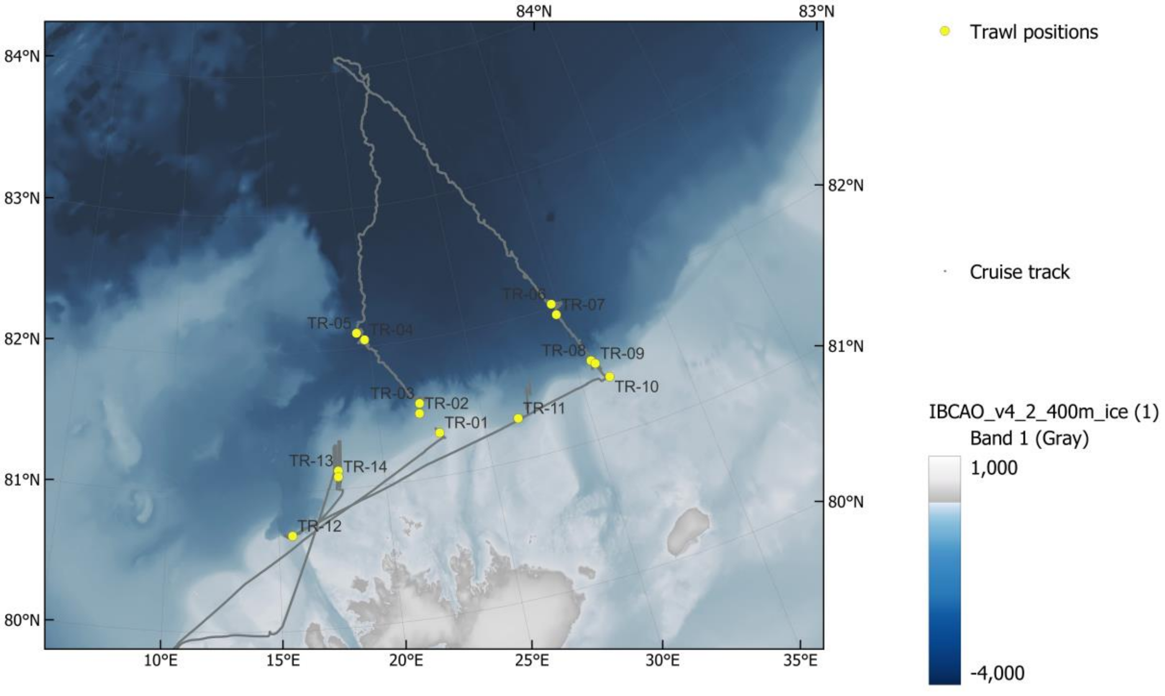

Figure 23. Trawling locations during the Arctic Ocean 2 Cruise.

The last three trawl stations with the larger Vito pelagic trawl (TR-12, 13 , 14) in open waters at the slope of the continental shelf, there were catches of Greenland halibut, cod, redfish, haddock, polar cod and capelin. Haul TR-13 was taken just for 15 min on good recordings near surface, and the catch consisted of 0- group and 1-year capelin, and juvenile polar cod, cod, haddock and redfish. Many international students helped to sort, measure, weigh and sample fishes caught in pelagic and benthic trawls (Figures 25, 26).

Table 12. Catches obtained during pelagic trawl sampling in the Polar Ocean August 2023 by RV *Kronprins Haakon*.

Trawl st. nr.	Gear (trawl type)	Date	Latitude	Longitude	Trawl depth (m)	Catch (kg)	Main species
TR-1	Harstad reg.	20230813	N 81,33°	E 22,76°	305 - 320	2.4992	*Mallotus villosus, Sebastes mentella*
TR-2	Harstad reg.	20230813	N 81,47°	E 21,98°	358 - 368	6.4031	*Mallotus villosus, Sebastes mentella*
TR-3	Harstad reg.	20230814	N 81,55°	E 21,56°	50 - 400	3.7558	*Mallotus villosus, Thysanoessa* sp., *Meganyctiphanes* sp.
TR-4	Harstad ice	20230815	N 82,05°	E 19,84°	140 - 460	1.0920	*Beroe, Mertensia ovum, Pheriphylla periphylla, Thysanoessa* sp., *Themisto* sp.
TR-5	Harstad ice	20230816	N 82,14°	E 19,44°	80 - 120	0.1234	*Beroe, Metridia ovum, Thysanoessa* sp., *Themsito* sp.
TR-6	Harstad ice	20230821	N 82,00°	E 29,73 °	342 - 398	4,8000	*Pheriphylla periphylla, Eukrohnia hamata, Thysanoessa* sp, *Themisto* sp.
TR-7	Harstad ice	20230822	N 81,95°	E 29,82 °	83 - 395		*Eukrohnia hamata, Thysanoessa, Gonatus, Boreogadus saida, Themisto, Pheriphylla*
TR- 8	Harstad ice	20230823	N 81,57 °	E 30,78 °	349- 354		*Mallotus villosus, Reinhardtius hippoglossoides Themisto, Thysanoessa*
TR-9	Harstad	20230823	N 81,52°	E 30,98°	350 - 380		*Sebastes mentella, Mallotus villosus, Themisto, Thyssanoessa, Gadus morhua, Reinhardtius hippoglossoides*
TR-10	Harstad ice	20230824	N 81,41°	E 31,37°	43 - 76		*Mallotus villosus*
TR-11	Campelen bottom trawl	20230824	N 81,30°	E 26,67°	550 - 560		*Reinhardtius hippoglossoides, Sebastes mentella, Gadus morhua, Boreogadus saida, Pandalus borealis*
TR-12	Vito	20230825	N 80,68°	E 15,55°	304 - 337		*Mallotus villosus, Thyssanoessa, Boreogadus saida, Themisto, Gadus morhua, Reinhardtius hippoglossoides*
TR-13	Vito	20230825	N 81,13°	E 17,02°	28 - 32		*Mallotus villosus, Boreogadus saida, Gadus morhua, Melanogrammus aeglefinnus, Sebastes mentella, Reinhardtius hippoglossoides*
TR-14	Vito	20230825	N 81,09°	E 17,85°	384-401		*Gadus morhua, Pandalus borealis, Mallotus villosus, Boreogadus saida, Melanogrammus aeglefinnus, Sebastes mentella, Reinhardtius hippoglossoides*

Figure 24. The helmet jellyfish (Periphylla periphylla) has moved into the Arctic Ocean. Photo: Vegard Stürzinger (NPI).

Figure 25. International students and staff sorting juvenile fishes caught in pelagic trawl.

Figure 26. International students and staff identifying fishes. Photo: Haakon Hop (NPI).

Bottom trawl - sampling

Contacts: Jacob Max Christensen (Jacob.Christensen@uit.no), UiT The Arctic University of Norway, Haakon Hop, Norwegian Polar Institute

At the bottom trawl station (TR-11) there were adult Greenland halibut, shrimp, cod and redfish as well as some individuals of families Liparidae, Cottidae, and Zoarcidae. Bottom fauna as sponges and sea urchins were also abundant. The abundance of sponges, indicated that this area had never been trawled with bottom trawl (Figure 27). The trawl bag contained substantial amounts of clay which made the subsampling tedious because dirt and washing.

Small benthic species with difficult taxonomic status, caught in the bottom trawl, were collected by Jacob Max Christensen for use in his PhD thesis (Table 13). The purpose of this project was to provide new insights into the life history, population structure, and dispersal trends of three understudied Arctic fish families – Liparidae, Cottidae, and Zoarcidae. A combination of traditional techniques (otolith aging, stomach content analysis, etc.) and modern molecular techniques with data processing will help create a better understanding on the roles these species play in Arctic marine ecosystems and fish communities.

Length and weight of each specimen were taken immediately after collection, followed by submergence in freezing 96% ethanol. Immediate preservation in EtOH was performed to minimize degradation of DNA. Extraction and further processing of samples will be conducted under the supervision of Kim Præbel at UiT's Research Group for Genetics. Data will be made available as soon as the process of peer review has commenced.

Table 13. Fish sampling for Jacob's PhD project.

ID	Species	Tissue type	Length (cm)	Weight (g)	Preservation	Station	Date	Latitude	Longitude	Depth	Equipment used
LEECH3000	*Notostomum laeve*	whole specimen	20	8	ethanol	st39	24.08.23	81.2993	26.6419	556.64	bottom trawl
SQUID1	*Gonatus fabricii*	whole specimen	14	4.5	ethanol	st04	13.08.23	81.3126	22.8437		Harstad trawl
SQUID2	*Gonatus fabricii*	whole specimen	7.8	1.5	ethanol	st04	13.08.23	81.3126	22.8437		Harstad trawl
SQUID3	*Gonatus fabricii*	whole specimen	9.9	2.5	ethanol	st04	13.08.23	81.3126	22.8437		Harstad trawl
LE1	*Lycodes eudipleurostictus*	whole specimen	24	52.2	ethanol	st39	24.08.23	81.2993	26.6419	556.64	bottom trawl
LE2	*Lycodes eudipleurostictus*	whole specimen	16	18	ethanol	st39	24.08.23	81.2993	26.6419	556.64	bottom trawl
LE3	*Lycodes eudipleurostictus*	whole specimen	11.9	6.5	ethanol	st39	24.08.23	81.2993	26.6419	556.64	bottom trawl
LE4	*Lycodes eudipleurostictus*	whole specimen	11.2	5.5	ethanol	st39	24.08.23	81.2993	26.6419	556.64	bottom trawl
LE5	*Lycodes eudipleurostictus*	whole specimen	15.7	17.5	ethanol	st39	24.08.23	81.2993	26.6419	556.64	bottom trawl
LE6	*Lycodes eudipleurostictus*	whole specimen	15.5	18	ethanol	st39	24.08.23	81.2993	26.6419	556.64	bottom trawl
LE7	*Lycodes eudipleurostictus*	whole specimen	15.3	13.5	ethanol	st39	24.08.23	81.2993	26.6419	556.64	bottom trawl
LE8	*Lycodes eudipleurostictus**	whole specimen	9.7	3.5	ethanol	st39	24.08.23	81.2993	26.6419	556.64	bottom trawl
LE9	*Lycodes eudipleurostictus*	whole specimen	12.2	6.5	ethanol	st39	24.08.23	81.2993	26.6419	556.64	bottom trawl
LE10	*Lycodes eudipleurostictus*	whole specimen	29.5	117	ethanol	st39	24.08.23	81.2993	26.6419	556.64	bottom trawl
LE11	*Lycodes eudipleurostictus*	whole specimen	30.5	104	ethanol	st39	24.08.23	81.2993	26.6419	556.64	bottom trawl
CM1	*Cottonculus microps*	whole specimen	7.8	8.5	ethanol	st39	24.08.23	81.2993	26.6419	556.64	bottom trawl
CM2	*Cottonculus microps*	whole specimen	10	16	ethanol	st39	24.08.23	81.2993	26.6419	556.64	bottom trawl
CM3	*Cottonculus microps*	whole specimen	8.6	12.5	ethanol	st39	24.08.23	81.2993	26.6419	556.64	bottom trawl
CM4	*Cottonculus microps*	whole specimen	6.7	5.5	ethanol	st39	24.08.23	81.2993	26.6419	556.64	bottom trawl
CM5	*Cottonculus microps*	whole specimen	7.8	10.5	ethanol	st39	24.08.23	81.2993	26.6419	556.64	bottom trawl
CM6	*Cottonculus microps*	whole specimen	4.5	2	ethanol	st39	24.08.23	81.2993	26.6419	556.64	bottom trawl
CR1	*Careproctus reinhardti*	whole specimen	6.5	2.5	ethanol	st39	24.08.23	81.2993	26.6419	556.64	Bottom trawl
CR2	*Careproctus reinhardti*	whole specimen	6.5	3	ethanol	st39	24.08.23	81.2993	26.6419	556.64	Bottom trawl
CR3	*Careproctus reinhardti*	whole specimen	6.9	3.5	ethanol	st39	24.08.23	81.2993	26.6419	556.64	Bottom trawl
CR4	*Careproctus reinhardti*	whole specimen	8	5	ethanol	st39	24.08.23	81.2993	26.6419	556.64	Bottom trawl
CR5	*Careproctus reinhardti*	whole specimen	7.2	8.5	ethanol	st39	24.08.23	81.2993	26.6419	556.64	Bottom trawl

Figure 27. The deep-water sponge Geodia barretti *caught in bottom trawl on the upper slope north of Svalbard. Photo: Haakon Hop (NPI).*

eDNA sampling

Contact: Jacob Max Christensen (Jacob.Christensen@uit.no), UiT The Arctic University of Norway

Environmental DNA was collected for the SUDARCO project. Sampling was conducted at nine sites between the two transects.

Materials and Methods

The following summary describes the protocol used to collect eDNA from water samples:

1) Niskin bottles on the CTD were used to collect water. Each bottle was sterilized with 10% bleach prior to descent.
2) After the retrieval of the CTD, approximately 5 L of water was taken from each sample depth.
3) Each collection of water was run through 0.22 µM Sterivex filters (one L each, three replicates per depth), using a peristaltic pump.
4) One-litre of milli-Q water was filtered as a blank for each station.
5) The used filters were bagged and tagged according to station number and depth, and immediately stored at -80°C.

Ecotoxicology mercury sampling

Contacts: Sonja Gindorf (sonja.gindorf@aces.su.se), Sofi Jonsson (sofi.jonsson@aces.su.se), Stockholm University, Sweden

Introduction

Mercury (Hg) is a metal that naturally occurs in all compartments of the environment in different forms. It is emitted into the atmosphere through both natural processes (e.g. volcanic activity, soil erosion, and sea spray) and anthropogenic activities (e.g. industrial processes, coal combustion, and mining). Once released, Hg can travel long distances through the atmosphere, often in gaseous form (elemental Hg, Hg^0), before being deposited onto land and water surfaces, including the Arctic Ocean. Besides atmospheric deposition, Hg can enter the Arctic Ocean through river and surface runoff as well as ocean currents. In the marine environment, microbes can methylate inorganic Hg (Hg^{II}) to the organic form methylmercury (MeHg). MeHg can have one or two methyl groups: monomenthylmercury (MMHg) and dimethylmercury (DMHg). Our understanding of the role of DMHg in the biogeochemical of Hg is still very limited. MMHg is of particular concern in marine ecosystems because it is a neurotoxin that effectively bioaccumulates and biomagnifies in the food web posing especially high risks to species of higher trophic levels (Figure 28). This process is especially relevant in the Arctic due to a simplified food web and slow metabolic rates of cold-adapted species. As higher trophic fish and marine mammals are an important part of nutrition for indigenous communities in the Arctic, it is crucial to improve our knowledge of MeHg concentration in Arctic species and better understand what environmental management measures we can implement to limit the exposure of wildlife and people to this neurotoxin.

Hg and MeHg can bind to particles and sink through the water column to the ocean floor. In the sediments, anoxic conditions and microbial communities dominated by sulphate-reducing bacteria and methanogens can favour Hg methylation. Through resuspension, Hg and MeHg can enter the water column. Sea ice can physically trap and sequester Hg within its structure. During melting, the ice releases the Hg it has trapped back into the surrounding water. This can contribute to a pulse of

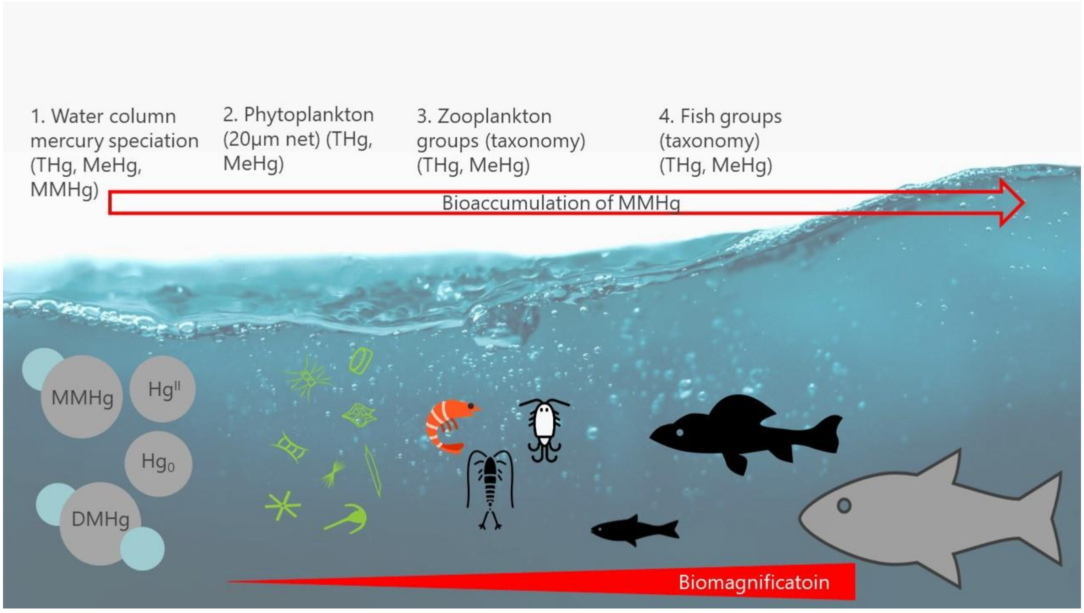

Figure 28. Mercury contaminants in the marine environment and the bioaccumulation/biomagnification in marine food webs.

mercury entering the marine ecosystem. The timing and extent of sea-ice melting can influence the magnitude of this release. Moreover, Sea ice can play an important role for the distribution of Hg in the surface Arctic Ocean, as it can transport Hg over long distances drifting with ocean currents. This can lead to the redistribution of mercury from areas of higher contamination to more pristine regions, impacting ecosystems that are farther away from direct pollution sources.

Enhanced warming in the Arctic can affect the biogeochemical cycle of Hg in several ways. Thawing permafrost and increased runoff from melting glaciers may release previously sequestered Hg into the aquatic environment. Higher temperatures might enhance microbial activity and therefore methylation processes.

We collected samples for:

1) Water column mercury speciation (Total Hg, MeHg, MMHg), surface sediment (total Hg, MeHg)
2) Biota (total Hg, MeHg) of different trophic levels (filter feeders, primary producers, grazers, predators)
3) Sea ice (THg and MeHg)

to better understand the complex interplay of these different parts of the biogeochemical cycle of Hg. Moreover, this data will hopefully help us to improve our understanding of how mercury speciation and distribution change across the shelf slope into the open ocean. The biota of different trophic levels will be used to calculate biomagnification factors and can help to improve modelling of mercury accumulation in the Arctic Ocean food web.

Sampling Methods

Sea water

Unfiltered water column samples were collected from 10L Niskin bottles on a Seabird carousel CTD rosette (Figure 29). Samples for total mercury (THg), methylmercury (MeHg), and monomethylmercury (MMHg) were collected through a silicon tube connected to the Niskin bottle. All Hg species samples were collected after a threefold rinse without headspace. Hg samples were always collected before any other samples were taken from the respective Niskin bottle to minimize contamination potential as well as gas exchange of the seawater and atmosphere within the Niskin bottle. THg was collected in 40 mL glass vials with septum tight screw caps that were wrapped with parafilm right after collection. MeHg and MMHg samples were collected in 150 mL cubic PET bottles. MMHg samples were reduced to a volume of 125 mL and purged with nitrogen gas for 10 min at a flow rate of 250 mL min^{-1} to strip all dimethylmercury (volatile, gaseous) out of the sample. MMHg and MeHg samples were acidified to 0.4 % v:v using trace metal grade hydrochloric acid. All mercury speciation samples were stored at 4 °C in the dark in double zip-lock bags.

