PolarFront Cruise

3-15 January 2024

RV Helmer Hanssen

Cruise report

Edited and compiled by Malin Daase

Ecosystem studies using novel autonomous technologies

Contents

1. Introduction

This expedition of the NRC funded project "Polar Front ecosystem studies using novel autonomous technologies: Knowledge for environmental management and assessing ecological risk" (PolarFront) elucidated the hydrographical, chemical and biological processes in the Barents Sea Polar Front region specifically during winter season. After successful missions in spring 2022 and August 2023, identical approaches were used to characterize the food web from bacterial activities to fish stomach contents in January 2024. Financial support for this expedition was provided by the NRC, UiT, Conoco Philips, and Equinor.

Until recently, winter months in Arctic Seas had been considered the dormant period of the year in contrast to the bloom situations encountered in spring as we could sample during our May 2022 expedition. However, recent studies revealed that this paradigm had to be revised with many taxa staying active in the winter season. We therefore focused this January cruise to evaluate biodiversity and biological processes along the entire food web from bacteria to fish in Atlantic and Arctic waters of the Barents Sea, and further tested if the Polar Front has unique properties or acts as a boundary between water masses.

The research vessel Helmer Hanssen left port in Tromsø in the afternoon of January 3 heading towards the first sampling location at 75degN and 29deg30min E. However, this plan was abandoned as a major gale had formed in the Barents Sea that would have made it impossible for any scientific regular sampling. We therefore decided to steam directly towards ideally to 78 deg N and 29deg30min E. The sea ice this winter had been moving far southwards due to wind drift and local ice formation and we encountered the first pancake ice fields in the morning hours of Jan 4. Adjusting slightly the ship course, we moved towards 77ºN, avoiding areas of denser sea ice. Consequently, we did not follow continuously the 29º30'E line. While in sea ice, we conducted regular sea ice observation, roughly following the standardized ICEWATCH approach. At each of the upcoming stations we needed to adjust sampling program to ice conditions and air temperatures (often below -15ºC). For example, trawls had to be relocated to open water sites, and net sampling was negatively impacted by the freezing air temperatures.

The first sampling occurred at our northernmost station J1 at ca 77º25' N and 30º E, including CTD, water samples, vertical plankton nets but no pelagic and benthic trawling due to the presence of vast areas of young ice and problems with the winch system due to low temperatures After completing the station, we headed southwards to complete a transect to 75 º30'N and 29º 30' E in order to get an overview over the hydrographical settings across our transect line using the LOPC, which ended at this southernmost sampling location (station J2). Afterwards we moved northwards along the transect line conducting one full station per day and additional in-between sampling with LOPC, trawl or the fish disco at night. On Jan 10, we were in sea ice again, which made it impossible to do trawling, and again freezing issues in the CTD pump system and the winches impacted the sampling effort at air temperatures of ca. -18º C. Nevertheless, we still felt lucky that winds were calm and we were greeted by a clear sky and northern lights.

On the way north we sampled stations J3 to J6 with the last station located just at the southern tip of southwards extending Arctic water. Realizing that we would not be able to reach stations further north due to time and sea ice constrains, we conducted a temporal variation investigation at J6 using the LOPC, where we were rewarded by the visit of a polar bear. We then continued a transit along the ice edge to the ice edge close to Hopen, where we conducted trawling just outside the ice edge (station J7) and then moved westwards ca 15nm to a station within the ice to sample within Arctic water masses (station J8).

The science activities were concluded on Jan 13 in the early morning hours and after a relatively calm transit we returned to Tromsø on Jan 15 in the morning. Overall, the science mission in this last Polarfront project expedition has been very successful and all groups could collect more data than we

originally had hoped for, considering the harsh winter conditions. This was also possible due to the outstanding support we had received from the captain and crew of Helmer Hanssen throughout the entire science mission.

Rolf Gradinger, UiT, cruise leader

A hint of daylight (Photo: Malin Daase)

2. List of participants

last name	first name	function	institution
Gradinger	Rolf	cruise leader	UiT The Arctic University of Norway
Daase	Malin	researcher	UiT The Arctic University of Norway
Basedow	Sünnje	researcher	UiT The Arctic University of Norway
Berntsen	Richard	UiT technician	UiT The Arctic University of Norway
Buvang	Ronald	UiT technician	UiT The Arctic University of Norway
Geoffroy	Maxime	researcher	Memorial University St John's
Sandbank	Einat	PhD student	Memorial University St John's
Rappin	Florence	master student	UiT The Arctic University of Norway
Schick	Lorenz	master student	UiT The Arctic University of Norway
Trudnowska	Emilia	researcher	Institute for Oceanology Polish Academy of Sciences
Renaud	Paul	researcher	Akvaplan-niva
Cnossen	Frida	researcher	Akvaplan-niva
Utengen	Ingvild	researcher	Akvaplan-niva
Miettinen	Anna	technician	Akvaplan-niva
Laber	Christien	UiT technician	UiT The Arctic University of Norway
Hanson	Kelsey Rae	master student	UiT The Arctic University of Norway
Norrbin	Fredrika	researcher	UiT The Arctic University of Norway
Lutier	Mathieu	researcher	UiO
Albertsen	Sophie	master student	UiO

Group picture in the ice under a beautiful northern light (Photo: Frida Cnossen)

3. Cruise summary & study area

3.1. Cruise Summary

Text and photos: Malin Daase, UiT

This cruise marked the 11th polar night cruise aboard RV Helmer Hanssen since 2012. Over the years, we've weathered our fair share of challenging January weather in the Barents Sea and surrounding Svalbard waters, with last year's expedition standing out as particularly tumultuous, compounded by particularly crappy weather and series of "everything that can go wrong will go wrong". Historically, our January cruises have primarily navigated the waters around Svalbard. While the journey from Tromsø to Svalbard has been consistently met with rough conditions, the fjords usually provided some shelter and respite for our work. However, this year presented a unique scenario — our cruise was exclusively set in open waters, offering minimal shelter from the elements. Armed with memories of the previous year's tumultuous voyage, some of us Polar-Night-Cruise veterans embarked with a sense of trepidation and tempered expectations for the next 12 days. Surprisingly, fortune favoured us this time, and both the cruise and weather gods seemed to smile upon our endeavours! While this translates to a remarkably successful expedition, it regrettably contributes to a somewhat uneventful cruise report.