At the deep stations, samples were collected from 9 depths: Bottom (-10 m), 3000 m, 2000 m, 1000 m, 500 m, 250 m, 100 m, 50 m, 15 m. At stations shallower than 3000 m, the sampled depths were adjusted to distribute the samples well throughout the water column. At the shelf stations only 6 depths were sampled. Details can be found in the mercury sample log (Appendix 2).

Figure 29. CTD water column sampling and MMHg purging (right). Photos: Sonja Gindorf.

Ice

Ice cores were collected at station 17 (84.0898 N, 20.0730 E). A total of three ice cores were collected for mercury speciation (Figure 30). Prior to collecting the cores for mercury, the barrel was conditioned by collecting the cores for physical and biological parameters. A saw was used to cut the ice cores into 20-cm sections right after collection. The outside of each section was generously scraped with a sterile scalpel. Mercury ice-core sections were then transferred into zip-lock bags and melted at room temperature. The melted cores were then transferred into 40 mL glass vials (THg) and 150 mL PET bottles (MeHg and MMHg) and processed as seawater samples for each species.

Figure 30. Ice coring (left) and a scraped 20 cm section of an ice core (right). Photos: Sofi Jonsson.

Phytoplankton

Phytoplankton samples were collected from a 20-µm net during the easternmost transect. Phytoplankton samples were stored in a -20 °C freezer directly after collection.

Zooplankton

At all stations where water was collected from the CTD, Zooplankton samples were collected from the 1500 µm MIK net (Table 14). Dominant species or groups were sorted and collected in falcon tubes (Figures 31, 32). Samples were drained from water and stored in a -20 °C freezer to be transported frozen to Stockholm University where they were freeze dried and homogenized for analysis.

Table 14. Zooplankton species collected from each station.

	Station St01	**Station St04**	**Station St06**	**Station St13**	**Station St15**
1	*Themisto abyssorum*	*Hymenodora glacialis*	*Hymenodora glacialis*	*Themisto abyssorum*	*Themisto abyssorum*
2	*Themisto libellula*	*Thyssanoessa* spp.	*Themisto abyssorum*	*Themisto libellula*	*Themisto libellula*
3	*Thyssanoessa* spp.	*Calanus* spp.	*Themisto libellula*	*Thyssanoessa* spp.	*Paraeuchaeta* spp.
4	*Clione limacina*	*Themisto abyssorum*	*Calanus* spp.	*Calanus* spp.	*Calanus* spp.
5	Arrow worms (*Parasagitta elegans*)	*Themisto libellula*	*Clione limacina*	Arrow worms	*Thyssanoessa* spp.
6	*Mertensia ovum*	*Clione limacina*	Arrow worms	*Aglantha digitale*	*Meganycti-phanes norvegica*
7	*Aglantha digitale*	*Cyclocaris guilelmi*	*Thyssanoessa* spp.	*Hymenodora glacialis*	*Hymenodora glacialis*
8	*Calanus* spp.	*Hymenodora glacialis* (juveniles)	*Paraeuchaeta* spp.	*Beroe cucumis*	*Oikopleura vanhoeffeni*
9	*Limacina helicina*	*Aglantha digitale*	*Eusirus holmii*	*Clione limacine*	*Clione limacina*
10		Arrow worms (*Parasagitta elegans, Eukrohnia hamata*)	*Cyclocaris guilelmi*	*Cyclocaris guilelmi*	*Aglantha digitale*
11		*Beroe cucumis*	*Beroe cucumis*	*Eusirus holmii*	Arrow worms
12		*Paraeuchaeta* spp.		*Paraeuchaeta* spp.	*Eusirus holmii*
13				*Oikopleura vanhoeffeni*	*Cyclocaris guilelmi*
14				*Meganycti-phanes norvegica*	*Botrynema* spp.
15				*Botrynema* spp.	
	Station St17	**Station St23**	**Station St26**	**Station St33**	**Station St35**

1	*Themisto abyssorum*	*Hymenodora glacialis*	*Hymenodora glacialis*	*Hymenodora glacialis*	*Calanus* spp.
2	*Themisto libellula*	*Calanus* spp.	Arrow worms	Arrow worms	*Themisto abyssorum*
3	*Botrynema* spp.	*Themisto abyssorum*	*Themisto abyssorum*	*Themisto abyssorum*	*Themisto libellula*
4	*Calanus* spp.	*Themisto libellula*	*Themisto libellula*	*Themisto libellula*	*Clione limacina*
5	Arrow worms	*Paraeuchaeta* spp.	*Thyssanoessa* spp.	*Eusirus holmii*	*Thyssanoessa* spp.
6	*Thyssanoessa* spp.	*Aglantha digitale*	*Calanus* spp.	*Cyclocaris guilelmi*	*Paraeuchaeta* spp.
7	*Aglantha digitale*	Arrow worms	*Paraeuchaeta* spp.	*Paraeuchaeta* spp.	*Eusirus holmii*
8	*Hymenodora glacialis*	*Oikopleura vanhoeffeni*	*Aglantha digitale*	*Aglantha digitale*	*Botrynema* spp.
9	*Paraeuchaeta* spp.	*Botrynema* spp.	*Eusirus holmii*	*Clione limacina*	*Beroe* spp.
10	*Oikopleura vanhoeffeni*	*Cyclocaris guilelmi*	*Cyclocaris guilelmi*	*Thyssanoessa* spp.	*Aglantha digitale*
11	*Eusirus holmii*	*Thyssanoessa* spp.	*Beroe sp.*	*Meganycti-phanes norvegica*	Arrow worms
12		*Mertensia ovum*	*Meganycti-phanes norvegica*	*Botrynema* spp.	
13			*Botrynema* spp.	*Calanus* spp.	

	Station St38	**Station St39**	**Station St40**
1	*Themisto abyssorum*	*Calanus* spp.	*Hymenodora glacialis*
2	*Themisto libellula*	*Themisto abyssorum*	*Themisto abyssorum*
3	*Calanus* spp.	*Themisto libellula*	*Themisto libellula*
4	*Oikopleura vanhoeffeni*	*Aglantha digitale*	*Meganyctiphanes norvegica*
5	*Beroe* sp.	*Thyssanoessa* spp.	*Thyssanoessa* spp.
6		Arrow worms	*Paraeuchaeta* spp.
7	*Mertensia ovum*	*Meganyctiphanes norvegica*	Arrow worms
8	*Thyssanoessa* spp.		*Calanus* spp.
9	Arrow worms		*Aglantha digitale*

Figure 31. The MIK net coming up (left) and sorting of species in the wet lab (right). Photos: Sonja Gindorf.

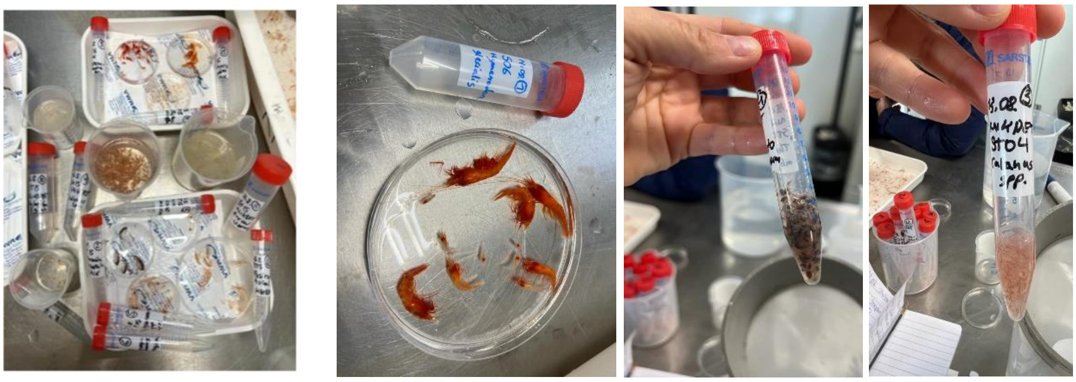

Figure 32. Species selection and sampling of zooplankton from the MIK net. Photos: Sonja Gindorf.

Trawling

Fish samples were collected from pelagic and benthic trawling. For mercury analysis, ca 1×1 cm sections of muscle tissue were cut using a scalpel (Figure 33). Samples were stored in individual zip lock bags in a -20 °C freezer to be transported to Stockholm University frozen for further processing. From the bottom trawl, sea cucumbers, starfish and sponges were collected and frozen at -20 °C (Figure 34).

Figure 33. Fish sampling for mercury analysis, 1 piece of muscle tissue. Photo: Sonja Gindorf.

Figures 34. Sponges and sea cucumber samples from the benthic trawl. Photos: Sonja Gindorf.

Surface sediments

From each box core that was deployed during the cruise, surface sediment was collected using a plastic spoon. The surface sediment was transferred into 50 mL falcon tubes and stored in a -20 °C freezer. From one box core (St 23), we also collected worms and a sea urchin that were stored in a -20 °C freezer (Figure 35).

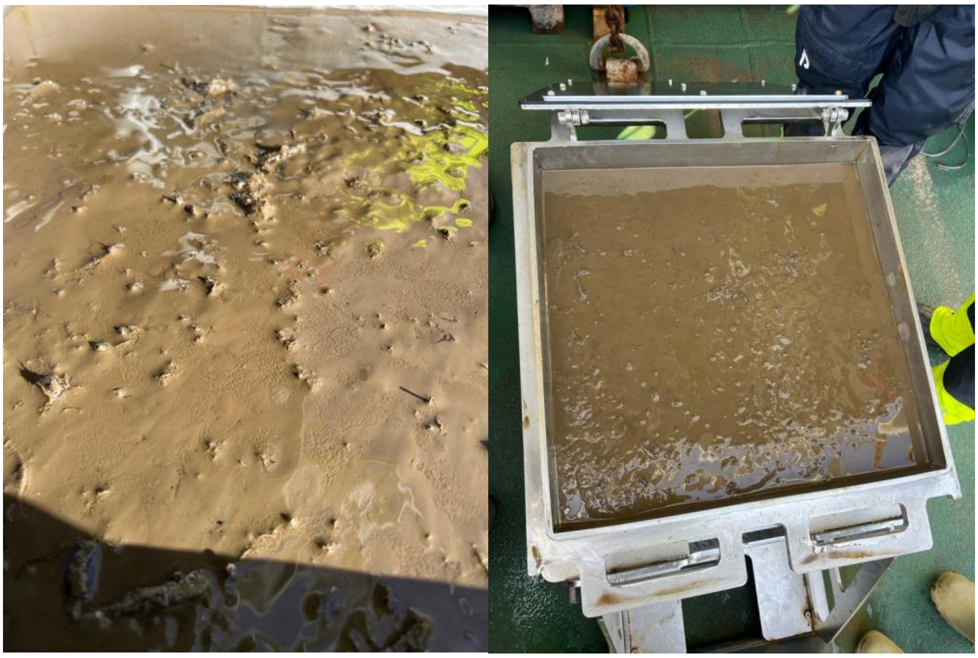

Figure 35. Surface sediment in the box corer. Photos: Sonja Gindorf.

In total, 822 samples from different parts of the marine food web were collected for mercury analyses (Table 15).

Table 15. Sample summary for collections for mercury analyses.

<table>
<tr><th>Sample type</th><th>THg</th><th>MeHg</th><th>MMHg</th><th>Sum</th></tr>
<tr><td>CTD water column</td><td>90</td><td>90</td><td>90</td><td>270</td></tr>
<tr><td>Ice core sections</td><td>22</td><td>22</td><td>22</td><td>66</td></tr>
<tr><td>Zooplankton</td><td colspan="2">146</td><td></td><td>146</td></tr>
<tr><td>Phytoplankton</td><td colspan="2">6</td><td></td><td>6</td></tr>
<tr><td>Fish</td><td colspan="2">153</td><td></td><td>153</td></tr>
<tr><td>Surface sediment</td><td colspan="2">7 sites (4 samples each)</td><td></td><td>28</td></tr>
<tr><td>Box corer biota</td><td colspan="2">2</td><td></td><td>2</td></tr>
<tr><td>Bottom trawl (not fish)</td><td colspan="2">8</td><td></td><td>8</td></tr>
<tr><td>Total to analyse</td><td>355</td><td>355</td><td>112</td><td>822</td></tr>
</table>

Surface and downcore sediment sampling for sedimentary ancient DNA with box corer

Contacts: Flore Wijnands (flore.wijnands@geo.su.se), Stockholm University, Nalan Koc (Nalan.Koc@npolar.no), NPI

Introduction

Sedimentary ancient DNA (sedaDNA) is the study of ancient DNA fragments from dead organisms deposited in the sediments of lakes or oceans. Due to slow deposition rates, the near absence of disturbances and low temperatures, the Central Arctic Ocean is a very suitable environment for sedaDNA studies. While other paleoenvironmental proxies, such as micropalaeontology and biomarkers are restricted to certain groups of microbial organisms, sedaDNA can be used to reconstruct entire ecosystems. Available sedaDNA research on marine sediments is however still very limited and no studies have been performed yet in the Central Arctic Ocean. The samples collected with box corer during this expedition will therefore have the potential to greatly enhance our understanding of Early Holocene and Late Pleistocene marine Arctic environments. In addition, the collected material will be used to improve our methods for sedaDNA lab protocols and bioinformatic pipelines, especially for Arctic marine environments.

Materials and Methods: The surface and subsurface sediments were retrieved using a boxcorer (50×50×50 cm, KC Denmark. Model 80.250-50; Figure 36a). From each box core, 3 to 4 subsamples were taken using 35 cm long plastic core liners (Figure 36b). The relatively short length of the core liners was chosen to ease transportation, as the cores need to be transported in a vertical position. No subsampling of the cores were performed on board to avoid contamination. The cores were transported to Stockholm University where they will be subsampled for sedimentary DNA analysis in a clean environment. In addition, the physical, chemical, and biological properties of the cores will be studied using XRF scanning, geochemical analyses, and micropalaeontology.

Activities: Box core sediments were retrieved from 6 different locations (Table 16) over a depth gradient from the upper part of the continental slope (~900 m) to the deepest part of the Nansen Basin (~4000 m). To avoid hitting hard-bottom layers unsuitable for sampling or disturbed and redeposited sediments, the subsurface was scanned using sub-bottom profiler 300. Only areas that displayed relatively flat topography and some horizontal layering were sampled. After retrieving the box corer, the water above was siphoned off using plastic tubes. Pictures were taken of the surface and the core liners were pushed as far as possible into the sediment. The caps were placed on the top of the core liners to prevent contamination from surrounding sediments and the remaining sediment in the box corer was removed using garden shovels. Once the core liners were sufficiently exposed, they were lifted out of the box corer and the bottom cap was placed. After cleaning the outside of the core liners, they were stored at -20°C for DNA and geochemical analysis and at 5°C for palaeontological and physical analysis.

Preliminary results

Location st13 was close to the Yermak Plateau and contained suspected redeposited material which would not be suitable for the purpose of this research. Therefore, this box core was not sampled further. A total of 19 sub-cores using plastic core liners of 35 cm were sampled from the 5 stations. In addition, surface samples were collected in 4 plastic tubes for mercury analysis for Sonja Gindorf. All box cores showed a similar stratigraphy with a top layer (±3-5 cm) of light brown clay, interpreted to be the Holocene top layer, followed by a very smooth grey clay, most likely deposited during the Last Glacial Maximum (Figure 37).

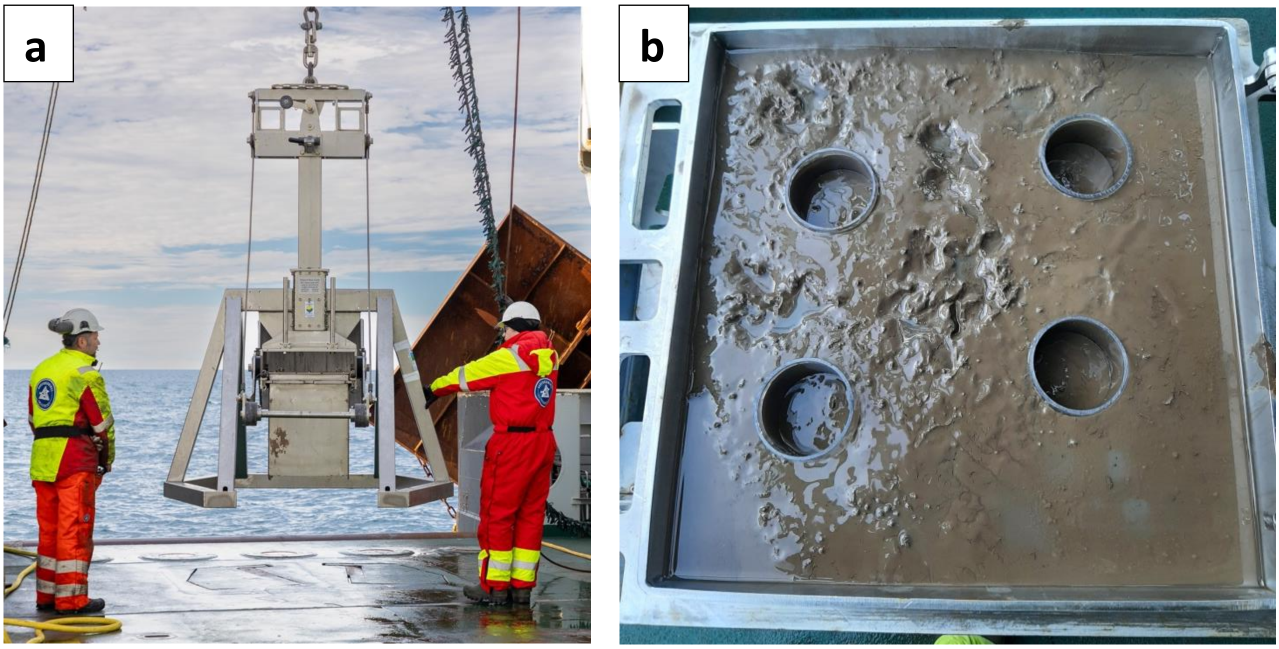

Figure 36. a) Box core deployment b) Top view of the box corer with well-preserved surface layer after the core liners had been pressed into the sediment. Photos: Flore Wijnands (Stockholm Univ.).

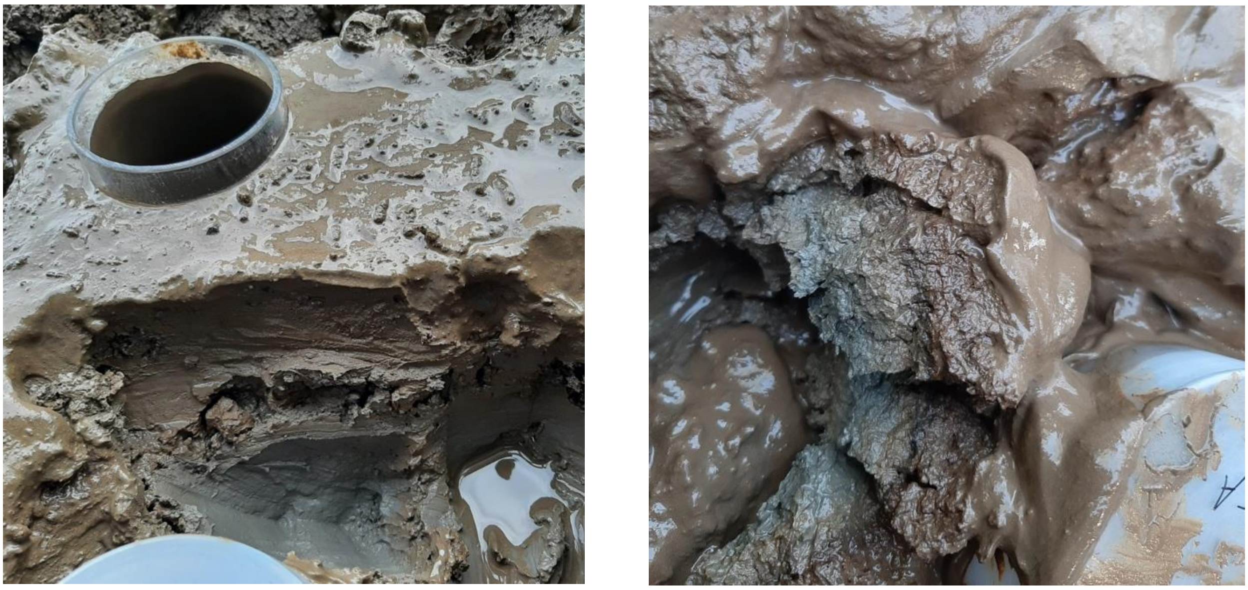

Figure 37. horizontal layering as found in the sampled sediments. Brown Holocene deposits are followed by grey glacial clays. Photos: Flore Wijnands (Stockholm Univ.).

Table 16. Box corers retrieved during NPI Arctic Ocean Cruise II 2023.

Station	Gear	Date	Latitude	Longitude	Depth (m)	Sample type	Number of samples
St04	Box corer	13-08-2023	81,5007	22,1597	888,1	Surface and subsurface sediment	4
St06	Box corer	14-08-2023	81,5517	21,9554	1477,76	Surface and subsurface sediment	4
St13	Box corer	15-08-2023	82,0417	19,5373	3489,00	Surface and subsurface sediment	0
St18	Box corer	19-08-2023	83,6675	23,6115	4023	Surface and subsurface sediment	4
St23	Box corer	21-08-2023	82,2879	28,8142	3655,36	Surface and subsurface sediment	3
St32	Box corer	22-08-2023	81,6160	30,7033	1952	Surface and subsurface sediment	4

The glacial clay was similar in texture between all locations, with the exception of station st23 where the clay was interrupted by gravel layers. The brown top layer consisted of pure clay at station st18 and st32, but had traces of silt and sand at st04, st06 and st23. St06 also contained stones in the surface sediments. For two of the stations (st18 and st32) the sediment surface was disturbed due to overpenetration of the sediment. The other stations showed *in situ* benthic mesofauna, showing that the sediment surface was undisturbed. At station st23 the box corer penetrated only the upper ±35 cm of the sediment due to gravel layers.

Multibeam Echosounder and Subbottom Profiler Survey

Contact: Nalan Koc (Nalan.Koch@npolar.no), NPI

Sea bottom topography and bottom sediments in the shelf area north of Hinlopen Strait (Hinlopenrenna) was mapped by Multibeam Echosounder and Subbottom Profiler on board RV *Kronprins Haakon* in four N-S going transects of 12 nm in length (Figure 38). The survey continued as a single transect as we sailed towards Moffen Island and stopped before the 12 nm territorial border was reached. The Subbottom Profiler showed several sediment basins in the northern parts of the transects (Figure 39), which can be considered as suitable areas for sediment coring in the future.

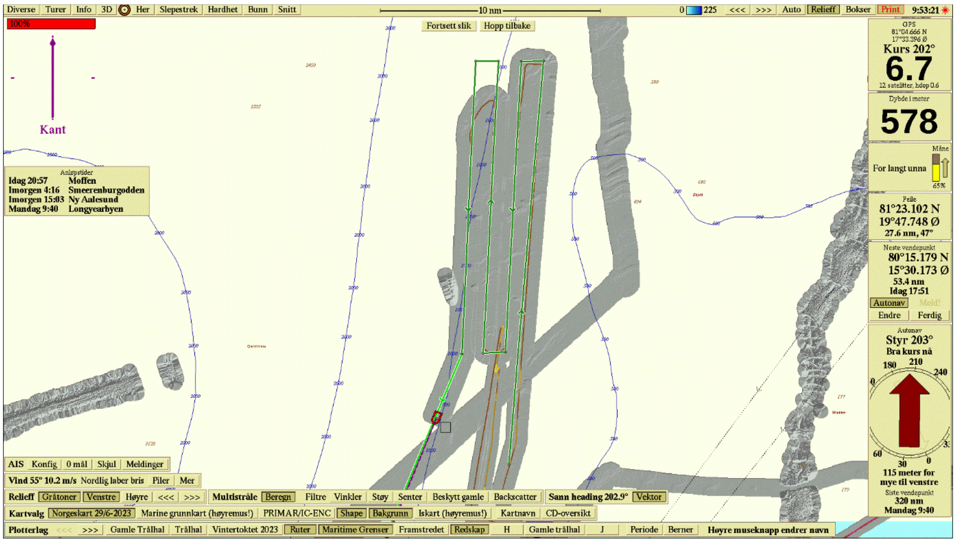

Figure 38. Route for the mapping survey with Multibeam Echosounder and Sub-bottom Profiler.

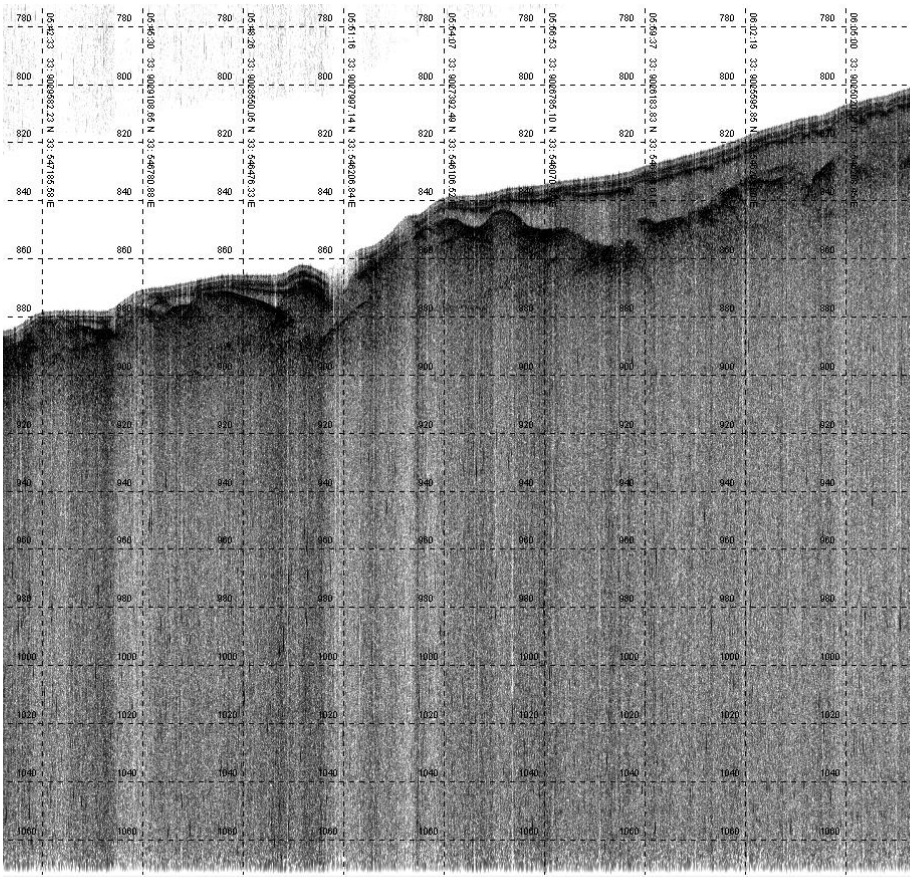

Figure 39. Sub-bottom profile showing a sediment basin in the top right half of the section.

Sea-ice distribution and thickness, observations from the observation deck

Contacts: Marika Marnela (Marika.Marnela@npolar.no), NPI, Matias Uusinoka (matias.uusinoka@aalto.fi), Aalto University

Sea-ice observations were aimed to be made every four hours during transitions, and when arriving to measurement stations, from the observation deck. The observations included sea-ice parameters such as concentration, thickness, snow, mean floe size, rafting, ridging, brown ice and melt ponds. The parameters were observed for different ice types: white ice (first-year and multiyear), dark and light nilas, grey, brash and pancake ice, slush and open water. In addition to the ice characteristics, we gathered data on ship position, speed and heading as well as meteorological data on air and water temperature, air pressure, wind speed and direction, and humidity. During each observation, three digital photos were taken towards port, bow and starboard of the ship from the observation deck (Figure 40). The final observation set includes 29 observations mainly from when the ship was in the ice zone. The observations were taken from 15-23 August. The observations have been copied to the ASSIST Data Network.

The ice edge in the area investigated north-east of Svalbard was intersected by leads (Figure 41). At St. 06 on 14 Augusth 2023 at N81° 56.7’ E022° 15,1’ we towed the pelagic trawl (TR-3) along the ice edge. During the evening of 14 August 2023, the ship headed into the ice, and St.13 was taken in an ice covered area. The ship manoeuvred rather easily north through the ice-covered area taking advantage of the many leads and broken ice floes. The ice radar was actively used to plan easy sailing through the ice covered area north to the Nansen I mooring.

On 20-22 August at RADARSAT images were available for the area we were working in North East of Svalbard (Figure 42). The satellite imagery was obtained for navigational purposes, but can be used to put the *in-situ* measurements and ice observations into a large-scale context. Images were processed by NPI in Tromsø and sent to the ship via an email link within a few hours of acquisition. The ice free area in the lower part of the image reflect the impact of the inflow of warm Atlantic water masses (Figure 43) The ice edge appear rather ruptured, or uneven intersected by large leads.

Figure 40. Ice conditions registered with digital photos in three directions from the observation deck of the ship. Photo: Marika Marnela (NPI).

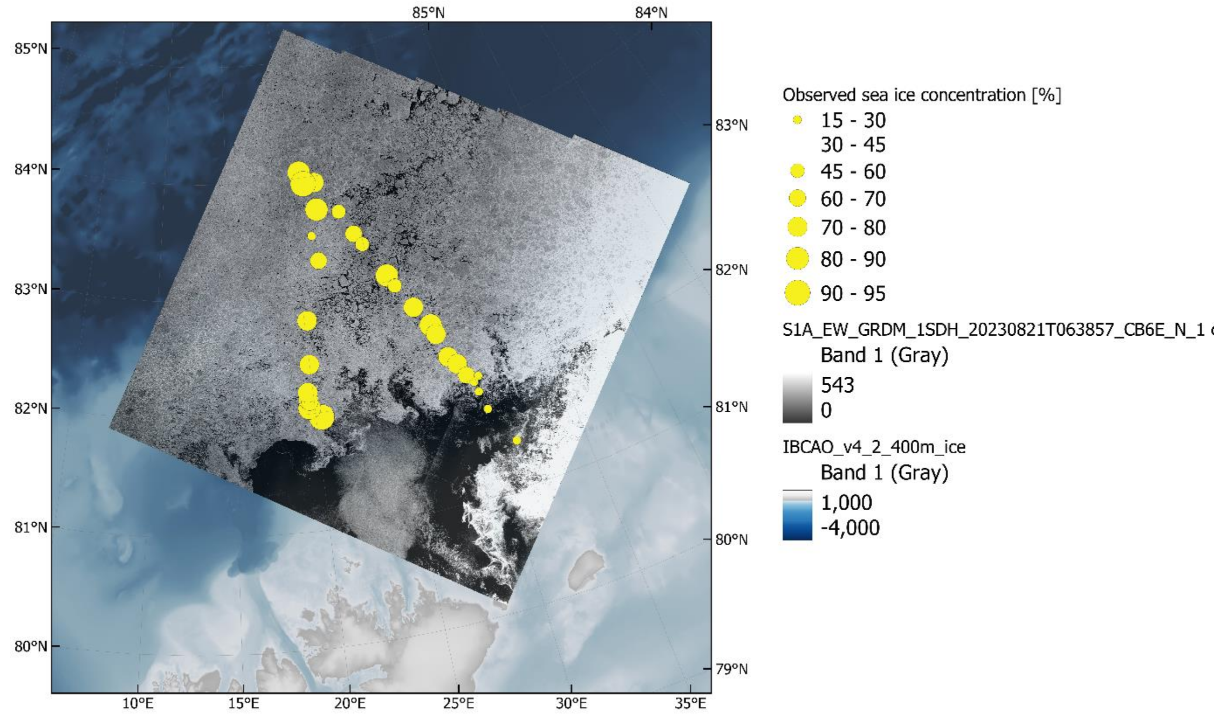

Figure 41. Observed sea ice concentrations over a Sentinel-1 satellite image from 21 August, 2023.

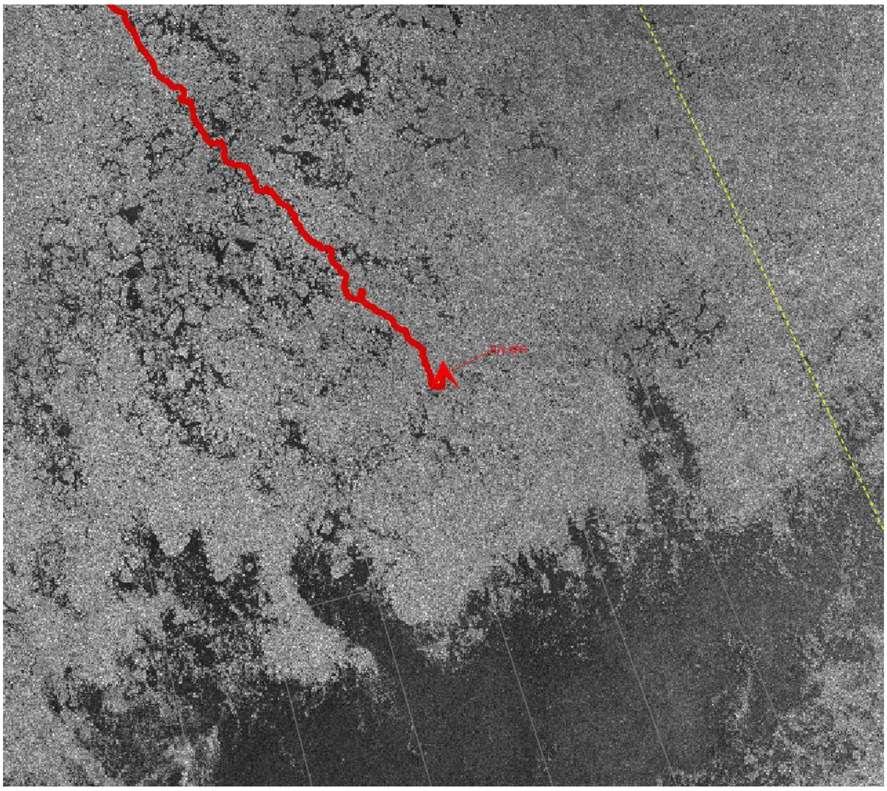

Figure 42. RADARSAT image of the sea ice cover in a selected area of the Arctic Ocean. The read line indicates the ship track on August 20th, and the arrow points to the position of the ship at 12:30 on 20 August 2023.

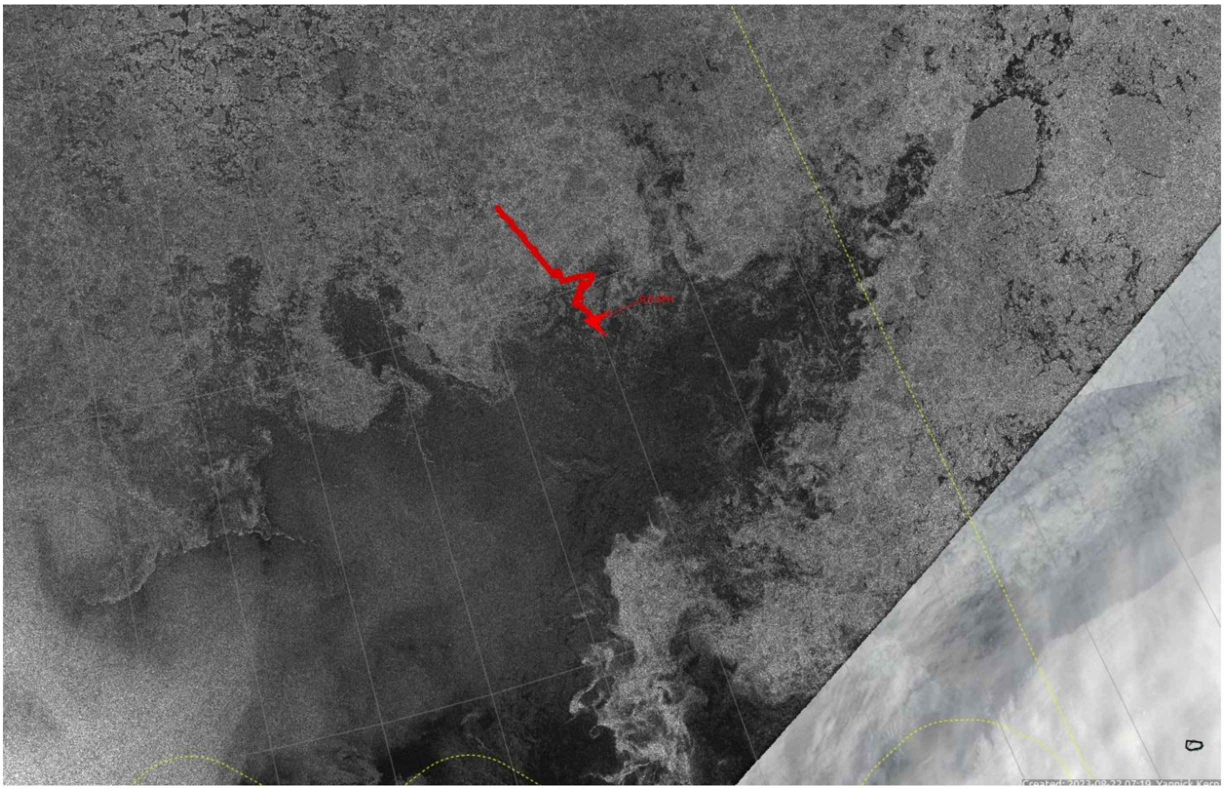

Figure 43. RADARSAT image of the sea ice cover in a selected area of the Arctic Ocean on 22 August 2023. The read line indicates the ship track, and the arrow points to the position of the ship at 07:30 on 23 August 2023.