Wednesday, 3 January: Departure and steaming North

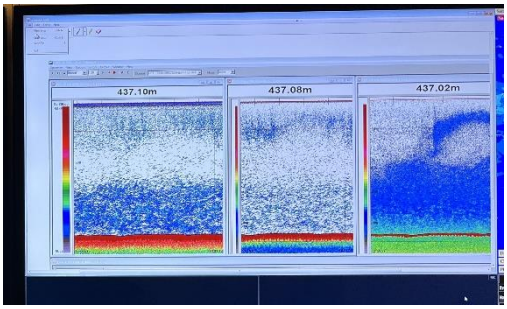
Two work, two supervise

All cruise participants managed to get to Tromsø in time and without major problems, with some of us having to travel over New Years. And apart from Max's luggage, all equipment also arrived in time, so we were off to a good start when we met at 8 am in the harbour. Weather in Tromsø was brilliant: clear sky and -10ºC. The crew had also just returned from their holidays, so everything had to be prepared this morning and the crew was already busy mounting the trawl and loading supplies and equipment, while all non-Norwegian cruise participants went to the police at 8:45 for border control.
Once back on board the crew started loading our equipment and we were busy for a few hours unpacking and establishing the labs. A few participants had to go back to Fram Centre or UiT to get things they had forgotten. After a safety briefing by the crew, we finally were ready to depart around 14:30. The afternoon was spend setting up the nets and compiling "Frankenstein". Everything went smoothly and most things were ready by coffee break at 17:00.
During dinnertime, we departed from the tranquil fjords and entered the open ocean, where the sea exhibited a slightly more tumultuous demeanor. We discussed the cruise plan during an evening meeting. The aim was to head to 75ºN where we would start sampling our first full station with estimate time of arrival set for the next evening. However, the weather forecast predicted that we were heading into a gale exactly at that time and place where we planned our first station. The decision how to deal with this challenge was postpone to the next day.

Thursday, 4 January: Transit

Temperatures were still above zero during the first part of the day, but the further north we came the colder it got and by late evening it had cold down to -8ºC. The sea was a bit rough, but conditions were

overall not too bad. After consulting the weather forecast one more time, it became clear that the wind would be too strong to do any work at 75°N and we decided to aim for the northern most station instead, heading towards 78°N directly. The ETA was set to the next evening, so we had time to relax. We used the steaming time to collect data on the response of the pelagic community to artificial light emitted by a research vessel. While steaming, the ships lights were switched on and off every hour. Throughout the afternoon and evening we did see an instant response in the 120 khz of the EK60 and it became rather exciting to follow the response on the echosounder display every hour when the lights were switched on or off. We had a short meeting in the evening and people were largely out and about, although everyone was a bit tired still finding their sea legs. In the late evening, the Northern lights were dancing in the sky.



Lights "off" response in 120 khz

Nighttime and daytime aurora

Friday, 5 January: Transit and Station 1

The sea was a bit rocky during the night. Ice had start forming fast over the last days and we reached the ice edge at around 77°N in the early afternoon. From there we slowly worked our way northwards through fresh pancake ice. We eventually stopped at 77.30°N and started sampling at the first station at around 22:00. While ice conditions prevented us from deploying any trawls, we could deploy all other gear as planned. However, by now air temperatures had reached -17°C, and sampling was slowed down by gear and winches starting to freeze.

Saturday, 6 January: Station 1

We worked through the night and until the early morning. The Multinet was still dry, so preparing it went fine, but it was rather cold standing on the upper deck where a strong cold wind was blowing. Emptying the CTD also had its challenges as tubes and nuzzles were freezing. We managed to deploy a few WP2s and the Frankenstein before the "telleverket" of the hydraulic winch froze, which took a while to fix. Nevertheless, we managed to take all the samples we needed and after breakfast, ice conditions around the vessel had opened up and we were able to deploy the tucker trawl. We then moved

It's cosy warm in the lab

southwards to find open water for a pelagic and a bottom trawl. On our way out of the ice, we stopped every 5 nm to deploy a Frankenstein. Mid-afternoon we got into open water and wanted to trawl, but problems with the hydraulics of the trawl winch put a stop for that. Instead, we continued southwards with Frankensteins every 5nm until we reach the southern end of our transect at approx. 75°N. It was still -16 in the evening, the northern lights were dancing again and the weather forecast looked good.

Multinet-ing

Sunday, 7 January: Station 2

We continued with the Frankenstein transect throughout the night and early morning, with a profile every 5nm. Around 10 am we decided that this would be the end of the transect and we started the new station a 75.29°N. It was warmer today with temperatures around -10°C, the sea was calm and surface temperatures reached +3°C. Consequently, sampling worked much smoother than yesterday. In the evening, we deployed the pelagic trawl catching juvenile redfish, a few capelins and some krill and shrimps. Afterwards we took a benthic trawl and caught large Atlantic cod, lots of red fish and flat fish, and some cute lumpsuckers.
Sünnje plotted the CTD data from the transect and we selected the locations where we would sample the next days.

Catch of the day

Monday, 8 January: Station 3

Once we finished at station 2, we moved northwards to the next location at 76°N. We started with the new station after breakfast, following the same order of gear deployments as at the other stations. Wind speed as 1 ms^{-1} and the sea was completely calm which no-one had expected as this time of the year. There was even a hint of daylight in the morning, and temperatures were still around -10 °C. Everything went smoothly and we became more and more efficient.
We managed to finish the plankton nets before lunch and continued sampling throughout the afternoon. Things became dramatic in the lab in the afternoon after Malin reported a somewhat higher abundance of *C. hyperboreus* at this location. This led Mathieu to the decision to discard all *Metridia longa* he and Sophie had painstakingly picked out of the samples taken at Station 1 over the last 2 days, very much to the dismay of Sophie and the disbelief of everyone else. Mathieu and Sophie spend the rest of the evening taking 9 WP2 nets in hope of catching more *C. hyperboreus*, and then started from scratch with picking out organisms. Later in the evening, we took another bottom trawl, catching not quite as much as at the previous location.

Perfect day for Tucker trawling

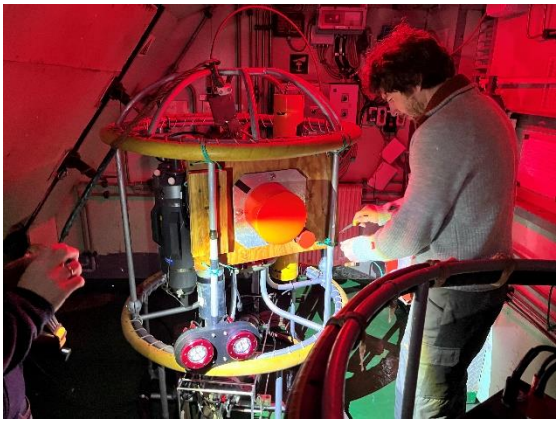
Tuesday, 9 January: Station 4

Catch of the day: capelin!

After finishing at Station 3, we steamed to the next waypoint and deployed the FishDisco™ overnight. The usual sampling program commenced after breakfast. It was another relatively calm day, with temperatures dropping a bit (-12ºC) and the wind picking up again. By now, deploying the Multinet involved a few buckets of hot water to defrost the mechanisms, but overall everything went smoothly again, and we had a pelagic trawl full of capelin. We were done with the core sampling by 17:00 and started a Frankenstein transect to resolve the next section in 2.5 nm steps. That meant that the Frankenstein team had a long night of work. Just before we hit the ice again, we also took another pelagic trawl in the evening.

Wednesday, 10 January: Station 5

We were in the ice again, with the pancakes now having frozen into larger floes. We also reached the coldest temperature so far with -18.4ºC, which was enhanced by some wind, and working out on deck was rather chilling. The sky was clear and there was a bit of daylight at noon. We proceeded with the usual sampling but could not deploy any trawls due to ice. Instead, we had a longer deployment of the VPR. In the evening, we all went out to the front deck for a group picture under the northern lights. Ice conditions did not allow steaming further north, so we turned south again to fill the gap between stations 4 and 5 at approx. 77º N. This was supposed to be outside the ice, but once we got there the ice edge had already reached this region. We deployed the FishDisco™ for 3 hours in the evening. Meanwhile, the fish group had a FishDisco™ in the lab while analysing fish stomachs.



Getting ready to disco!

Thursday, 11 January: Station 6

Another cold day at -16.4ºC. Skies were still clear and in the morning, we got a glimpse of daylight in the south, while Northern Lights were dancing at night. The wind had picked up again and while we could not trawl again due to ice, everything else went smoothly.

When we were done with sampling, we steamed south out of the ice to deploy the Tucker trawl and a bottom trawl. Then we went back into the ice to station 6 and throughout the night, the Frankenstein team deployed the Frankenstein every 45 min, giving themselves another sleepless night. But everyone who was still up late in the evening was rewarded with a polar bear visit, as a bear suddenly appeared in front of Helmer Hanssen!

Every drop counts!

Friday, 12 January: Ice edge, Station 7 & 8

After we finished the Frankenstein time series in the early morning, we steamed south-west along the ice edge taking Frankensteins along the way. Our aim was to get into the ice further west to see if we could find a location dominated by Arctic waters on Hopenbanken. Before we enter the ice, we sampled with the Tucker and pelagic trawl outside the ice (Station 7) and then steamed into the ice for the last full station on the Bank. Here we had cold water throughout the water column, but the station was rather shallow with 140 m. We started sampling station 8 around 23:00 and continued throughout the night. It was still cold and clear, but the wind had increased quite a lot (14-15 ms^{-1}), so we deployed the WP2 instead of the Multinet.

Yes, there is a bear on this picture!

Finally, some real winter weather

Saturday, 13 January: Transit

Most people were up all night sampling and processing samples. We finished the station in the morning and then steamed a bit south for one final deployment of the WBAT before heading home. It was still quite windy and once out of the ice, the boat started to roll a bit more. Most people slept until lunch and we started to pack, clean and processing data throughout the afternoon and evening. It also started snowing and the weather finally resembled the typical polar night cruise experience.

Sunday, 14 January: Transit

The sea was rather rough on our way south. We steamed with lights on/off again and by late afternoon, we experienced the strongest waves so far. We had a final meeting in the afternoon, presenting preliminary results and fun facts. Afterwards we finalized packing boxes and cleaned the labs. Most of the work was done by dinner, and it was an early evening for most people given the ships movement and overall exhaustion after 12 days of hard work. We entered the fjords by midnight and the crew washed the trawls before heading to Tromsø.

Monday, 15 January: Arrival

We were back in Tromsø by breakfast and the crew started unloading right away. We went to the police at 8:45 and afterwards everyone departed. This marked the end of the cruise, which turned out to be blessed with the nicest weather and sea state of any polar night cruise so far! Well deserved!

3.2. Study area

We sampled along a transect crossing the polar front between 77.30ºN and 75.30ºN, along 29.30ºE. **Station names:** The stations are numbered consecutively as they were sampled (i.e. station 1 is the northern most, station 2 the southernmost) (Figure 1), and not in geographical order. Note that some groups some named the stations "PF" while others opted to call them "J" (for January). However, the numbers are consistent between groups. i.e. stations with the same number are the same (e.g. PF1 and J1 are the same station).