Ice radar observations for drift and deformation characteristics

Contacts: Matias Uusinoka (matias.uusinoka@aalto.fi), Aalto University, Finland

The Arctic atmospheric temperatures are rising at an accelerating rate resulting in thinner and mechanically weaker sea ice[1, 2]. Simultaneously, the Arctic sea-ice system is changing with multiyear ice being replaced with first year ice[3] and the portion of marginal ice zone getting larger due to the long-term decrease in ice concentration[4]. Even with decreased ice extent and concentration, the changes in ice are assumed to correspond to increase in dynamic activity, which highlights the importance of understanding the underlying physics of the highly nonlinear sea-ice rheologies.

Defining characteristics of sea ice deformation are scale invariance and localization into quasi-linear features[5, 6]. These characteristics are commonly analysed with multifractal spatiotemporal deformation scaling, a parameter defining the intermittency and spatial concentration of ice deformation. The presence of such statistics has been observed across ice zones and seasons[7]. The scale-invariant behaviour has analytically been suggested to apply from the scale of ice thickness to the scale of the Artic basin, but applicable data are still rare for floe-scale dynamics. Due to the recent interest in different ice-modelling communities towards floe-scale deformations, interest in additional data sets for high-resolution floe-scale ice dynamics has been increased.

Answering the suggested need for supplementary data, we gathered ice-radar imagery commonly used for ship navigation throughout the cruise. The data set offers an in-depth look into the varying summer conditions in the marginal ice zone, which tends to be dominated by granular-like mechanical behaviour rather than the elasto-brittle winter conditions widely covered in data gathered during the MOSAiC expedition (Nicolaus et al., 2022). The data set is assumed to be used in support of the ice-radar imagery from MOSAiC expedition for both empirical research and model calibration.

Materials and Methods

The ice-radar imagery was gathered automatically throughout the ice-covered parts of the cruise with a Sea-Hawk SHN-X9 dual X-band 25 kW radar system. The radar signal was formulated into .jpg files covering a varying size of area between 1.5 NM and 3 NM depending on the navigational needs of the crew. Raw signal output was not saved due to initial radar system calibration. With the given areal extents, the imagery has spatial resolutions of 3 and 6 m and temporal resolution of 1 min. The radar imagery includes ship motion in relation to the ice floes, which affects only transitions between stations. For deformation analysis, the length of the stationary periods is enough due to the considerably high drift rates characteristic for the marginal ice zone.

Preliminary results

The radar imagery constructs a gradient of varying levels of ice concentration through the Arctic marginal ice zone offering an insight into the granular-like mechanical behaviour of the ice field (Figures 44, 45). The ice concentration varied from 30% to 90% with ice floes differentiating between free drift conditions and granular ice deformation. The evolution of the ice field in radar imagery does not fully correspond to the increase in latitude as the large-scale ice conditions varied strongly during the cruise.

When applying the radar imagery to deep neural network based optical flow algorithm, the drift field shows the distinct movement of singular ice floes drifting, colliding and breaking. The observed drift speeds stay on a relatively low level due to the mild wind conditions during the cruise. When calculating the infinitesimal strain invariants from Lagrangian trajectories formed by integrating over interpolated displacement fields, the deformation rates show high estimates typical for summer conditions. The corresponding first moment spatial scaling exponents are in accordance with previous research from summer conditions. Further research will enable broader deformation statistics for model calibration.

[1)] Spreen, G., et al. 2011. Trends in Arctic sea ice drift and role of wind forcing: 1992–2009. *Geophysical Research Letters* 38.19. doi: 10.1029/2011GL048970.

[2)] Kwok, R., et al. 2013. Arctic sea ice circulation and drift speed: Decadal trends and ocean currents. *Journal of Geophysical Research: Oceans* 118.5: 2408-2425. doi: 10.1002/jgrc.20191.

[3)] Rampal, P., et al. 2009. Positive trend in the mean speed and deformation rate of Arctic sea ice, 1979–2007. *Journal of Geophysical Research: Oceans* 114.C5. doi: 10.1029/2008JC005066.

[4)] Olason, E., & Notz, D. 2014. Drivers of variability in Arctic sea-ice drift speed. *Journal of Geophysical Research: Oceans* 119.9: 5755-5775. doi: 10.1002/2014JC009897.

[5)] Kwok, R. 2001. Deformation of the Arctic Ocean sea ice cover between November 1996 and April 1997: a qualitative survey. *IUTAM Symposium on Scaling Laws in Ice Mechanics and Ice Dynamics: Proceedings of the IUTAM Symposium*, Fairbanks, Alaska, USA, 13–16 June 2000. Dordrecht: Springer Netherlands. doi: 10.1007/978-94-015-9735-7_26.

6)Moritz, R.E. & Stern, H.L. 2001. Relationships between geostrophic winds, ice strain rates and the piecewise rigid motions of pack ice. *IUTAM Symposium on Scaling Laws in Ice Mechanics and Ice Dynamics: Proceedings of the IUTAM Symposium*, Fairbanks, Alaska, USA, 13–16 June 2000. Dordrecht: Springer Netherlands, 2001. doi: 10.1007/978-94-015-9735-7_28.

7)Stern, H. L. & Lindsay, R. W. 2009. Spatial scaling of Arctic sea ice deformation. *Journal of Geophysical Research: Oceans* 114.C10. doi: 10.1029/2009JC005380.

8)Nicolaus, M. et al. 2022 Overview of the MOSAiC expedition: Snow and sea ice. *Elementa: Science of the Anthropocene* 10 (1): 000046. doi: https://doi.org/10.1525/elementa.2021.000046

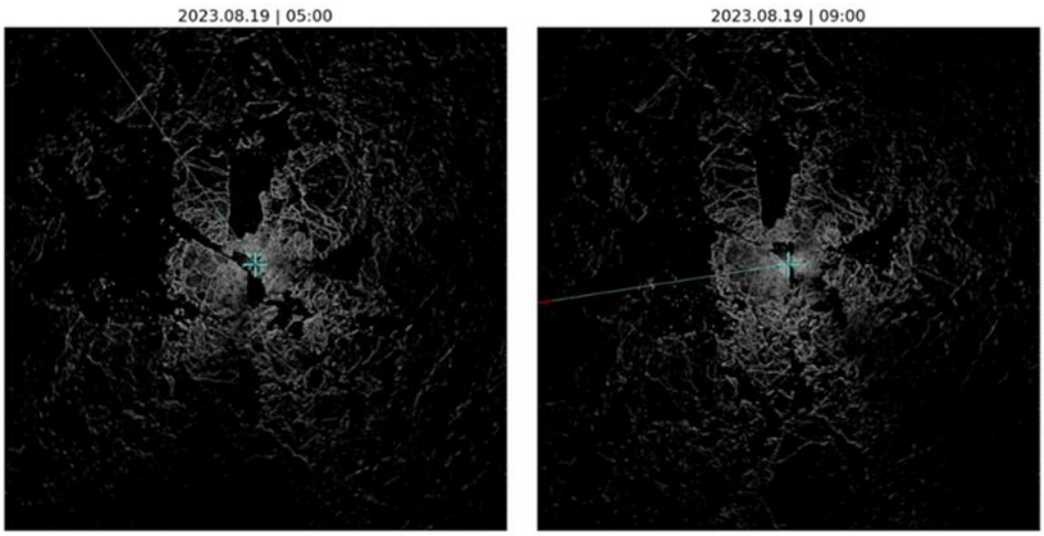

Figure 44. Two radar images on 19 August showing motion in the ice field during a 4-hour period.

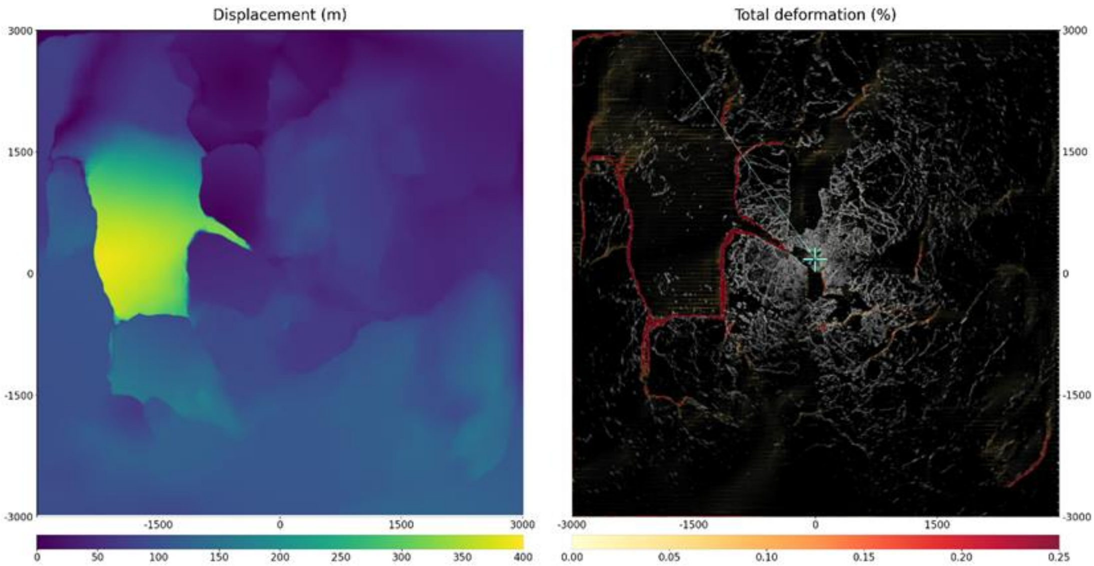

Figure 45. Observed drift field and the corresponding total deformation map in the example images in Figure 44.

Marine mammal observations

Contacts: Mario Acquarone (acquarone@amap.no), AMAP, Ole Arve Misund (Ole.Arve.Misund@npolar.no) and Marika Marnela (Marika.Marnela@npolar.no) NPI

Opportunistic sightings of marine mammals were made mainly from indoors on the bridge (deck 8, height of eye above sea level 18.4 m, theoretical horizon distance 15.3 km) or the observation lounge (deck 9) by cruise participants and crew. Data were recorded on a paper log sheet. The effort was not quantifiable and varied depending on the other onboard activities, weather and time of the day. Similarly, there was no quantification of sea state, glare, and other correction factors.

Totally 128 marine mammals were recorded during the cruise (Figure 46, Appendix 4). Of these there were observations of minke whales (*Balaenoptera acutorostrata*) (5), fin whales (*Balaenoptera physalus*) (25), 2 blue whales (*Balaenoptera musculus*) (2), and whited beaked dolphins (*Lagenorhynchus albirostris*) (18).

On the ice there were 12 scattered observations of seals, ring seal (*Pusa hispida*) and bearded seal (*Erignathus barbatus*) (Figure 47). Another 22 seals were observed in open waters. Surprisingly, walrus and bearded seals were present well into the Central Arctic Ocean over large depths and polar bears (*Ursus maritimus*) were not as abundant as expected.

A polar bear sow with yearling cub was observed on two occasions on 15 August when sailing north to the Nansen I mooring (Figure 48). They were observed on the sea ice shortly after a sighting of a male walrus resting on the ice. They were also resting as the ship passed them at a distance of approximately 500 m to reach a sampling station in the vicinity. About seven hours later, while the vessel was at Station 13, the bears approached the ship. The polar bears swam in the open leads, the up on ice floes, and came closer to the rear part of the vessel at post side. The polar bear sow approached the vessel to a distance of just about 25 m, while the young remained further calling repeatedly as the sow approached the vessel. After about 15 min in the vicinity of the vessel the polar bears walked away. At some distance from the ship the sow was laying down and rubbing its back on the snow before they continued (Figure 49).

Another adult bear was sighted walking on land on Amsterdamøya north of Gjøaneset. In the vicinity there were two other ships, MS O*rigo* close to Smeerenburgodden and MS *Stockholm* by Virgohamna. Two zodiacs with tourists from MS *Origo* headed towards the location of the bear and remained in loco for about one hour before returning to their ship. On our way south tracks of polar bears were observed on the ice floes (Figure 50). Such observations were made at six different positions. One walrus (*Odobenus rosmarus*) was observed resting on sea ice (Figure 50).

Kittiwakes, fulmars and Brünnich's guillemots were observed up to 84°N. Flocks of harp seals (*Pagophilus groenlandicus*) were observed north of Kvitøya, altogether 19 individuals. At Moffen and Smeerenburg another 41 walruses were counted, in flocks on the shore on both locations and swimming in the sea.

Additionally, short-duration (>10 min) listening points for underwater marine mammal vocalizations were made from a service boat at a variable distance from the ship at 10 locations and once at the ice station. The instrument employed was a hydrophone (Sensor Technology SQ26) connected to a recorder (Zoom H1). The recordings were made in uncompressed WAV format at 96kHz/24kb and were monitored in real time as well as at a later occasion when back on board the ship. Sound files were examined using the software Raven Lite 2.0.51[1, 2]. Marine mammal vocalizations were generally absent and only in one recording included a short sound from a bearded seal. From the recording one can appreciate the ship underwater noise even at a distance of >3 km and especially the signal of the echosounders. These recordings might provide some insight for future studies of noise pollution in the Central Arctic Ocean.

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[1]K. Lisa Yang Center for Conservation Bioacoustics. (2023). Raven Lite: Interactive Sound Analysis Software (Version 2.0.5) [Computer software].

[2]Ithaca, NY: The Cornell Lab of Ornithology. Available from https://ravensoundsoftware.com/.

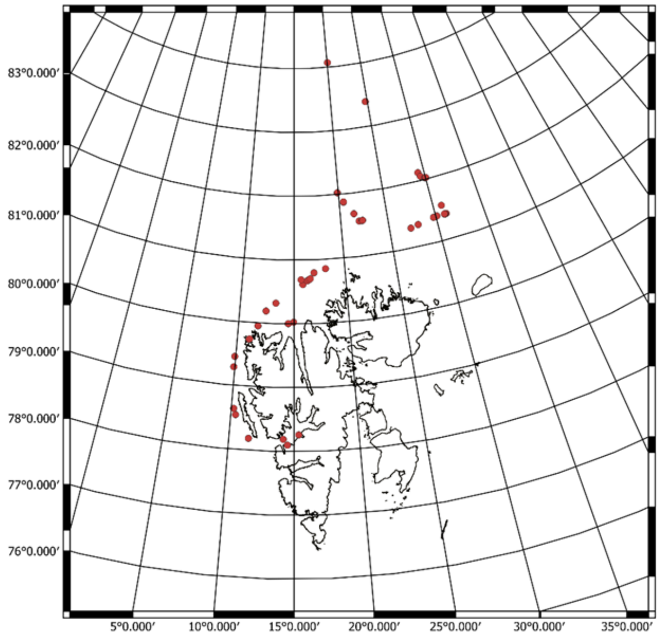

Figure 46. Map of the area and sightings (to be improved with legend and shading).

Figure 47. Ringed seal on ice in the fog. Photo: ***Mario Acquarone (AMAP).***

Figure 48. Polar bear sow and yearling approaching RV Kronprins Haakon on 18 August at N 81° 57,8' E 020° 21,1' at about 15:10. Photo: Jessica Cook (AC).

Figure 49. Polar bear sow rubbing its back on the snow at about 15:30 at the same location. Photo: Haakon Hop (NPI).

Figure 50. a) Tracks of a polar bear on an ice floe observed at N 83° 23' E024° 43,6' at 12:42 on 19 August 19 2023. Photo: Ole Arve Misund (NPI). B) Walrus on the ice with black-legged kittiwakes all around. Photo: Mario Acquarone (AMAP).

Management relevance of Arctic Ocean Cruise 2023

Contacts: Elizabeth McLanahan (PAME-USA), Cecilie von Quillfeldt (Cecilie.von.Quillfeldt), NPI

An extensive framework of international, regional and national instruments, measures and arrangements applies to the marine environment, including areas within national jurisdiction as well as areas beyond such as the Central Arctic Ocean. These governance mechanisms cover the breadth of activities ranging from marine scientific research to conservation and sustainable use of the Arctic marine environment.

On numerous occasions the Arctic states have reaffirmed their commitment to maintain peace, stability, and constructive cooperation in the Arctic which is done through the extensive legal framework as well as the Arctic Council. The Arctic Council, formally established in 1996, is the leading intergovernmental forum among the Arctic States and Arctic Indigenous peoples and promotes cooperation and coordination on issues of sustainable development and environmental protection in the Arctic. The Arctic Council's Working Groups produce an array of scientific assessments, management recommendations, and strategies to help guide the Arctic states in their understanding and conservation and sustainable use of the region.

The Protection of the Arctic Marine Environment (PAME) Working Group identified 17 Large Marine Ecosystems (LMEs) in the marine waters of the Arctic and adjacent seas in 2006 -- further revised to 18 LMEs in 2013 (Figure 51)[1]. LMEs are areas of ocean space 200,000 km^2 or greater, based upon ecological criteria such as bathymetry, hydrography, and productivity. PAME promotes the application of the Ecosystem Approach to Management (EAM) by developing Guidelines for Environmental Assessment (EA) Implementation, holding conferences on EAM (Note the 3rd International Conference on EAM in Tromsø Norway; April 2024), and producing integrated ecosystem assessments and reports. Ideally, each LME would be managed at this scale in an integrated and cross-sectoral manner; however, this can prove challenging given political boundaries (Figure 52) and the existing governance structure.

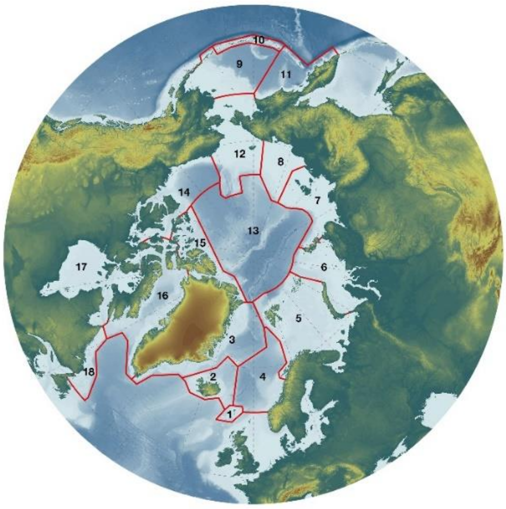

Figure 51. Large Marine Ecosystems of the Arctic (PAME 2016).

Figure 52. Economic Exclusive Zones (EEZs) of Coastal Arctic States. Source: https://sites.tufts.edu/lawofthesea/chapter-eight/

The United Nations Convention on the Law of the Sea (UNCLOS) sets out the legal framework within which all activities in the oceans and seas must be carried out (UNGA Resolution 67/78, 2012). Importantly for this cruise, freedom of scientific research is a high seas freedom enjoyed by all States and it comes with the general duty to disseminate knowledge resulting from marine scientific research. The research collected on this cruise will be vital to scientists and managers alike as they grapple with a warming and changing Arctic that opens the door to increased use and activity. The Arctic is seeing an increase in ship traffic, the presence of marine plastic pollution, claims for extended continental shelves, and additional interest in the region by non-Arctic states as well. Scientific information is invaluable to help understand the impacts of climate change and of human activities on the Arctic marine environment and its species.

There are a host of conventions, agreements, and instruments – at international, regional, and sectoral scales – applicable to the Artic marine environment, which aid in the region's management (Figure 53; Footnote: PAME, Central Arctic Ocean Synthesis Report (in draft, not for citation)). These cover, *inter alia*, shipping, fisheries, pollutants, trade in endangered species, whaling, biodiversity, climate, polar bears, scientific cooperation, search and rescue, and more. By combining robust science with this governance framework and international cooperation, the Arctic region can be managed in an integrated and sustainable manner for years to come.

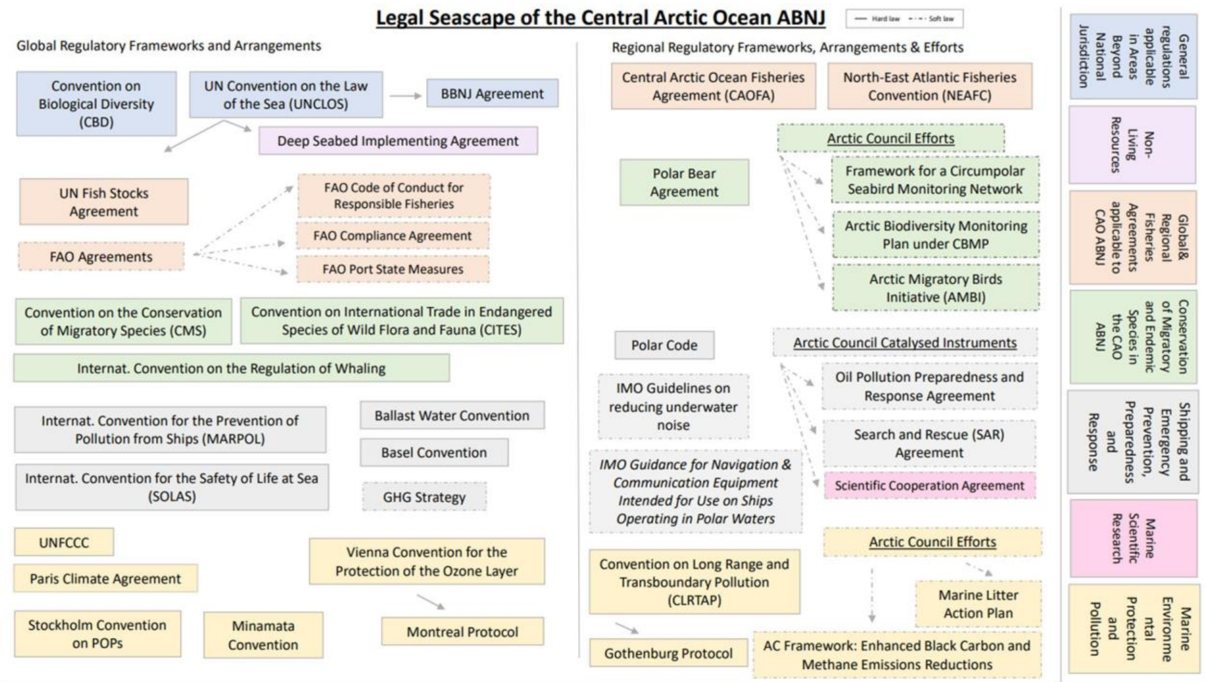

Figure 53. Legal Seascape illustrating the different Global and Regional Regulatory Frameworks, Arrangements and Efforts applicable and relevant to the Central Arctic Ocean (CAO) Areas Beyond National Jurisdiction (ABNJ). From: PAME, Central Arctic Ocean Synthesis Report (in draft, not for citation).

[1)]PAME 2016. Central Arctic Ocean LME. 13/18 LME Factsheet Series, Akureyri. 6 pp.

Figure 54. Elizabeth McLanahan (PAME) and Ole Arve Misund (NPI) getting ready to throw in a float with message inside, designed to monitor drift of plastic and other debris. Photo: Haakon Hop (NPI).

Figure 55. The float was thrown in a lead near the 2022-mooring positioned in the Nansen Basin (Lat: 83° 56.566 'N, Lon: 022° 15.038'E) as RV Kronprins Haakon left the location.

Human activities in the Arctic Ocean

Contact: Ole Arve Misund (Ole.Arve.Misund@npolar.no), NPI

When embarking RV *Kronprins Haakon* in the morning hours of Thursday 10 August, it became apparent that Longyearbyen is a busy harbour at that time of the year. R/V *Kronprins Haakon* had not received a place at the quay for that day, and its mob. boat was used for transporting cruise participants to the ship at position in Adventfjorden. Several other expedition cruise vessels, a tanker and the Norwegian Coast Guard vessel *Svalbard* were also at anchor in the fjord. The quay's were occupied by a large cruise vessels, one with likely several thousand passengers. All the ships in the Longyearbyen harbour definitely gave the impression of substantial activity in the area.

On 18 Augusth 2023, there were ships from five nations in the Polar Ocean north of 82° N (Figure 56). The Chinese research vessel RV *Xue Long II* was heading westwards towards the Makarov Ridge, the German research vessel RV *Polarstern* was heading north east wards along the Gakkel Ridge, and the French expedition cruise vessel CV *Le Commandante Charcot* was returning southwards from the North Pole. The Russian nuclear-powered ice breaker MV *Fifty Years of Victory* was heading northwards along the 50° E longitude, and MV *Akademik Tryoshnikov* was nearby RV *Severniy Polus* at N 85º 54' E 049° 39.9' E, possibly for resupply of the latter. The Norwegian RV *Kronprins Haakon* reached position N 84º 05.4' E 021º 54,32' for ice station and sampling with CTD and plankton nets.

By 21 August 2023, the situation had changed (Figure 57). *Le Commandante Charcot* had returned from the North Pole, and was entering Woodfjorden on the northern coast of Svalbard. Similarly *Fifty years of Victory* had also been to the North Pole, and was heading straight south towards Franz Josef Land. *Xue Long 2* had arrived at the Gakkel Ridge and *Polarstern* was working further north-east along the Gakkel Ridge. *Kronprins Haakon* was heading south along the Nansen transect.

By 24. August *Le Commandante Charcot* was in front of the glacier in Lilliehökfjorden on the northern coast of Svalbard. *Xue Long 2* was working at the Gakkel Ridge and *Polarstern* was working further north-east along the Gakkel Ridge. *Kronprins Haakon* was north of Kvitøya. MV *Akademik Tryoshnikov* was nearby RV *Severniy Polus* north of Franz Josef land.

Pressures that originate from ship traffic depends on types of vessels, but all can contribute to increased levels of noise, litter, contaminants, extraction of species, introductions of non-indigenous species, and disturbance from people. Other types of vessels are more involved in extraction of species (e.g. fishing vessels). With less sea ice, the ship traffic will increase, particularly with regard to transport of goods and tourism.

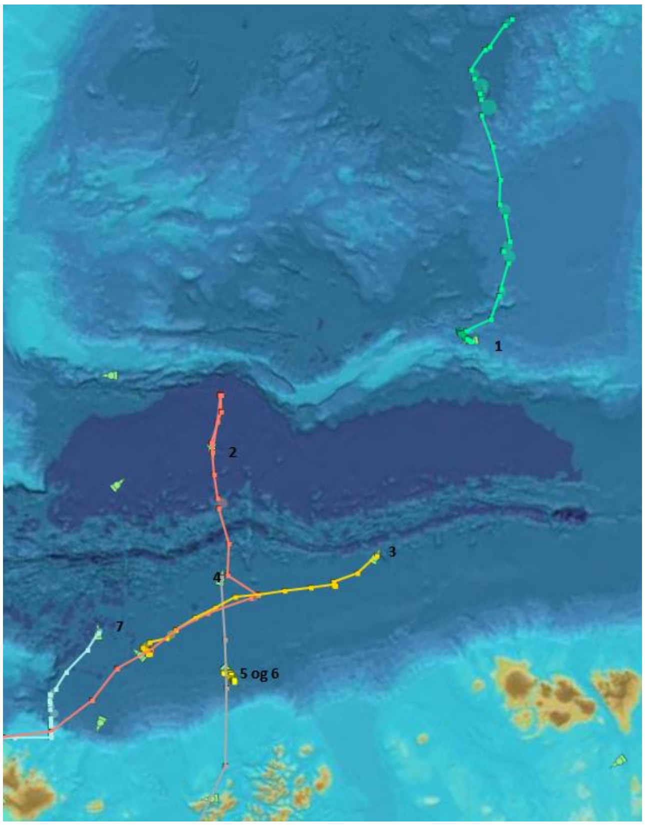

Figure 56. Ships in the Polar Ocean 18 August 2023 (1. Xue Long II*, 2.* Le Commandante Charcot*, 3.* Polarstern*, 4.* Fifty Years of Victory*, 5.* Akademik Tryoshnikov*, 6.* Severniy Polus*, 7.* Kronprins Haakon*).*

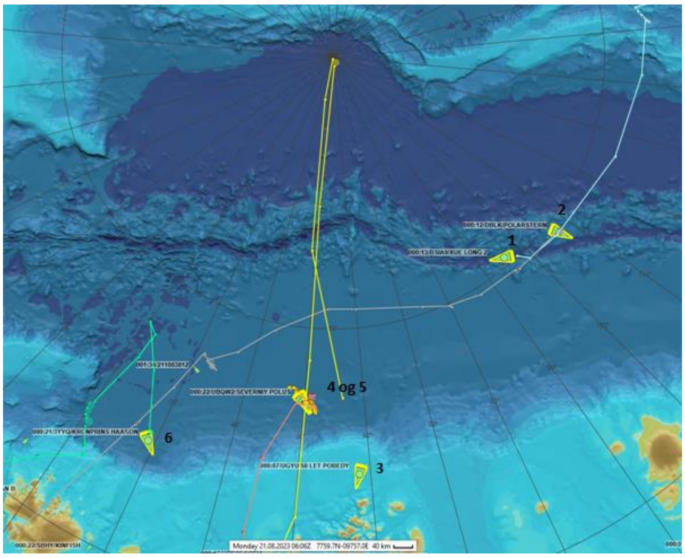

Figure 57. Ships in the Polar Ocean 21 August 2023 (1. Xue Long II, 2. Polarstern, 3. Fifty Years of Victory, 4. Akademik Tryoshnikov, 5. Severniy Polus, 6. Kronprins Haakon.

Safety training, equipment and procedures during KPH cruise AO-2 2023

Contact: Rupert Krapp (Rupert.Krapp@npolar.no), NPI Operations & Logistics, Longyearbyen

Introduction

Here we list and explain the relevant safety training that is required for all cruise participants, as well as the personal safety equipment provided from the Norwegian Polar Institute to all cruise participants. We also describe the safety procedures developed for various work and sampling situations onboard the ship, during small boat operations and on sea ice.

Cruise participants on *Kronprins Haakon* need to undergo familiarization training in the use of immersion survival suits, at least once every 5 years. Both student participants and employees were able to join such a 2-hour familiarization in Longyearbyen on two occasions prior to the cruise. Participants got familiar with all the suit's features first, and then practiced donning the suits, and using them in water, including linking up in both "star formation" and swimming in "caterpillar formation" (Figure 58). Finally, also the proper undressing, cleaning and maintenance of the suits was covered.

Figure 58. participants during survival suit familiarization in the small boat harbour in Longyearbyen.

Safety training – use of pyrotechnics (signal pistol flares) and firearms (bolt-action rifles)

Some pre-qualified participants employed by NPI and some members of the permanent crew of *Kronprins Haakon* needed to refresh their pyrotechnics and firearms handling skills so that they could function as approved polar bear guards. This training was done at the local shooting range in Longyearbyen. The focus of such training was mainly on proper use of signal pistols and flares, safe handling, half-loading and unloading procedures, and finally shooting practice with bolt-action rifles.

Personal safety equipment for use on board, during small-boat operations and on the ice

Prior to embarkation, cruise participants were able to collect all necessary protective and work clothing in their respective sizes from the warehouse of the Norwegian Polar Institute in the Svalbard Science Park, Longyearbyen. For work on deck, boots or shoes with protective toes are mandatory equipment, while snowmobile boots are often preferrable for use on ice. For general use on deck and on sufficiently safe sea ice floes, insulated one-piece floatation suits were also provided to all participants.

During work on sea ice, either floatation suits or survival suits were mandatory (Figure 59). Every team going on the ice had to also have access to at least one set of rescue rope bag (20 m) for buddy rescue and a set of ice spikes for self-rescue in case of falling off or breaking through the ice. Typically, each group brought two or more of these sets along.

Figure 59. Sea ice core sampling at the sea ice station at 84N in the Nansen Basin.

For small-boat operations away from the ship and in open water or open leads, participants had to either use these floatation suits together with automatic lifejackets, or survival suits. During launching and recovery of the ship's tender, and for any work in the hangar or on deck, hard hats were also mandatory, and provided for onboard the vessel.

Sea ice and polar bear safety procedures

The main principles for both sea ice safety and polar bear safety during such Arctic Ocean cruises are (1) thorough assessment prior to exposure, and (2) continuous monitoring during exposure to such risks (Figure 60). For practical purposes, these two aspects have been typically handled simultaneously.

Prior to establishing a sea ice station, the area in question was therefore assessed from the ship's bridge for a suitable area or ice floe, and before any work on the ice is to commence, a 3-person lookout equipped with binoculars and handheld VHF radios established a 360-degree overview of the area from the ship's bridge (Figure 61).

Figure 60. An adult female and her 2nd year cub photographed through the spotting scope.

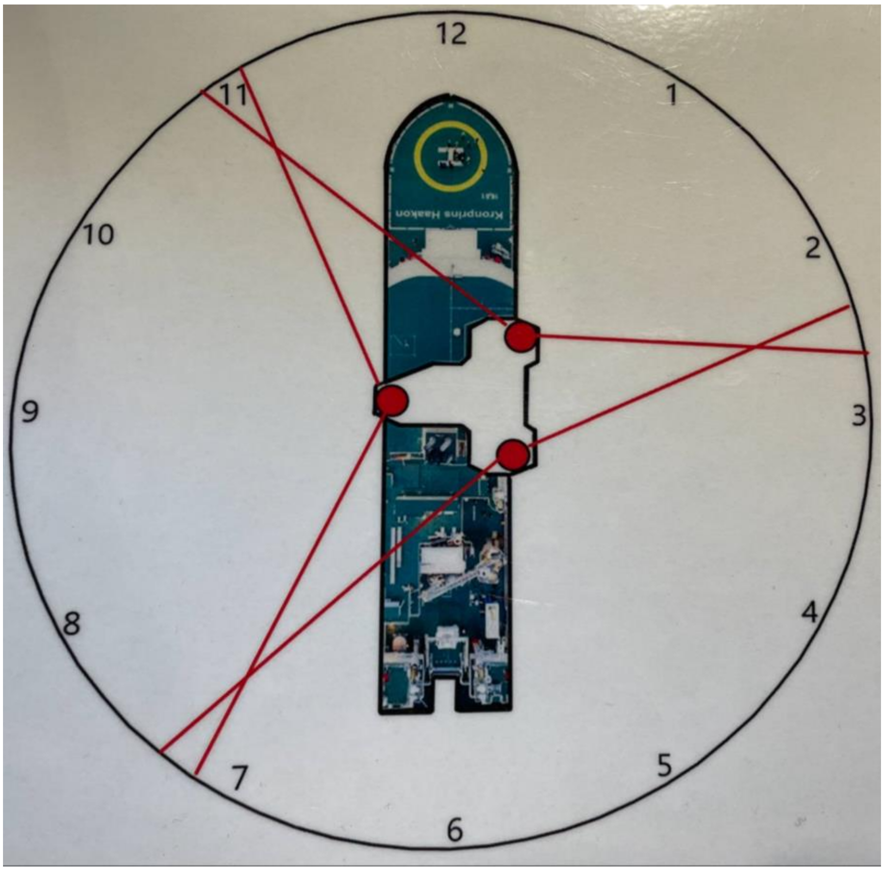

Figure 61. Schematic of the three lookout posts on the ship's bridge and their respective fields of overview.

The assistant cruise leader assigned all cruise participants to their respective 1-hour lookout duties for the relevant periods when there are people working on the ice. In that way, all participants took turns and thus contributed to the safe operation of a sea ice station, which was in line with the principle of safety being a shared responsibility that is maintained by the entire ship and all aboard.

Once this above mentioned 3-person lookout team was in place and had established a good overview, a small ice safety team including an armed polar bear guard went on the ice over the gangway installed from the main deck aft, and to check the ice thickness with a powered 2" ice drill at a suitable number of points. On this sea ice station at 84N, it was also necessary to mark a safe route with bamboo stakes, due to the frequency of deep unsafe melt ponds, and sampling sites for coring and marine mammal acoustics deployment were marked with flags.

Armed polar bear guards were equipped with both a signal pistol and flares, and a bolt-action rifle (30-06) with hunting ammunition. They also carried a handheld VHF radio, binoculars, a rescue rope bag, a set of ice spikes, and when several polar bear guards were on the ice, at least one was also carrying a GPS, a PLB (personal locator beacon) and/or InReach device, and a small first-aid pack.

The primary function of armed polar bear guards was to act as local lookout and communication relay point on the sea ice or ashore. Therefore, polar bear guards could not be included in any ongoing scientific sampling work or any other practical tasks, but needed to focus solely on these functions.

One armed polar bear guard was always the first person on the ice, and half-loaded their rifle on the ice before the rest of the party follows. The reverse was true for the conclusion of any ice work, where the armed polar bear guard was the last person still on the ice and unloaded their rifle on the ice in a safe direction immediately prior to re-entering the ship. This rule also needed to account for any crane loading of equipment pallets and gangway handling operations, where the ship's crew typically relied on getting secured by an armed polar bear guard.

Small boat operations and polar bear safety procedures

The HMOB tender of *Kronprins Haakon* was frequently used during the scientific transects of this cruise (Figure 62), and whenever sea ice was present in the launch area, the boat team included an armed polar bear guard.

For the planned but cancelled landing operations at Smeerenburg, Amsterdamøya, north-west Spitsbergen, the plan included a recce trip ashore to check and secure the site prior to launching landing operations, and then three armed polar bear guards ashore coming ashore prior to the main group, together with the four group leaders. This way, the armed polar bear guards could spread out and maintain outward facing lookout and overview positions, while the group leaders could address and guide the main group from the landing site to the area where the cultural heritage sites could be studied.

However, as the bridge crew spotted a polar bear wandering around in the same area close to our planned landing site and the cultural remains, both the recce trip and the landing operations had to be cancelled out of safety concerns.

Figure 62. The HMOB tender with RV Kronprins Haakon in the background.