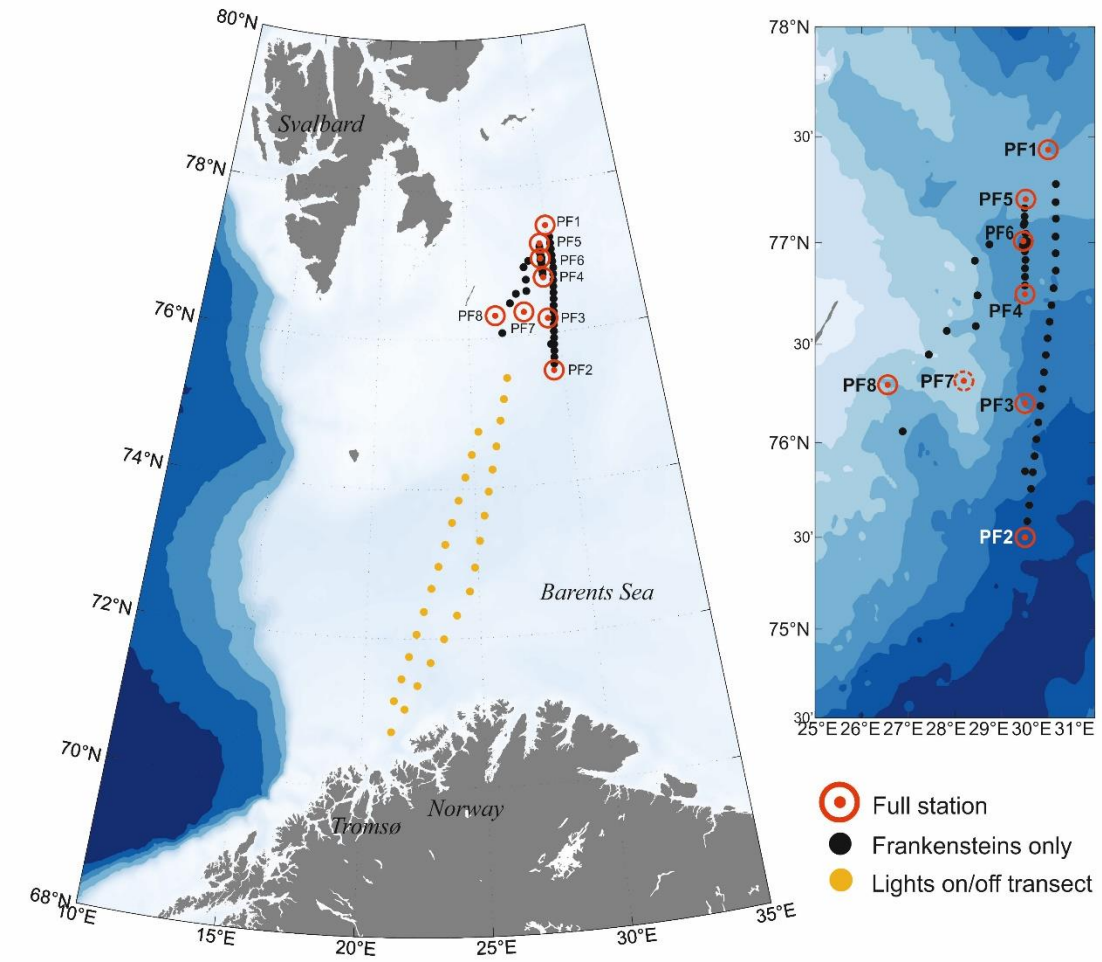


Figure 1: *Map over study area. Red dots mark full stations, where all parameters were sampled / all gear was deployed. Black dots mark stations where only the "Frankenstein" was deployed (CTD, LOPC, LISST, WBAT). Yellow dots mark transect were the vessel steam with lights on for one hour and off for the next.*

3.3. Sea-ice observations

Sea ice observations were conducted regularly throughout the cruise by Frida Cnossen and Ingvild Y. Utengen, at all stations. Percentage of open water versus ice cover was recorded, in addition to type of ice, and several other parameters based on the Ice Watch Manual (Hutchings et al. 2020). Sea ice data can provide a broader context for our research, aiding in the interpretation of biological and chemical observations.

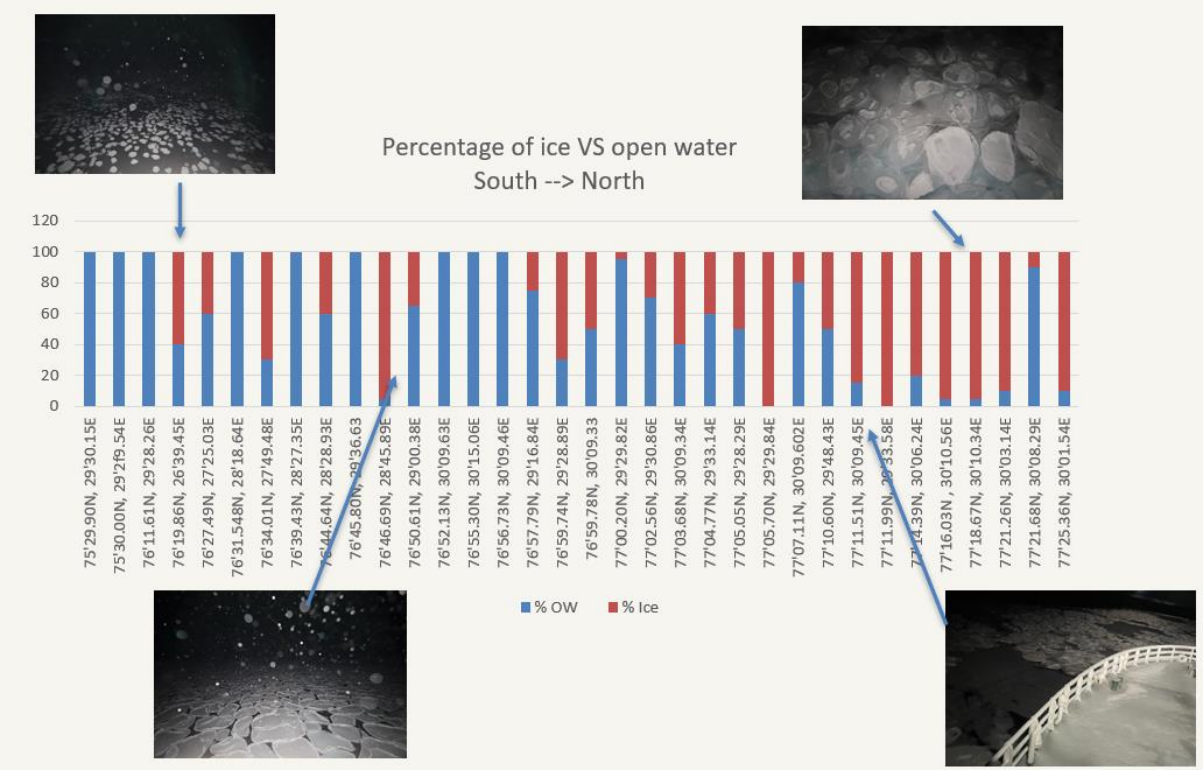


Figure 2: *Graph showing % open water in blue, vs % ice cover in red, arranged from south- to northernmost station. Pictures are showing ice type registered at some stations; pancake ice, merged pancakes, and nilas ice.*