Appendix 1. Activity log for sampling during the Arctic Ocean Cruise 2023, short version.

The complete log is "2023007014_Activity_Log_FINAL.xlsx"

Station Name	Date	Time (UTC)	Gear Type	Latitude	Longitude	Bottom Depth (m)	Local Station ID	Maximum depth(m)	Minimum depth (m)	Event Remarks
st01	12/08/23	17:43:20	CTD w/bottles	81.2759	22.9721	197.51	179	185	0	
st01	12/08/23	18:16:43	Phytoplankton net 10 um	81.2759	22.9721	197.44	48	50	0	
st01	12/08/23	19:06:07	Multinet Mammoth 180 um	81.2759	22.9721	197.36	49	180	0	
st01	12/08/23	19:51:20	Multinet Mammoth 180 um	81.2759	22.9719	197.43	50	180	0	
st01	12/08/23	20:35:08	MIK-net 1500 um	81.2759	22.9719	197.535	51	180	0	
st01	12/08/23	20:57:04	MIK-net 1500 um	81.2759	22.9719	197.58	52	180	0	
st01	12/08/23	21:18:17	MIK-net 1500 um	81.2759	22.9719	197.605	53	180	0	
st01	12/08/23	23:14:42	Harstad trawl	81.3126	22.8437	231.81	86	312	0	
st02	13/08/23	01:09:45	CTD w/bottles	81.3604	22.6584	402.125	180	390	0	
st03	13/08/23	02:30:38	CTD w/bottles	81.4341	22.4056	597.305	181	597	0	
st04	13/08/23	03:56:48	CTD w/bottles	81.5007	22.1597	888.18	182	880	0	CTD with water sampling
st04	13/08/23	04:54:35	Phytoplankton net 10 um	81.5007	22.1597	888.09	54	50	0	
st04	13/08/23	05:12:43	Phytoplankton net 20 um	81.5007	22.1597	888.005	55	50	0	
st04	13/08/23	06:05:44	Multinet Mammoth 180 um	81.5007	22.1597	887.8	56	857	0	
st04	13/08/23	07:40:15	Multinet Mammoth 180 um	81.5007	22.1597	887.65	57	857	0	
st04	13/08/23	09:05:13	MIK-net 1500 um	81.5007	22.1597	887.77	58	260	0	
st04	13/08/23	10:14:41	MIK-net 1500 um	81.5007	22.1597	888.1	59	260	0	
st04	13/08/23	11:51:52	Box core	81.5007	22.1597	888.10	20	888.10		
st04	13/08/23	13:50:03	Harstad trawl	81.4733	22.0401	789.24	87	367	0	
st04	13/08/23	16:16:58	Marine Mammal Observation	81.5179	21.9973	977.39	173			
st05	13/08/23	17:33:53	CTD w/bottles	81.5271	22.0499	988.54	183	993	0	
st06	13/08/23	18:43:22	CTD w/bottles	81.5524	21.9556	1499	184	1525	0	CTD with water

										sampling
st06	13/08/23	20:04:18	Phytoplankton net 10 um	81.5524	21.9557	1500.29	60	50	0	
st06	13/08/23	20:17:48	Phytoplankton net 10 um	81.5524	21.9556	1498.96	61	50	0	Small handheld net
st06	13/08/23	20:47:05	Multinet Mammoth 180 um	81.5524	21.9557	1498.59	62	1481	0	
st06	13/08/23	23:14:26	Multinet Mammoth 180 um	81.5524	21.9557	1500.28	63	1471	0	
st06	14/08/23	01:18:22	MIK-net 1500 um	81.5524	21.9557	1500.28	64	1450	0	
st06	14/08/23	03:00:21	MIK-net 1500 um	81.5523	21.9561	1499.59	65	1450	0	
st06	14/08/23	04:31:37	Box core	81.5522	21.9564	1499.59	21	1499.59		
st06	14/08/23	05:50:12	Box core	81.5517	21.9554	1477.76	22	1477.76		
st06	14/08/23	07:47:00	Harstad trawl	81.5452	22.1199	1477.76	88	460	0	
st06	14/08/23	10:30:30	Marine Mammal Observation	81.5958	22.0707	1793.31	174			
st07	14/08/23	12:10:23	CTD w/bottles	81.5936	21.8304	1941.31	185	1981	0	
st08	14/08/23	14:02:24	CTD w/bottles	81.6125	21.7304	2378	186	2505	0	
st09	14/08/23	16:12:34	CTD w/bottles	81.6393	21.6209	2910	187	3018	0	
st10	14/08/23	18:30:02	CTD w/bottles	81.6740	21.4855	3147.58	188	3219	0	
st11	14/08/23	21:20:22	CTD w/bottles	81.7601	21.1348	3312	189	3370	0	
st12	15/08/23	00:34:39	CTD w/bottles	81.8394	20.8155	3383.15	190	3471	0	
st13	15/08/23	04:48:57	CTD w/bottles	81.9249	20.4322	3383.15	191	3489	0	CTD with water sampling
st13	15/08/23	07:04:04	Phytoplankton net 10 um	81.9351	20.3357	3383.15	66	50	0	Inclusive small handheld net
st13	15/08/23	07:42:27	Multinet Mammoth 180 um	81.9395	20.3167	3489	67	3475	0	
st13	15/08/23	11:45:49	Multinet Mammoth 180 um	81.9620	20.3313	3489	68	3484	0	
st13	15/08/23	15:33:40	MIK-net 1500 um	81.9636	20.2836	3489	69	1000	0	
st13	15/08/23	17:11:34	MIK-net 1500 um	81.9723	20.1943	3489	70	1000	0	
st13	15/08/23	19:48:37	Harstad trawl	82.0540	19.8174	3489	89	470	0	Trawling in ice
st13	15/08/23	21:31:30	Box core	82.0417	19.5373	3489.00	23	3489.00		
st13	15/08/23	21:52:24	Marine Mammal Observation	82.0453	19.5389	3567.23	175			
st14	16/08/23	01:04:32	CTD w/bottles	82.0154	19.9900	3560	192	3625	0	CTD with water sampling
st15	16/08/23	06:15:14	Phytoplankton net 10 um	82.1159	19.6458	3560	71	50	0	Handheld net

st15	16/08/23	08:58:51	MIK-net 1500 um	82.1131	19.6524	3540	72	1000	0	
st15	16/08/23	10:33:29	MIK-net 1500 um	82.1238	19.6743	3527	73	1000	0	
st15	16/08/23	15:48:23	Harstad trawl	82.1076	19.4366	3527	90	134	0	
st15	16/08/23	16:53:18	Marine Mammal Observation	82.1325	19.6387	3527	176			
st15	16/08/23	18:05:27	Multinet Mammoth 180 um	82.1310	19.5814	3272.21	74	3139	0	
st17	17/08/23	19:15:11	CTD w/bottles	83.9469	22.1835	4023	193	400	0	CTD w/ water sampling. Switch to small rosette (12 bottles) due to connection problem CTD. Bottle 10,11 & 12 did not close (mechanical problem) so we redid the shallow cast for the upper 10 m
st17	17/08/23	19:44:48	Phytoplankton net 10 um	83.9461	22.1739	4023.37	75	50	0	
st17	17/08/23	20:03:28	Phytoplankton net 10 um	83.9457	22.1684	4023.26	76	50	0	Handheld nets
st17	17/08/23	20:23:54	CTD w/bottles	83.9452	22.1614	4023	194	20	0	CTD w/ water sampling. Test bottle 10,11,12 which did not close in previous cast & redo some depths
st17	17/08/23	21:17:42	CTD w/bottles	83.9438	22.1420	4023	195	4092	0	CTD w/ water sampling
st17	18/08/23	00:09:40	Multinet Mammoth 180 um	83.9384	22.0762	4023	77	3997	0	
st17	18/08/23	04:48:13	MIK-net 1500 um	83.9252	21.9545	4023	78	1000	0	
st17	18/08/23	06:11:40	MIK-net 1500 um	83.9219	21.9056	4023	79	1000	0	
st17	18/08/23	12:24:12	Ice station	84.0898	20.0730	4023	177			Ice station 1
st18	19/08/23	02:27:12	CTD w/bottles	83.6672	23.6610	4022	196	4093	0	
st18	19/08/23	05:04:22	Box core	83.6675	23.6115	4022.00	24	4022.00		

st19	19/08/23	11:35:56	CTD w/bottles	83.3687	24.9855	4011	197	4079	0	
st20	19/08/23	18:17:33	CTD w/bottles	83.0571	26.1842	4001	198	4062	0	
st21	20/08/23	01:18:02	CTD w/bottles	82.7446	27.4275	3906	199	3973	0	
st22	20/08/23	08:14:30	CTD w/bottles	82.4626	28.3970	3770	200	3833	0	
st23	20/08/23	08:37:18	Marine Mammal Observation	82.4655	28.4018	3770	178			
st23	20/08/23	13:20:27	CTD w/bottles	82.2754	28.8860	3737	201	400	0	CTD w/ water sampling
st23	20/08/23	13:48:58	Phytoplankton net 10 um	82.2732	28.8900	3737	80	50	0	
st23	20/08/23	14:44:48	CTD w/bottles	82.2689	28.8829	3644	202	3704	0	CTD w/ water sampling
st23	20/08/23	17:04:33	Multinet Mammoth 180 um	82.2647	28.8035	3655.36	81	3646	0	
st23	20/08/23	21:04:36	MIK-net 1500 um	82.2797	28.7399	3655.36	82	1000	0	
st23	20/08/23	22:30:16	MIK-net 1500 um	82.2857	28.7622	3655.36	83	1000	0	
st23	21/08/23	00:02:35	Box core	82.2879	28.8142	3644.00	25	3644.00		
st24	21/08/23	04:52:05	CTD w/bottles	82.1317	29.3071	3499.84	203	3557	0	
st25	21/08/23	08:24:12	CTD w/bottles	82.0530	29.5314	3406	204	3461	0	
st25	21/08/23	10:46:47	Phytoplankton net 10 um	82.0636	29.5885	3406	84	50	0	Handheld net
st25	21/08/23	11:51:32	Harstad trawl	82.0310	29.7098	3406	91	398	0	
st26	21/08/23	14:24:35	CTD w/bottles	81.9740	29.7720	3312	205	400	0	CTD w/ water sampling
st26	21/08/23	15:00:20	Phytoplankton net 10 um	81.9737	29.7880	3312	85	50	0	
st26	21/08/23	15:15:09	Phytoplankton net 20 um	81.9732	29.7980	3312	86	50	0	
st26	21/08/23	15:34:27	CTD w/bottles	81.9728	29.8115	3307.78	206	3272	0	CTD w/ water sampling
st26	21/08/23	17:43:11	Multinet Mammoth 180 um	81.9706	29.8607	3303.28	87	3296	0	
st26	21/08/23	21:24:21	MIK-net 1500 um	81.9881	29.8722	3321.66	88	1000	0	
st26	21/08/23	22:45:47	MIK-net 1500 um	81.9993	29.9128	3321.66	89	1000	0	
st26	22/08/23	02:16:32	Harstad trawl	81.9484	29.8058	3321.66	92	101	0	
st27	22/08/23	03:51:33	CTD w/bottles	81.8934	29.9645	3224	207	3357	0	
st28	22/08/23	06:22:11	Marine Mammal Observation	81.8958	29.9816	3222.01	179			
st28	22/08/23	08:35:00	CTD w/bottles	81.8131	30.1761	3308	208	3152	0	

st29	22/08/23	11:15:06	CTD w/bottles	81.7646	30.2872	3101	209	3054	0	
st30	22/08/23	13:57:22	CTD w/bottles	81.7155	30.4658	3011	210	2967	0	
st31	22/08/23	16:39:48	CTD w/bottles	81.6601	30.6080	2913	211	2535	0	
st32	22/08/23	18:37:30	CTD w/bottles	81.6159	30.7043	2447	212	1992	0	
st32	22/08/23	20:40:26	Box core	81.6160	30.7033	1952.00	26	1952.00		
st33	22/08/23	22:28:59	CTD w/bottles	81.5840	30.7799	1952	213	400	0	CTD w/ water sampling
st33	22/08/23	22:56:44	Phytoplankton net 10 um	81.5840	30.7801	1952	90	50	0	
st33	22/08/23	23:12:55	Phytoplankton net 20 um	81.5840	30.7801	1952	91	50	0	
st33	22/08/23	23:39:47	CTD w/bottles	81.5840	30.7801	1466	214	1493	0	CTD w/ water sampling
st33	23/08/23	00:53:20	Multinet Mammoth 180 um	81.5840	30.7808	1466	92	1464	0	
st33	23/08/23	02:45:20	MIK-net 1500 um	81.5841	30.7814	1467.98	93	1440	0	
st33	23/08/23	04:05:58	MIK-net 1500 um	81.5841	30.7814	1468.37	94	1440	0	
st33	23/08/23	06:04:55	Harstad trawl	81.5583	30.7784	1089.93	93	354	0	
st33	23/08/23	07:49:41	Marine Mammal Observation	81.4971	30.7224	1089.93	180			
st34	23/08/23	09:22:05	CTD w/bottles	81.5598	30.8300	1019.76	215	1027	0	
st35	23/08/23	10:35:50	CTD w/bottles	81.5463	30.8564	868	216	870	0	CTD w/ water sampling
st35	23/08/23	11:27:32	Phytoplankton net 10 um	81.5463	30.8564	868	95	50	0	
st35	23/08/23	11:42:59	Phytoplankton net 20 um	81.5463	30.8564	868	96	50	0	
st35	23/08/23	12:08:40	Multinet Mammoth 180 um	81.5463	30.8565	868	97	856	0	
st35	23/08/23	13:28:13	MIK-net 1500 um	81.5463	30.8566	868	98	840	0	
st35	23/08/23	14:40:56	MIK-net 1500 um	81.5463	30.8567	868	99	840	0	
st35	23/08/23	16:28:41	Harstad trawl	81.5292	30.9357	794.35	94	380	0	
st36	23/08/23	18:32:41	Marine Mammal Observation	81.4758	31.0465	794.35	181			
st37	23/08/23	19:38:17	CTD w/bottles	81.4918	30.9953	659.03	217	656	0	
st38	23/08/23	20:39:14	CTD w/bottles	81.4481	31.1077	392.32	218	384	0	
st38	23/08/23	21:30:46	CTD w/bottles	81.4003	31.2219	193	219	186	0	CTD w/ water sampling

st38	23/08/23	22:00:58	Phytoplankton net 10 um	81.4050	31.2263	193	100	50	0	
st38	23/08/23	22:18:40	Phytoplankton net 20 um	81.4083	31.2230	197.93	101	50	0	
st38	23/08/23	22:51:29	Multinet Mammoth 180 um	81.4123	31.2328	207.93	102	189	0	
st38	23/08/23	23:34:06	MIK-net 1500 um	81.4177	31.2372	218.65	103	185	0	
st38	23/08/23	23:57:04	MIK-net 1500 um	81.4216	31.2395	205.605	104	185	0	
st38	24/08/23	04:01:07	Harstad trawl	81.4066	31.4018	187.68	95	48	0	
st38	24/08/23	06:44:40	Marine Mammal Observation	81.4086	30.2726	222.675	182			
st39	24/08/23	11:17:18	CTD w/bottles	81.3090	27.2068	379.27	220	376	0	CTD w/ water sampling
st39	24/08/23	11:50:58	Phytoplankton net 10 um	81.3093	27.2061	379.625	105	50	0	
st39	24/08/23	12:06:16	Phytoplankton net 20 um	81.3093	27.2061	379.72	106	50	0	
st39	24/08/23	12:33:51	Multinet Mammoth 180 um	81.3093	27.2061	379.975	107	365	0	
st39	24/08/23	13:19:06	MIK-net 1500 um	81.3093	27.2062	380.055	108	350	0	
st39	24/08/23	13:54:42	MIK-net 1500 um	81.3093	27.2062	380.215	109	350	0	
st39	24/08/23	16:06:49	Beam trawl	81.2993	26.6419	556.64	96	556	0	
	25/08/23	07:26:01	Harstad trawl	80.6867	15.6064	520.17	97	311	0	Vito trawl
st40	25/08/23	09:21:08	CTD w/bottles	80.6853	15.5320	514.76	221	527	0	CTD w/ water sampling
st40	25/08/23	10:02:34	Phytoplankton net 10 um	80.6853	15.5322	515.73	110	50	0	
st40	25/08/23	10:35:42	Multinet Mammoth 180 um	80.6853	15.5322	519.33	111	507	0	
st40	25/08/23	11:31:59	MIK-net 1500 um	80.6853	15.5321	519.04	112	485	0	
st40	25/08/23	12:19:08	MIK-net 1500 um	80.6846	15.5284	510.14	113	484	0	
st40	25/08/23	14:08:10	Marine Mammal Observation	80.7368	16.1414	704.38	183			
	25/08/23	19:11:20	Harstad trawl	81.1338	17.8739	447.585	98	31	0	
	25/08/23	20:28:03	Harstad trawl	81.0906	17.8514	418.55	99	384	0	
	25/08/23	22:49:26	EM302	81.0470	17.9290	363.97	159			Acoustical transect
	25/08/23	23:21:48	SBP	81.0796	17.9599	375.88	160			Acoustical transect
	26/08/23	02:05:04	EM302	81.3456	18.0496	694.19	161			Acoustical transect
	26/08/23	02:05:53	SBP	81.3457	18.0418	694.47	162			Acoustical transect
	26/08/23	04:08:43	EM302	81.1342	17.7906	480.165	163			Acoustical transect
	26/08/23	04:08:48	SBP	81.1344	17.7906	479.83	164			Acoustical transect

	26/08/23	05:45:03	EM302	81.3125	17.7790	646.39	165			Acoustical transect
	26/08/23	05:45:06	SBP	81.3125	17.7788	646.05	166			Acoustical transect
	26/08/23	07:26:02	EM302	81.1251	17.6797		167			Acoustical transect
	26/08/23	07:26:06	SBP	81.1250	17.6794		168			Acoustical transect

Appendix 2. Activity log for mercury activity log during the Arctic Ocean Cruise 2023.

Sample type	Gear Type	Date	Start Time (UTC)	Station Name	Latitude	Longitude	Bottom Depth (m)	Local Station ID	Sample Depth (m)	sampled parameter	sample ID	NISKIN
seawater	CTD w/bottles	12-08-23	17:43:20	st01	81.2759	22.9721	197.51	179	190	THg, MeHg, MMHg	St01-001	6
seawater	CTD w/bottles	12-08-23	17:43:20	st01	81.2759	22.9721	197.51	179	100	THg, MeHg, MMHg	St01-002	8
seawater	CTD w/bottles	12-08-23	17:43:20	st01	81.2759	22.9721	197.51	179	75	THg, MeHg, MMHg	St01-003	10
seawater	CTD w/bottles	12-08-23	17:43:20	st01	81.2759	22.9721	197.51	179	50	THg, MeHg, MMHg	St01-004	12
seawater	CTD w/bottles	12-08-23	17:43:20	st01	81.2759	22.9721	197.51	179	34	THg, MeHg, MMHg	St01-005	14
seawater	CTD w/bottles	12-08-23	17:43:20	st01	81.2759	22.9721	197.51	179	25	THg, MeHg, MMHg	St01-006	16
Fish	Harstad trawl	12-08-23	23:14:42	st01	81.3126	22.8437	231.81	86		THg, MeHg		
Zooplankton	MIK-net 1500 um	12-08-23	20:35:08	st01	81.2759	22.9719	197.535	51		THg, MeHg		
Zooplankton	MIK-net 1500 um	13-08-23	10:14:41	st04	81.5007	22.1597	888.1	59		THg, MeHg		
seawater	CTD	13-08-23	03:56:48	st04	81.5007	22.1597	888.18	182	880	THg, MeHg,	St04-007	7

	w/bottles									MMHg		
seawater	CTD w/bottles	13-08-23	03:56:48	st04	81.5007	22.1597	888.18	182	400	THg, MeHg, MMHg	St04-008	9
seawater	CTD w/bottles	13-08-23	03:56:48	st04	81.5007	22.1597	888.18	182	200	THg, MeHg, MMHg	St04-009	11
seawater	CTD w/bottles	13-08-23	03:56:48	st04	81.5007	22.1597	888.18	182	100	THg, MeHg, MMHg	St04-010	13
seawater	CTD w/bottles	13-08-23	03:56:48	st04	81.5007	22.1597	888.18	182	50	THg, MeHg, MMHg	St04-011	15
seawater	CTD w/bottles	13-08-23	03:56:48	st04	81.5007	22.1597	888.18	182	25	THg, MeHg, MMHg	St04-012	17
surface sediment	Box core	13-08-23	11:51:52	st04	81.5007	22.1597	888.1	20	888.1	THg, MeHg		
Fish	Harstad trawl	13-08-23	13:50:03	st04	81.4733	22.0401	789.24	87		THg, MeHg		
seawater	CTD w/bottles	13-08-23	18:43:22	st06	81.5524	21.9556	1499	184	1490	THg, MeHg, MMHg	St06-013	7
seawater	CTD w/bottles	13-08-23	18:43:22	st06	81.5524	21.9556	1499	184	1000	THg, MeHg, MMHg	St06-014	10
seawater	CTD w/bottles	13-08-23	18:43:22	st06	81.5524	21.9556	1499	184	750	THg, MeHg, MMHg	St06-015	11
seawater	CTD w/bottles	13-08-23	18:43:22	st06	81.5524	21.9556	1499	184	500	THg, MeHg, MMHg	St06-016	12
seawater	CTD w/bottles	13-08-23	18:43:22	st06	81.5524	21.9556	1499	184	300	THg, MeHg, MMHg	St06-017	14
seawater	CTD w/bottles	13-08-23	18:43:22	st06	81.5524	21.9556	1499	184	200	THg, MeHg, MMHg	St06-018	15
seawater	CTD w/bottles	13-08-23	18:43:22	st06	81.5524	21.9556	1499	184	100	THg, MeHg, MMHg	St06-019	16
seawater	CTD w/bottles	13-08-23	18:43:22	st06	81.5524	21.9556	1499	184	50	THg, MeHg, MMHg	St06-020	18

seawater	CTD w/bottles	13-08-23	18:43:22	st06	81.5524	21.9556	1499	184	25	THg, MeHg, MMHg	St06-021	20
Zooplankton	MIK-net 1500 um	14-08-23	03:00:21	st06	81.5523	21.9561	1499.59	65				
Surface sediment	Box core	14-08-23	05:50:12	st06	81.5517	21.9554	1477.76	22	1477.76	THg, MeHg		
Fish	Harstad trawl	14-08-23	07:47:00	st06	81.5452	22.1199	1477.76	88		THg, MeHg		
Zooplankton	MIK-net 1500 um	15-08-23	15:33:40	st13	81.9636	20.2836	3489.00	69		THg, MeHg		
seawater	CTD w/bottles	15-08-23	04:48:57	st13	81.9249	20.4322	3383.15	191	3375	THg, MeHg, MMHg	St12-022	7
seawater	CTD w/bottles	15-08-23	04:48:57	st13	81.9249	20.4322	3383.15	191	3000	THg, MeHg, MMHg	St12-023	10
seawater	CTD w/bottles	15-08-23	04:48:57	st13	81.9249	20.4322	3383.15	191	2000	THg, MeHg, MMHg	St12-024	11
seawater	CTD w/bottles	15-08-23	04:48:57	st13	81.9249	20.4322	3383.15	191	1000	THg, MeHg, MMHg	St12-025	12
seawater	CTD w/bottles	15-08-23	04:48:57	st13	81.9249	20.4322	3383.15	191	500	THg, MeHg, MMHg	St12-026	13
seawater	CTD w/bottles	15-08-23	04:48:57	st13	81.9249	20.4322	3383.15	191	250	THg, MeHg, MMHg	St12-027	15
seawater	CTD w/bottles	15-08-23	04:48:57	st13	81.9249	20.4322	3383.15	191	100	THg, MeHg, MMHg	St12-028	17
seawater	CTD w/bottles	15-08-23	04:48:57	st13	81.9249	20.4322	3383.15	191	50	THg, MeHg, MMHg	St12-029	19
seawater	CTD w/bottles	15-08-23	04:48:57	st13	81.9249	20.4322	3383.15	191	25	THg, MeHg, MMHg	St12-030	20
surface sediment	Box core	15-08-23	21:31:30	st13	82.0417	19.5373	3489.00	23	3489	THg, MeHg		

	Harstad trawl	15-08-23	19:48:37	st13	82.0540	19.8174	3489.00	89		THg, MeHg		
seawater	CTD w/bottles	17-08-23	19:15:11	st17	83.9469	22.1835	4023.00	193	250	THg, MeHg, MMHg	St16-036	2
seawater	CTD w/bottles	17-08-23	19:15:11	st17	83.9469	22.1835	4023.00	193	100	THg, MeHg, MMHg	St16-037	4
seawater	CTD w/bottles	17-08-23	19:15:11	st17	83.9469	22.1835	4023.00	193	50	THg, MeHg, MMHg	St16-038	7
seawater	CTD w/bottles	17-08-23	19:15:11	st17	83.9469	22.1835	4023.00	193	25	THg, MeHg, MMHg	St16-039	9
seawater	CTD w/bottles	17-08-23	21:17:42	st17	83.9438	22.1420	4023.00	195	4010	THg, MeHg, MMHg	St16-031	2
seawater	CTD w/bottles	17-08-23	21:17:42	st17	83.9438	22.1420	4023.00	195	3000	THg, MeHg, MMHg	St16-032	3
seawater	CTD w/bottles	17-08-23	21:17:42	st17	83.9438	22.1420	4023.00	195	2000	THg, MeHg, MMHg	St16-033	4
seawater	CTD w/bottles	17-08-23	21:17:42	st17	83.9438	22.1420	4023.00	195	1000	THg, MeHg, MMHg	St16-034	5
seawater	CTD w/bottles	17-08-23	21:17:42	st17	83.9438	22.1420	4023.00	195	500	THg, MeHg, MMHg	St16-035	10
Zooplankton	MIK-net 1500 um	18-08-23	06:11:40	st17	83.9219	21.9056	4023.00	79		THg, MeHg		
Ice Core 1	Ice station	18-08-23	12:24:12	st17	84.0898	20.0730	4023.00	177	0-160 cm	THg, MeHg, MMHg	20 cm sections	
Ice Core 1	Ice station	18-08-23	12:24:12	st17	84.0898	20.0730	4023.00	177	0-140 cm	THg, MeHg, MMHg	20 cm sections	
Ice Core 1	Ice station	18-08-23	12:24:12	st17	84.0898	20.0730	4023.00	177	0-140 cm	THg, MeHg, MMHg	20 cm sections	
surface sediment	Box core	19-08-23	05:04:22	st18	83.6675	23.6115	4022	24	4022	THg, MeHg		
Zooplankton	MIK-net	20-08-23	21:04:36	st23	82.2797	28.7399	3655.36	82		THg, MeHg		

	1500 um											
seawater	CTD w/bottles	20-08-23	13:20:27	st23	82.2754	28.8860	3737	201	250	THg, MeHg, MMHg	St23-045	2
seawater	CTD w/bottles	20-08-23	13:20:27	st23	82.2754	28.8860	3737	201	100	THg, MeHg, MMHg	St23-046	4
seawater	CTD w/bottles	20-08-23	13:20:27	st23	82.2754	28.8860	3737	201	50	THg, MeHg, MMHg	St23-047	6
seawater	CTD w/bottles	20-08-23	13:20:27	st23	82.2754	28.8860	3737	201	25	THg, MeHg, MMHg	St23-048	8
seawater	CTD w/bottles	20-08-23	14:44:48	st23	82.2689	28.8829	3644	202	3630	THg, MeHg, MMHg	St23-040	2
seawater	CTD w/bottles	20-08-23	14:44:48	st23	82.2689	28.8829	3644	202	3000	THg, MeHg, MMHg	St23-041	3
seawater	CTD w/bottles	20-08-23	14:44:48	st23	82.2689	28.8829	3644	202	2000	THg, MeHg, MMHg	St23-042	4
seawater	CTD w/bottles	20-08-23	14:44:48	st23	82.2689	28.8829	3644	202	1000	THg, MeHg, MMHg	St23-043	5
seawater	CTD w/bottles	20-08-23	14:44:48	st23	82.2689	28.8829	3644	202	500	THg, MeHg, MMHg	St23-044	6
surface sediment	Box core	21-08-23	00:02:35	st23	82.2879	28.8142	3644	25	3644	THg, MeHg		
sediment biota	Box core	22-08-23	01:02:35	st24	82.2879	28.8142	3644	25	3644	THg, MeHg		
Fish	Harstad trawl	21-08-23	11:51:32	st25	82.0310	29.7098	3406	91		THg, MeHg		
Zooplankton	MIK-net 1500 um	21-08-23	21:24:21	st26	81.9881	29.8722	3321.66	88		THg, MeHg		
seawater	CTD w/bottles	21-08-23	14:24:35	st26	81.9740	29.7720	3312	205	250	THg, MeHg, MMHg	St26-054	2
seawater	CTD	21-08-23	14:24:35	st26	81.9740	29.7720	3312	205	100	THg, MeHg,	St26-055	4

	w/bottles									MMHg		
seawater	CTD w/bottles	21-08-23	14:24:35	st26	81.9740	29.7720	3312	205	50	THg, MeHg, MMHg	St26-056	6
seawater	CTD w/bottles	21-08-23	14:24:35	st26	81.9740	29.7720	3312	205	25	THg, MeHg, MMHg	St26-057	7
seawater	CTD w/bottles	21-08-23	15:34:27	st26	81.9728	29.8115	3307.78	206	3300	THg, MeHg, MMHg	St26-049	2
seawater	CTD w/bottles	21-08-23	15:34:27	st26	81.9728	29.8115	3307.78	206	3000	THg, MeHg, MMHg	St26-050	3
seawater	CTD w/bottles	21-08-23	15:34:27	st26	81.9728	29.8115	3307.78	206	2000	THg, MeHg, MMHg	St26-051	4
seawater	CTD w/bottles	21-08-23	15:34:27	st26	81.9728	29.8115	3307.78	206	1000	THg, MeHg, MMHg	St26-052	5
seawater	CTD w/bottles	21-08-23	15:34:27	st26	81.9728	29.8115	3307.78	206	500	THg, MeHg, MMHg	St26-053	6
fish	Harstad trawl	22-08-23	02:16:32	st26	81.9484	29.8058	3321.66	92		THg, MeHg		
surface sediment	Box core	22-08-23	20:40:26	st32	81.6160	30.7033	1952	26	1952	THg, MeHg		
seawater	CTD w/bottles	22-08-23	22:28:59	st33	81.5840	30.7799	1952	213	300	THg, MeHg, MMHg	St33-062	2
seawater	CTD w/bottles	22-08-23	22:28:59	st33	81.5840	30.7799	1952	213	200	THg, MeHg, MMHg	St33-063	3
seawater	CTD w/bottles	22-08-23	22:28:59	st33	81.5840	30.7799	1952	213	100	THg, MeHg, MMHg	St33-064	4
seawater	CTD w/bottles	22-08-23	22:28:59	st33	81.5840	30.7799	1952	213	50	THg, MeHg, MMHg	St33-065	6
seawater	CTD w/bottles	22-08-23	22:28:59	st33	81.5840	30.7799	1952	213	25	THg, MeHg, MMHg	St33-066	7
seawater	CTD w/bottles	22-08-23	23:39:47	st33	81.5840	30.7801	1466	214	1450	THg, MeHg, MMHg	St33-058	2

seawater	CTD w/bottles	22-08-23	23:39:47	st33	81.5840	30.7801	1466	214	1000	THg, MeHg, MMHg	St33-059	3
seawater	CTD w/bottles	22-08-23	23:39:47	st33	81.5840	30.7801	1466	214	750	THg, MeHg, MMHg	St33-060	4
seawater	CTD w/bottles	22-08-23	23:39:47	st33	81.5840	30.7801	1466	214	500	THg, MeHg, MMHg	St33-061	6
zooplankton	MIK-net 1500 um	23-08-23	02:45:20	st33	81.5841	30.7814	1467.98	93		THg, MeHg		
fish	Harstad trawl	23-08-23	06:04:55	st33	81.5583	30.7784	1089.93	93		THg, MeHg		
Zooplankton	MIK-net 1500 um	23-08-23	13:28:13	st35	81.5463	30.8566	868	98		THg, MeHg		
seawater	CTD w/bottles	23-08-23	10:35:50	st35	81.5463	30.8564	868	216	850	THg, MeHg, MMHg	St35-067	6
seawater	CTD w/bottles	23-08-23	10:35:50	st35	81.5463	30.8564	868	216	500	THg, MeHg, MMHg	St35-068	7
seawater	CTD w/bottles	23-08-23	10:35:50	st35	81.5463	30.8564	868	216	200	THg, MeHg, MMHg	St35-069	9
seawater	CTD w/bottles	23-08-23	10:35:50	st35	81.5463	30.8564	868	216	100	THg, MeHg, MMHg	St35-070	10
seawater	CTD w/bottles	23-08-23	10:35:50	st35	81.5463	30.8564	868	216	50	THg, MeHg, MMHg	St35-071	13
seawater	CTD w/bottles	23-08-23	10:35:50	st35	81.5463	30.8564	868	216	25	THg, MeHg, MMHg	St35-072	14
fish	Harstad trawl	23-08-23	16:28:41	st35	81.5292	30.9357	794.35	94		THg, MeHg		
Zooplankton	MIK-net 1500 um	23-08-23	23:34:06	st38	81.4177	31.2372	218.65	103		THg, MeHg		
seawater	CTD w/bottles	23-08-23	21:30:46	st38	81.4003	31.2219	193	219	185	THg, MeHg, MMHg	St38-073	2

seawater	CTD w/bottles	23-08-23	21:30:46	st38	81.4003	31.2219	193	219	150	THg, MeHg, MMHg	St38-074	4
seawater	CTD w/bottles	23-08-23	21:30:46	st38	81.4003	31.2219	193	219	100	THg, MeHg, MMHg	St38-075	5
seawater	CTD w/bottles	23-08-23	21:30:46	st38	81.4003	31.2219	193	219	75	THg, MeHg, MMHg	St38-076	6
seawater	CTD w/bottles	23-08-23	21:30:46	st38	81.4003	31.2219	193	219	50	THg, MeHg, MMHg	St38-077	9
seawater	CTD w/bottles	23-08-23	21:30:46	st38	81.4003	31.2219	193	219	25	THg, MeHg, MMHg	St38-078	10
fish	Harstad trawl	24-08-23	04:01:07	st38	81.4066	31.4018	187.68	95		THg, MeHg		
Zooplankton	MIK-net 1500 um	24-08-23	13:19:06	st39	81.3093	27.2062	380.055	108		THg, MeHg		
seawater	CTD w/bottles	24-08-23		st39					400	THg, MeHg, MMHg	St39-079	6
seawater	CTD w/bottles	24-08-23		st39					300	THg, MeHg, MMHg	St39-080	8
seawater	CTD w/bottles	24-08-23		st39					200	THg, MeHg, MMHg	St39-081	10
seawater	CTD w/bottles	24-08-23		st39					100	THg, MeHg, MMHg	St39-082	11
seawater	CTD w/bottles	24-08-23		st39					50	THg, MeHg, MMHg	St39-083	15
seawater	CTD w/bottles	24-08-23		st39					25	THg, MeHg, MMHg	St39-084	16
seawater	CTD w/bottles	25-08-23		st40					550	THg, MeHg, MMHg	St40-085	1
seawater	CTD w/bottles	25-08-23		st40					400	THg, MeHg, MMHg	St40-086	3
seawater	CTD	25-08-23		st40					200	THg, MeHg,	St40-087	5

Norsk Polarinstitutt

	w/bottles									MMHg		
seawater	CTD w/bottles	25-08-23		st40					100	THg, MeHg, MMHg	St40-088	7
seawater	CTD w/bottles	25-08-23		st40					50	THg, MeHg, MMHg	St40-089	10
seawater	CTD w/bottles	25-08-23		st40					25	THg, MeHg, MMHg	St40-090	13

Appendix 3. Species list and occurrence in 20 µ net samples.

+++ dominant, ++ frequent, + regular, p present (observed only a few times). Note! 10 µ net was used at station 40.