Reference: Hutchings, J., Delamere, J., & Heli, P. (2020). The Ice Watch Manual

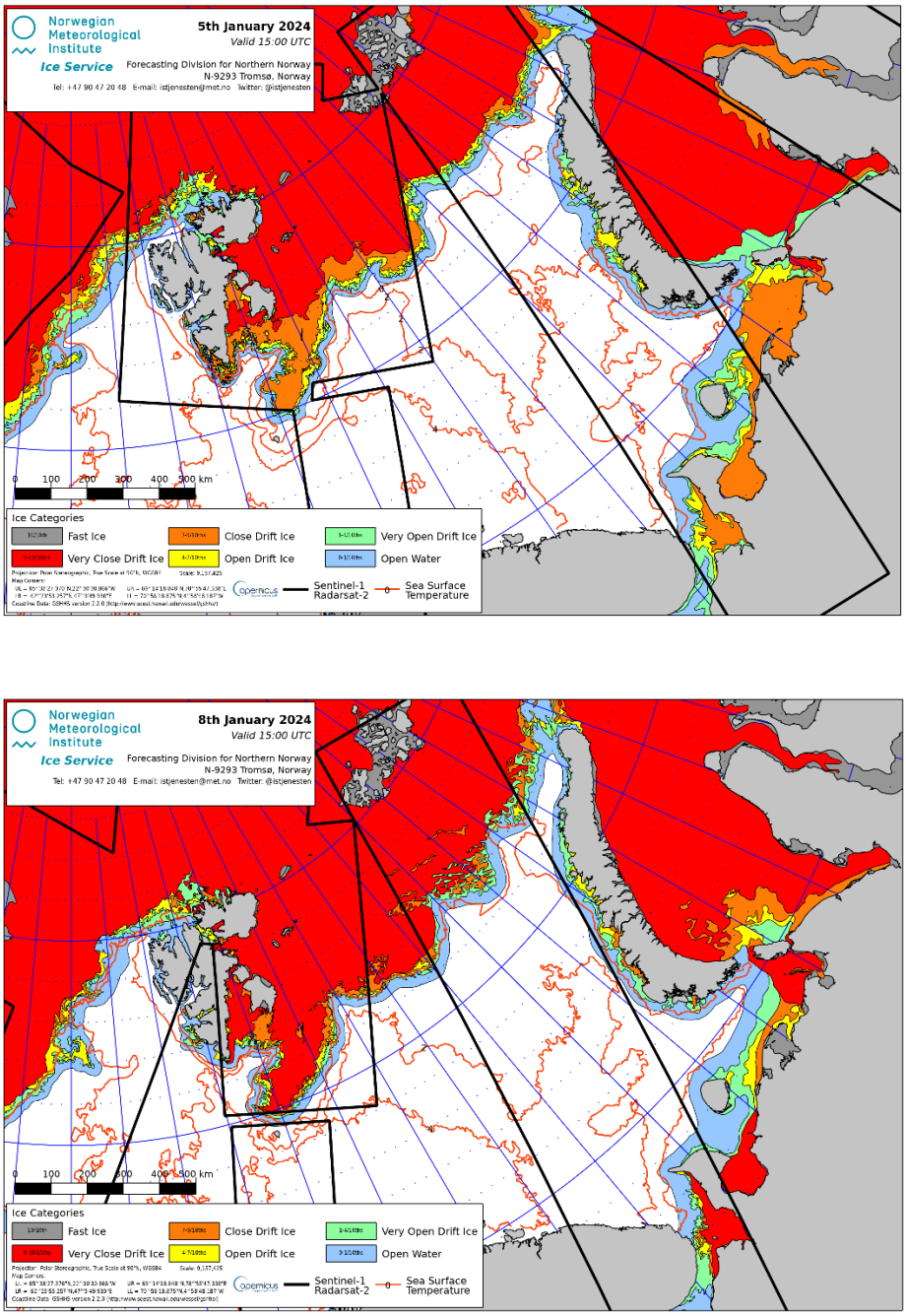


Figure 3: *Sea ice conditions in the study area at the start and halfway through the cruise (from cryo.met.no)*

3.4. Hydrography

At each full station, a CTD profile was taken with the CTD on Helmer Hanssen. In addition, a CTD profile was taken with each "Frankenstein" profile (see section 4.5.).
The CTD data from the Helmer Hanssen CTD is stored at UiT. Note that the fluorescence sensor was not working correctly at the first two stations. Samples to calibrate the salinity sensors were taken with each deployment of the HH CTD and will be analysed at UiT.

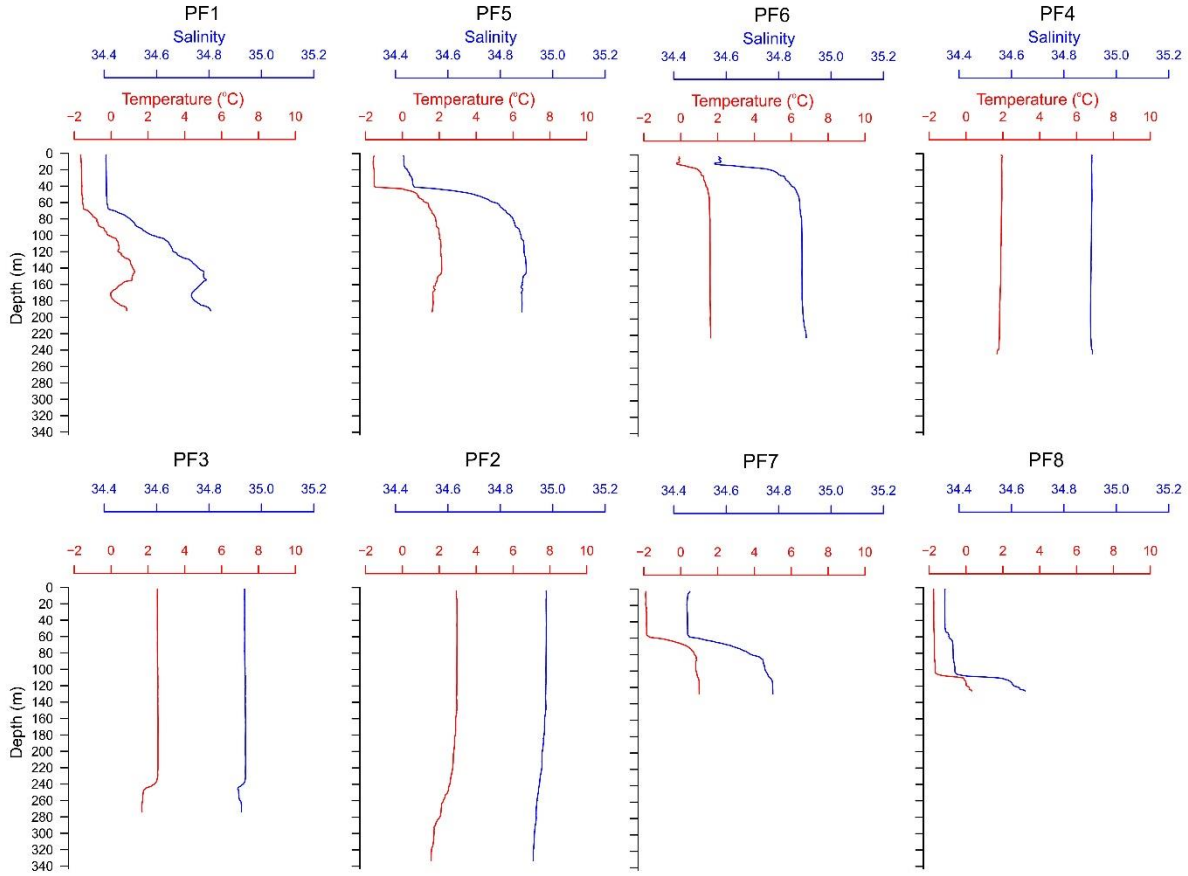


Figure 4: *CTD profiles at full stations taken with Seabird 911 on the Helmer Hanssen rosette. Stations PF1-6 are ordered from north to south (see Figure 1), PF7 and PF8 were located west of the main transect. Data are not quality controlled.*

Temperature and Salinity transects can be found in section 4.5.

4. Research activities

4.1. Water sampling, phytoplankton and production rate measurements

Anna Miettinen, Kelsey Rea Hanson, Christien Laber

The Phytoplankton group collected water samples from the Niskin bottles attached to the rosette with the Conductivity, Temperature and Depth (CTD) sensor. These samples are analysed for various parameters including Chlorophyll- a (Chl-a), Particulate Organic Carbon/Nitrogen (POC/PON), taxonomy, flow cytometry, nutrients, Dissolved Organic Carbon (DOC). The CTD sampling was performed in two casts at each station, the first collecting water from close to the bottom, depth of maximum in situ Chl a fluorescence and 5 m. The second cast was used to collect water from 100, 50, and 10 m depth. Depending on the nature of water parameters and protocols, some of the water samples from the Niskin bottles at each CTD station were directly collected in labelled bottles and tubes, i.e. Chl-a, POC, Taxonomy, while those parameters that are analysed in dissolved state were first filtered to remove particulate material and then stored in the labelled bottles, for example, nutrients and DOC. Among the list of variables shown in Table.4.1.1, only Chl-a was analyzed onboard. The remaining samples were stored frozen (or cooled) and will be processed later at UiT – The Arctic University of Norway. Further details are provided in the methodology section.

Table 4.1.1. *Overview of the water parameters measured with their procedures, storage and importance.*

Variable	Filter	Container	Storage	Importance
Chl-a	GF/F (25 mm)	Polycarbonate vials; 5ml 90% acetone	4ºC; dark for 12-24 hours prior to extraction	Serves as proxy for phytoplankton biomass
Nutrients	Burnt GF/F (25 mm), Swinnex, syringe	15 ml Falcon tube	-20ºC; dark	Concentrations of inorganic macronutrients available in the water
Taxonomy 100 ml	None	Brown glass bottle (100 mL; 1% formaldehyde (2.5 mL), buffered with Hexamin	4ºC; dark	Microscopic analysis of phytoplankton species composition.
Flow Cytometry	None	4 ml cryovials, 20 µL of glutaraldehyde	-80ºC; Ziploc	Number and size of cells in a water sample. Differentiate algal and bacteria.
POC/PON	Burnt GF/F (25 mm)	Burnt tinfoil pocket;	-20ºC	Content of carbon and nitrogen in particulate organic material
DOC	Burnt GF/F (25 mm), Swinnex, syringe	HCl addition	4ºC; dark	Dissolved organic carbon in the water, potentially used by bacteria

Table 4.1.2: *Overview of all water samples taken for different types of analyses and incubations during the cruise*

Water samples overview

x: replicate (from field sample)

station	date	depth	event #	Samples taken							Activity measurements		
				Chl a	POC/PON	13C/15N	Nutrients	DIC*	flow cytometry	taxonomy	14C primary production	bacterial production	mixotrophy
J1	05.01.2024	5	17	xxx	xxx		xx		xx	x			x
	05.01.2024	10	21	xxx	xxx		xx		xx	x			
	05.01.2024	Chla max	17	xxx	xxx	xxxx	xx	x	xx	x	x	x	
	05.01.2024	50	21	xxx	xxx		xx		xx	x			
	05.01.2024	100	21	xxx	xxx		xx		xx	x			
	05.01.2024	bottom	17	xxx	xxx		xx			x			
J2	07.01.2024	5	58	xxx	xxx		xx		xx	x			x
	07.01.2024	10	65	xxx	xxx		xx		xx	x			
	07.01.2024	Chla max	58	xxx	xxx	xxxx	xx	x	xx	x	x	x	
	07.01.2024	50	65	xxx	xxx		xx		xx	x			
	07.01.2024	100	65	xxx	xxx		xx		xx	x			
	07.01.2024	bottom	58	xxx	xxx		xx		xx	x			
J3	08.01.2024	5	81	xxx	xxx		xx		xx	x			x
	08.01.2024	10	86	xxx	xxx		xx		xx	x			
	08.01.2024	Chla max	81	xxx	xxx	xxxx	xx		xx	x			
	08.01.2024	50	86	xxx	xxx		xx		xx	x			
	08.01.2024	100	86	xxx	xxx		xx		xx	x			
	08.01.2024	bottom	81	xxx	xxx		xx		xx	x			
J4	09.01.2024	5	106	xxx	xxx		xx		xx	x			x
	09.01.2024	10	111	xxx	xxx		xx		xx	x			
	09.01.2024	Chla max	106	xxx	xxx	xxxx	xx	x	xx	x	x	x	
	09.01.2024	50	111	xxx	xxx		xx		xx	x			
	09.01.2024	100	111	xxx	xxx		xx		xx	x			
	09.01.2024	bottom	106	xxx	xx		xx		xx	x			
J5	10.01.2024	5	134	xxx	xxx		xx		xx	x			x
	10.01.2024	10	138	xxx	xxx		xx		xx	x			
	10.01.2024	Chla max	134	xxx	xxx	xxxx	xx		xx	x			
	10.01.2024	50	138	xxx	xxx		xx		xx	x			
	10.01.2024	100	138	xxx	xxx		xx		xx	x			
	10.01.2024	bottom	134	xxx	xxx		xx		xx	x			
J6	11.01.2024	5	151	xxx	xxx		xx		xx	x			x
	11.01.2024	10	155	xxx	xxx		xx		xx	x			
	11.01.2024	Chla max	151	xxx	xxx	xxxx	xx	x	xx	x	x	x	
	11.01.2024	50	155	xxx	xxx		xx		xx	x			
	11.01.2024	100	155	xx(x)	xxx		xx		xx	x			
	11.01.2024	bottom	151	xxx	xxx		xx		xx	x			
J8	12.01.2024	5		xxx	xxx		xx		xx	x			x
	12.01.2024	10		xxx	xxx		xx		xx	x			
	12.01.2024	Chla max		xxx	xxx	xxxx	xx		xx	x			
	12.01.2024	50		xxx	xxx		xx		xx	x			
	12.01.2024	100		xxx	xxx		xx		xx	x			
	12.01.2024	bottom		xxx	xxx		xx		xx	x			

Chlorophyll-a

Water samples for chlorophyll-a measurements were taken at defined depths using a Niskin bottle rosette. Because there was no chlorophyll maximum depth observed with the CTD fluorometer, all chlorophyll-a maximum depths were collected at 25m. A vacuum pump system and glass microfiber papers with a mesh size of 0.7 µm were used for filtering the samples, and the volume of water (Tab. 4.1.2) necessary for acquisition of sufficient amounts of chlorophyll was filtered. Three replicates of each sample were processed. After filtration, filter papers were removed with a forceps and deposited in individually labelled plastic tubes inside a fridge for chlorophyll-a extraction in 5 mL of 90% acetone overnight.