Species	Trans 1	Trans 1	Trans 1	Trans 1	Trans 2	Trans 2	Trans 2	Trans 2	Trans 2	Trans 2	Trans 2	A-DBO	Comments
	St 4	St 6	St 13	St 15	St. 17	St 23[7]	St 26	St 33	St 35	St 38[7]	St 39	St 40[8]	
Diatoms (Cl. Bacillariopphyceae, Coscinodiscophyceae and Mediophyceae)													
Attheya septentrionalis	p		P[6]	P[6]	p		P[6]						Epiphyte
Bacterosira bathyomphala		p		p		P[1]							Spring
Centric spp.		p				P[4]							
Chaetoceros atlanticus		p	p	p	+	p	p	p	p		p		
C. borealis	+	p	p	p	p			p	p	p	p	p	
C. brevis		p	++	++	+++	+	+		p		p	p	
C. convolutus	p	p	p	p	+	p	++		+	p			
C. debilis	p	p											
C. decipiens	+++	++	p	++	++		+++	+	+	P[2]	+	+	
C. gelidus	p	p	P[2,4,5]	P[5]	p								spring
C. karianus	p												
C. laciniosus	p	+											
C. teres	p	p					p						
C. wighamii	p	p											
C. spp.	p			p			p						

Corethron hystrix	p	p								p		p	
Coscinodiscus radiatus									p		p		
C. spp.								p	p				
Cylindrotheca closterium		p	p	p		p	p			p			Ice/water
Dactyliosolen fragilissimus												++	
Entomoneis cf. *kjellmanii*				p									
Eucampia groenlandica				p			P[1]				p		
Fossulaphycus arcticus		p		p									Ice/water, spring
Fragilariopsis cylindrus						P[4]	P[3]						
F. oceanica	P[1]	P[5]	p	+[5]			P		p				Ice/water, spring
Melosira arctica	P[2]			P[2]									
Navicula pelagica			p, p[4]	P	P[1]								Ice
N. spp.	p	p, p[3]	p, p[4]	p		p, p[4]	p, p[3]			p		p	
Nitzschia cf. *arctica*		P[2]											Ice
N. frigida	P[3]	P[3]	P[4]	p, p[3]	p	P[1]	P[3],P[4],P[1]			P[4]			Ice
N. promare	P[3]		P[4]						P[3]				Ice covered waters/ice
N. spp.							p		p				
Pennate spp.			p		p	p	p					p	Ice/water
Plagiotropis longa		p											
Porosira glacialis						P[4]	P[3]			P[4]			
Proboscia alata		p						p	p				
P. cf. *eumorpha*									p				
Pseudo-nitzschia delicatissima	+++	+++						p		+	p	+	
P. granii	p	p											Inside *Phaeocystis* colonies
Rhizosolenia borealis		p					p	p	p	p	p		
R. hebetata f. *semispina*	+	p	+, p[4]	++	+	+	++	+	+		p	p	
R. styliformis								p	p				
Shionodiscus bioculatus		p	+	+	p	P[1]	P[2]						Ice covered waters/ice
Synedropsis hyperborea			P[4]	p	P[6]		P[3]		P[3]	P[4]			epiphyte
Thalassiosira antarctica var. *borealis*			P[5]	+[5]	p		p			p	P[4,5]		spring
T. cf. *constricta*												p	
T. cf. *eccentrica*	p	++					p	+	+	p	p	p	
T. cf. *gravida*		p											

T. nordenskioeldii				P[2]									
T. spp.	p	p	P[4]					p	p	p	p		
Cl. Dinophyceae													
Balechina gracile									p		+	p	
Dinophysis acuminata	p							p			p	p	
D. acuta								p	p		p		
D. norwegica									p		p		
Diplopsalis lenticula									p			p	
Gymnodinium spp.		p			p	p							
Gyrodinium spirale											p		
G. spp.				p	p	p		p	p		p		
Cf. *Katodinium* sp.						p							
Lingulodium polyedrum												p	
Phalacroma rotundatum							p	+	+	p	+		
Polarella glacialis	P[3]		P[4]	P[3]			P[4]		P[3]				Ice
Cf. *Protoerythropsis* sp.						p							
Protoperidinium bipes	p	p		p		p					p		
P. cf. *breve*				p						p			
P. brevipes				p			p	p	p		+	p	
P. cf. *conicoides*									p				
P. depressum	p	p					p			+	+		
P. divergens		p											
P. granii	p	p		p			p				p	p	
P. cf. *ovatum*		p			p		p						
P. pallidum		p	p				p	+	+	p	+		
P. pellucidum	p	p	p	p			p	+	+	+	++	p	
P. cf. *pyriform*								p					
P. steinii			p										
P. spp.	p	+	p	p	p	p	+	+	++	+	+	+	
Scrippsiella cf. *trochoidea*	p	p				p					p		
Small, naked dinoflagellates						+	p	++	++	p	p	+	
Small, thecate dinoflagellates						p	p	++	+++	p	+	p	
Tripos arcticus[9]	p	p				p							

T. fusus								p	p		p	p	
T. lineatum												p	
T. longipes[9]	p	p		p		p	p	+	++	+	+	p	
T. tripos								p			p		
Cl. Chrysophyceae													
Dinobryon balticum	++	+++		p			p	+	+		++, +[4]	+	
Ocatctis speculum	p	p	p	p	p		p		p	p	p		All year round
Cl. Coccolithophyceae													
Phaeocystis pouchetii	p	p	++	+									Spring/early summer
Cl. Pyramimonadophyceae													
Halosphaera viridis				p									
Pterosperma sp.												p	
"Lumps" with remains of ice algae													
	p	p		p		p							
Other groups													
Ciliates						p	p						
Choanoflagellates							p						
Echinoderms							p		p		p		
Molluscs									p	p			
Nauplius of copepods	+	p	p	p	p	p	+	+	++		+		
Other crustaceans							+	+	++	p	+		
Polychaeta larvae						p							
Radiolarians					p		p	p		p			
Tintinnids	+	p	p	p	p	p	+	+	+	p	p	+	
Phycopellets													
	+[4]	p	p	p	+	+	+	+	+	+	++	p	

1. Poor condition
2. Empty
3. In "lumps" of ice algae, mostly empty or in bad condition, e.g. *Navicula* spp., *Nitzschia frigida*, *Polarella glacialis,* resting spores of *Chaetoceros gelidus*
4. Phycopellets: Some with ice algae or algae typical for ice covered waters, e.g. *Navicula pelagica*, *Nitzscia frigida*, *Nitzschia promare*, *Nitzschia* spp., *Polarella glacialis, Synedropis hyperborea*.

5. A few with resting spores
6. Attached to *Nitzschia frigida*
7. Very little in the sample
8. Only 10 µ net
9. Typical *Tripos arcticus* and *T. longipes* are possible to distinguish but they can sometimes be easily confused as both have highly variable and partly overlapping shape.

Appendix 4. Marine mammal observations during the Arctic Ocean Cruise 2023

Observers: Ole Arve Misund (OAM), Mario Acquarone (MAC), Juni Bjørneset (JB), Ida Fammestad (Officer, IF), Øyvind Nilsen (Officer, ØN), Andreas Iversen (AI), Malou Platou Johansen (MPJ), Marika Marnela (MM), Bryan Vandenbrink (BV)

No	Date	Time (CET)	Lat N	Lon E	Bears	Males	Females	Cubs	Species	#	Comments	Observer
1	11 Aug 2023	15:14	78.2633	15.3600					Minke whale	1		OAM
2	11 Aug 2023	16:45	78.1015	14.4950					Fin whale	1	Photo: Marika Marnela	OAM
3	11 Aug 2023	16:45	78.1015	14.4950					Minke whale	1	Photo: Marika Marnela	OAM
4	11 Aug 2023	16:52	78.1917	14.1692					Fin whale	3	out of Ymerbukta	OAM
5	11 Aug 2023	20:18	78.1883	11.5000					Fin whale	1	South by Grønfjorden	MAC
6	11 Aug 2023	20:18	78.1883	11.5000					Fin whale	1	Towards Isfjorden	ØN
7	11 Aug 2023	22:39	78.5450	10.3733					White beaked dolphins	8	Bow riding	JB/MAC

8	11 Aug 2023	23:11	78.6400	10.1900					White beaked dolphins	5		AI/JB
9	12 Aug 2023	02:40	79.2900	9.9067					Fin whale	1	large blow	IR
10	12 Aug 2023	03:30	79.4533	9.9150					Fin whale	1	large blow	IR
11	12 Aug 2023	08:10	80.1950	12.4233					Blue whale	1	fluke out	OAM
12	12 Aug 2023	09:16	80.3233	13.3017					Minke whale	1		JB/MAC
13	12 Aug 2023	11:56	80.6183	15.8400					Fin whale	1		MAC
14	12 Aug 2023	12:29	80.6767	16.2833					Fin whale	3		MAC/JB
15	12 Aug 2023	12:38	80.6917	16.4383					Blue whale	1		JB/MAC
16	12 Aug 2023	12:40	80.7067	16.5717					Fin whale	1		MAC/JB
17	12 Aug 2023	14:15	80.8550	18.0933					Fin whale	1		MAC

18	14 Aug 2023	00:00	81.5533	21.9600					Fin whale	3		MPJ
19	14 Aug 2023	10:05	81.5533	22.2617					Bearded seal	1	swimming	MAC
20	14 Aug 2023	10:19	81.5583	22.3217					Ringed seal	1	swimming	MAC/JB
21	14 Aug 2023	20:42	81.6767	21.4850					Ringed seal	1	on ice	MAC
22	15 Aug 2023	05:30	81.8733	20.4717					Walrus	1	male, on ice	MM/MAC
23	15 Aug 2023	05:35	81.8783	20.4717	2		1	1	Polar bear		Fat female with large cub (2nd year?). Female with hanging lower lip, but no sign of recent damage. Female was curious of the ship and later (15:10) briefly approached to 25m but cub seemed to be more careful and vocalized at mother when she approached. They left heading north.	BV/MAC
25	15 Aug 2023	21:14	82.0283	19.8850					Bearded seal	1	on ice	MAC
26	17 Aug 2023	00:54	82.0283	19.8850					Walrus	1	on ice	MM
27	18 Aug 2023	20:50	84.0738	20.0613					Unspecified seal	1	swimming	MM

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28	19 Aug 2023	12:42	83.3917	24.7267					Bearded seal	1	on ice, 500m away	OAM
29	21 Aug 2023	07:16	82.1317	29.2983					Bearded seal	1	on ice, nervous	MM/MAC
30	21 Aug 2023	09:50	82.0683	29.4650					Ringed seal	1	on ice, calm	MAC
31	21 Aug 2023	14:20	82.0283	29.9183					Ringed seal	1	on ice	MAC
32	21 Aug 2023	14:27	82.0283	29.9567					Ringed seal	1	in water	MAC
33	21 Aug 2023	14:40	82.0267	30.0400					Ringed seal	1	on ice	MAC
34	23 Aug 2023	18:10	81.5433	30.8717					Fin whale	1		JB
35	24 Aug 2023	06:50	81.4000	31.1400					Bearded seal	1	on ice	OAM
36	24 Aug 2023	07:08	81.3967	31.0467					Harp seal	8	swimming	MAC
37	24 Aug 2023	07:20	81.3950	30.9867					Walrus	1	swimming	MAC

38	24 Aug 2023	07:23	81.3950	30.9600					Harp seal	1	swimming	MAC
39	24 Aug 2023	07:28	81.4017	30.9417					Harp seal	32	swimming	MAC
40	24 Aug 2023	10:13	81.4017	30.1283					Harp seal	10	swimming	MPJ
41	24 Aug 2023	10:35	81.3933	29.7400					Harp seal	1	swimming	MAC
42	24 Aug 2023	12:18	81.3400	28.0133					Minke whale	1		MAC
43	24 Aug 2023	15:10	81.3100	27.2067					Fin whale	1		OAM
44	25 Aug 2023	15:29	80.6933	15.6800					White beaked dolphins	17		MAC
45	25 Aug 2023	17:58	80.7983	16.9433					Fin whale	2		ØN
46	26 Aug 2023	19:47	80.0283	14.9550					Fin whale	1		ØN
47	26 Aug 2023	20:16	80.0055	14.4745					Walrus	2	swimming	JB

48	26 Aug 2023	21:00	80.0055	14.4745					Walrus	18	on Moffen haulout	MAC
49	26 Aug 2023	21:00	80.0055	14.4745					Walrus	7	swimming by Moffen	MAC
50	27 Aug 2023	02:13	79.9567	11.7517					White beaked dolphins	4	Bow riding	IF
51	27 Aug 2023	02:13	79.9567	11.7517					Minke whale	1		IF
52	27 Aug 2023	07:00	79.7367	11.0367	1				Polar bear		on land N of Smeerenburg	MAC
53	27 Aug 2023	07:00	79.7367	11.0367					Walrus	10	7 on land and 3 in water	MAC
54	27 Aug 2023	07:00	79.7367	11.0367					Walrus	1	swimming	MAC
55	27 Aug 2023	09:05	79.7450	11.0850					Walrus	1	swimming	OAM

Appendix 5. Presentations on board by cruise participants.

Name	Organization/ Representation	Responsibility/ Studies	Tema Scientific Presentation * if there is something wrong here, you may correct it yourself	Presentation date
Ole Arve Misund	NPI	EK80 Hydroacoustic – Cruise Leader	Welcome to the Polar Ocean Cruise II	10 August
Nalân Koc	NPI	Young scientists' program – Research Director	Intro to students	10 August
Cecilie von Quillfeldt + Lucie Goraguer	NPI	Phytoplankton/ice algae/env. Management + Chlorophyll a measurement	Intro to students	10 August
Haakon Hop	NPI	Fish trawling/zooplankton – Chief Scientist	Intro to scientific program on board	10 August
Einar Pétur Jónsson	Iceland	Ph.D. student on ocean acidification. Marine and Freshwater Research Institute (MFRI)	Present your study shortly, and present what you are planning to do and sample on this cruise (Studying multiple stressors in marine environments - pH and temperature, maybe included contamination as well)	10 August
Flore Wijnands	Sweden	Ph.D. student on marine geology, Stockholm university	Present your study shortly, and present what you are planning to do and sample on this cruise (Sedimentary ancient DNA as a proxy for past biodiversity in the Arctic Ocean)	10 August

Sonja Gindorf	Sweden	Ph.D. student Department of Environmental Sciences, Stockholm university	Present your study shortly, and present what you are planning to do and sample on this cruise (Biogeochemical mercury cycle)	10 August
Jacob M. Christensen	UiT (SUDARCO project)	Fish genetics	Present your study shortly, and present what you are planning to do and sample on this cruise (Sleeper shark population and phylogenetics)	10 August
Matias Uusinoka	Finland	D.Sci.(Tech) Applied Mechanics, Modelling sea-ice deformation behaviour, Aalto University, Department of Mechanical Engineering	Present your study shortly, and present what you are planning to do and sample on this cruise (Methods in sea-ice deformation: From computer vision to continuum parametrization)	10 August
All			Pecha Kucha / Introductions	11 August
Cecilie von Quillfeldt	NPI	Phytoplankton/ice algae/env. management	Microalgae and biodiversity in the Arctic; Arctic Ocean biodiversity, from microbes to fish	12 August
Nalân Koc	NPI	Young scientists' program – Research Director	Arctic climate changes	12 August
Anette Wold	NPI	Zooplankton – Ass. Chief Scientist	Zooplankton in the Arctic Ocean in the Autumn (data Nansen Legacy Sept 2021)	13 August
Haakon Hop	NPI	Fish trawling/zooplankton – Chief	Life in sea ice and fish in the Arctic Ocean	13 August

		Scientist	
Marika Marnela	NPI	Oceanography	Oceanography of the Arctic Ocean with focus on Atlantic Water transport
Vegard Stürzinger	NPI	Fish trawling/zooplankton	Chaos, love, and career choices; Drone operations
Jessica Cook	Arctic Council Secretariat	Communications	About the Arctic Council
Mario Acquarone	AMAP Secretariat		About AMAP
Elizabeth McLanahan	PAME, NOAA, USA	NOAA, USA	International Arctic marine policy - the work being undertaken by the Arctic Council (e.g. marine litter, a synthesis report of the Central Arctic Ocean which will help us to identify governance gaps, engagement with Indigenous Peoples, etc.) as well as international agreements with application to the Arctic (e.g. the new Biodiversity Beyond National Jurisdiction Agreement, Central Arctic Oceans Fisheries Agreement, International Maritime Organization work, etc.).
Einar Pétur Jónsson	Iceland	Ph.D. student on ocean acidification. Marine and Freshwater Research Institute (MFRI)	Studying multiple stressors in marine environments - pH and temperature, maybe included contamination as well
Jacob M. Christensen	UiT (SUDARCO project)	Fish genetics	Sleeper shark population and phylogenetics
Matias	Finland	D.Sci.(Tech) Applied Mechanics, Modelling sea-ice	Methods in sea-ice deformation: From

Uusinoka		deformation behaviour, Aalto University, Department of Mechanical Engineering	computer vision to continuum parametrization
Flore Wijnands	Sweden	Ph.D. student on marine geology, Stockholm university	Sedimentary ancient DNA as a proxy for past biodiversity in the Arctic Ocean
Emily Stidham	USA	M.Sc. student, College of Fisheries and Ocean Sciences, University of Alaska Fairbanks	Tunicates - "Two-decades of observations on pelagic tunicates and pelagic snails in the Northern Gulf of Alaska (NGA)" / Or tunicates in the Arctic
Malou Platou Johansen	Inuit Circumpolar Council (ICC)	Masters of Arctic Marine Ecology, Fish communities in NE Greenland, UiT	Fish diversity In Northeast Greenland
Concepcion (Connie) Melovidov	UAF Student	Master’s Candidate in Fisheries, University of Alaska Fairbanks	A pilot study using mrPATs to examine movements of snow crab in the eastern Bering Sea
Per-Henning Mathisen	Saami Council	Master student at the University of Tromsø	Saami language and the marine and arctic environment
Bryan Vandenbrink	Inuit Circumpolar Council (ICC)	Masters of Integrative Biology, University of Guelph, Canada	Range expansion of insect species northwards due to climate change
Sofie Hauge Andersen	Denmark	M.Sc. student Arctic marine pelagic ecosystems currently enrolled at Aarhus University	Thoughts about her master's thesis which will be based on data collection from the cruise
Sean Mack	Aleut International Association (AIA)	Geography/ GIS Aleut student	Using remotely sensed data (specifically Lidar and drone photography) to create 3D models that can be used to identify archaeological sites in Alaska

Aurora Heim	Saami Council	Working on a bachelor's degree in Ocean Engineering at the University of Tromsø	
Mario Acquarone	AMAP Secretariat		Arctic marine mammals, whaling, impact of human activity on marine mammals in the Arctic
Jessica Cook	Arctic Council Secretariat		Science to policy communication
Juni Bjørneset	NPI / Norway	Fish trawling/zooplankton	Environmental pollution in killer whales
Lucie Goraguer	NPI	Chlorophyll a measurement	
OLA LYR	NPI	Logistics/polar bear safety	

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NPI Arctic Ocean Cruise II Group Photo

Top row from the left: Emily Stidham (eastidham@alaska.edu), Matias Uusinoka (matias.uusinoka@aalto.fi), Bryan Vandenbrink (bryan.vandenbrink@gmail.com), Haakon Hop (haakon.hop@npolar.no), Sean Mack (Seanrmack@yahoo.com), Einar Pétur Jónsson (einar.petur.jonsson@hafogvatn.is), Vegar Stürzinger (vegard.stuerzinger@gmail.com), Ole Arve Misund (ole.arve.misund@npolar.no), Jacob M. Christensen (jacob.christensen@uit.no), Mario Acquarone (acquarone@amap.no)

Second row from the left: Flore Wijnands (florewijnands@hotmail.com), Aurora Heim (auroraheim365@gmail.com), Elizabeth McLanahan (Elizabeth.McLanahan@noaa.gov), Cecilie von Quillfeldt (cecilie.von.quillfeldt@npolar.no), Marika Marnela (marika.marnela@npolar.no), Lucie Goraguer (Lucie.Goraguer@npolar.no)

Bottom row from the left: Rupert Krapp (rupert.krapp@npolar.no), Per-Henning Mathisen (per_henning.1998@hotmail.com), Sofie Hauge Andersen (201908559@post.au.dk), Sonja Gindorf (sonja.gindorf@aces.su.se), Malou Platou Johansen (Malou.P.J@hotmail.com), Juni Bjørneset (jbjorneset@gmail.com), Nalân Koç (nalan.koc@npolar.no), Anette Wold (anette.wold@npolar.no), Concepcion Melovidov (Camelovidov2@alaska.edu)

Photo: Jessica Cook (jessica.cook@arctic-council.org)