Following overnight extraction, samples were taken out of the fridge appx. 15 minutes before fluorescence measurements to attain room temperature. Fluorescence measurements were carried out using a fluorometer and a fluorometric acidification method. Each acetone solution was transferred to a glass cuvette by pouring and placed in the fluorometer, after which the fluorometer readout in volts

was noted. Subsequently, the cuvette was taken out of the instrument and 2 drops of 5% HCl was added, followed by covering of the cuvette opening with a piece of clean parafilm and gentle mixing. The sample was then placed back in the fluorometer and the new readout was written down. This process was repeated for each sample and replicate.

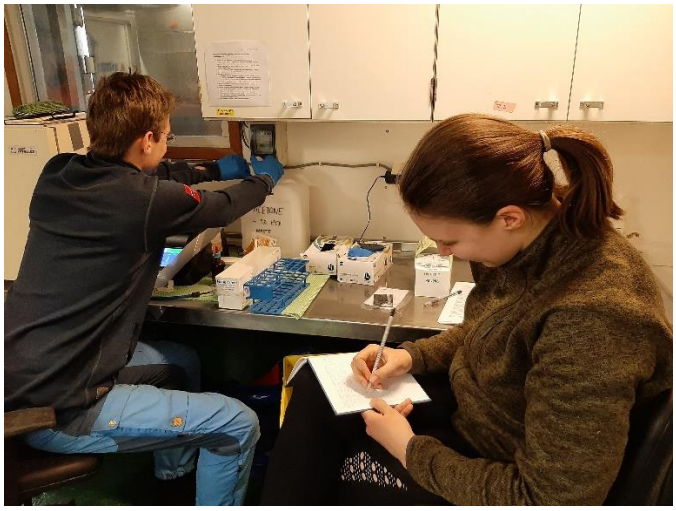


Figure. 4.1.1: *Chla measurements onboard with a Turner fluorometer (picture from previous cruise).*

Preliminary results of chlorophyll-a measurements

Generally, the chlorophyll-a fluorescence values indicated that the primary producer abundances were very low throughout the water column, as chlorophyll concentrations were 2-3 orders of magnitude lower than those observed during previous legs of the study, ranging between 0.01 and 0.03 µg l^{-1} (Fig. 4.1.2). There were however still patterns observed throughout the water column,that were consistent between stations, other than the two northern most stations. This included chlorophyll concentration increasing from 5m to 10m, decreasing to 25m, and increasing again to 50m. The opposite pattern was regularly observed in the Phaeophytin concentrations. This may be indicative of higher grazing activity at those depths with elevated Phaeophytin. Phaeophytin concentration was higher than chlorophyll-a for all stations and all depths.

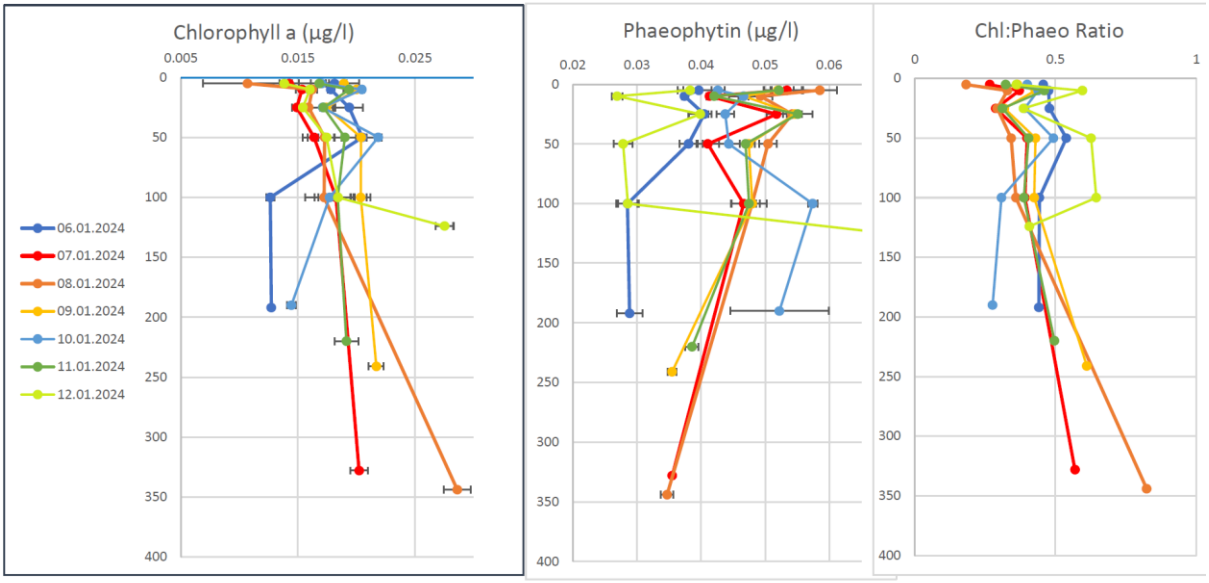


Figure 4.1.2. *Chlorophyll-a and Phaeophytin concentrations and the ratio of Chlorophyll-a to Phaeophytin measured from water samples taken at six depths at each station.*

The amount of Chl a integrated over the entire water column (based on the concentration measurements from 6 distinct depths ranged from 2 to 7 mg Chla m^{-2} (Figure 4.1.3), with the last station (J8) showing the lowest, and the third station (J3) the highest concentrations. With the very low concentrations observed at all stations, this calculation is highly influenced by the depth of the water column at each station.

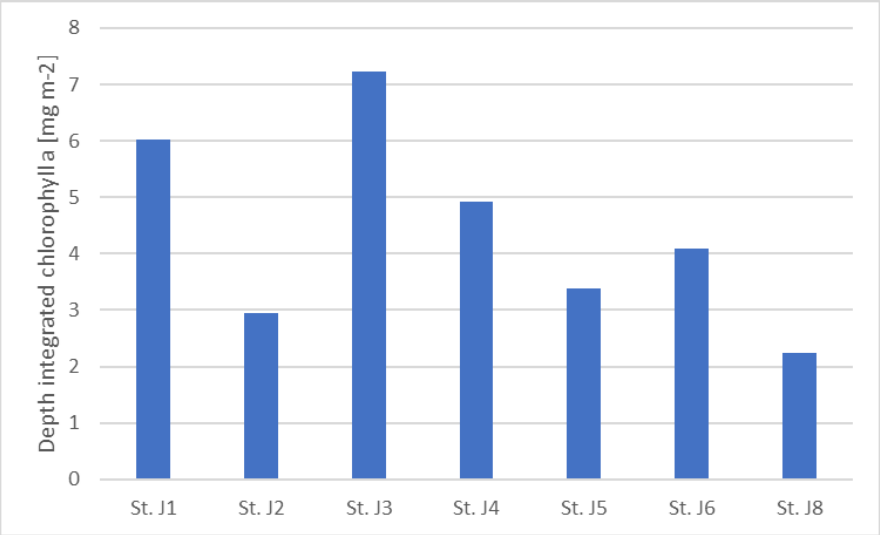


Figure 4.1.3: *Depth-integrated Chla at all sampling stations, calculated from the discrete measurements.*

Nutrients

The water samples were directly taken with a sterile syringe and vinyl gloves to avoid contamination from the Niskin bottles for nutrients. A Swinnex filter holder with a burnt GF/F (25mm) filter was attached to the acid-washed syringe. After rinsing the filter and the containers, the water was then filtered in three replicates into 15 ml centrifuge tubes for each depth, respectively. The samples were then stored at -20°C until further analysis on return to land.

Taxonomy

For species composition analysis samples were collected from the CTD. From each depth, 100 ml of water was filled into a labelled brown glass bottle. 2.5 ml of formaldehyde (and some hexamine as a buffer) was added to each sample and stored in darkness at 4°C for later analysis on land.

Flow Cytometry

Water samples will be measured for bacteria and pico-, nano-algae abundance using Flow Cytometry. In preparation for this, duplicates of each sample were made, one for bacteria and one for algae. Two 5 ml cryovials were filled with 3.5-4 ml of a sample before adding 20 µL of glutaraldehyde (25%) in each tube. Samples were then frozen at -80ºC.

POC/PON

At each station for the POC measurements, the collected water from the CTD for each depth was filtered in three replicates through burned GF/F (25mm) filters with the aid of a low vacuum pressure pump. The volume (2.3L) for each replicate and the time needed for filtering was noted down. The bottles and funnels were rinsed with filtered seawater after each sample. The filters were then folded and individually packed in burned tinfoil, packaged in plastic zip bags and stored at -20°C until analysis in the lab on return.

DIC

Total dissolved inorganic carbon measures the sum of bicarbonate, carbonate and carbonic acid and dissolved CO2. Here DIC was taken as a reference measurement for spike and incubation measurements with C^{14}; therefore, the samples were taken not directly from the Niskin bottle, but from the bulk sample

that was prepared for these incubations. For DIC and the ^{14}C incubation, seawater was taken from 5m and the depth corresponding to the chlorophyll maximum of each sampling station, respectively and filled into air-tight containers. To these exetainers, 20µl HgCl were added under strict safety standards. Each exetainer was then stored at 4°C in the dark until analysis on land.

Primary and bacterial production

By Christien Laber

Primary production and bacterial production were measured at 25m at four (J1-J2 J4, J6) out of the 7 stations. Water samples from the rosette were collected into insulated containers, with all incubations started within three hours of collection.

Primary production

60 mL subsamples were measured into six clear and two dark incubation flasks (*Corning*), with the latter containing di-chloromethyl urea. Each bottle was spiked with ^{14}C working solution (4 µCi/mL) and incubated for three hours in temperature-controlled PI chambers before filtration onto GF/F (*Whatman*). The light intensity in the chamber was between 10-14 µE as measured using a Walz four-pi microsensor. Temperatures were set to *in situ* as measured by the CTD, aside from PF1 where the incubation temperature was set at -1.5°C. Filters were acidified with 0.5N HCl and dried (48h) before addition of 10 mL Ecolume scintillation cocktail. Samples were transported to UiT for scintillation counting after the cruise. See Campbell et al. (2016) for details on incubation methodology.

Bacterial production

15 mL subsamples were measured into six sterile falcon tubes and spiked with ^{3}H-Leucine (59 µCi/mL). Three samples were immediately killed with 50% trichloroacetic acid solution. Samples were incubated in darkness for six hours at *in situ* temperatures, aside from PF1 which was incubated at 1°C. After incubation the three remaining samples were killed with the 50% TCA solution, before filtration onto 0.2 µm cellulose acetate filters (*Whatman*). Filters were rinsed with 5% TCA and 80% ethanol, and dried (24h) before dissolution with ethyl acetate and addition of 10 mL Ecolume scintillation cocktail. Samples were transported to UiT for scintillation counting after the cruise.

4.2. Phytoplankton composition

Rolf Gradinger (UiT)

A preliminary assessment of the phytoplankton composition was done based on 20um net plankton samples collected from 40m water depths to the surface at each station. A small non-fixed subsample (ca. 3ml) was filled into an Utermoehl chamber and analysed within 1.5 hours after sampling to provide first insights into species diversity.

Differences between the seven investigated stations were very small. In general, net phytoplankton abundances (for examples see Fig. 4.2.1) were relatively low with highest occurrences for phototrophic dinoflagellates, specifically the two *Ceratium(/Tripos)* species *C. arcticum* and *C. fusus*. Most abundant heterotrophic cells were different species of tintinnids, specifically from the genus *Parafavella*. Naked ciliates were rare. Interestingly, radiolarians, acantharians and a few foraminifera were found in the samples. Heterotrophic dinoflagellates of the genus *Protoperidinium* as well as *Phalachroma* rotundatum were also regularly observed. Diatoms were seen only in very low occurrences, dominated by Chaetoceros spp. Interestingly pennate diatoms including *Entomoneis* sp. also occurred, but also as single cells. The spring bloom forming genera *Thalassiosira* was seen only in one single cell and *Phaeocystis pouchetii* in one single colony. Overall diversity and abundances appeared to be reduced compared to the spring and summer observations.

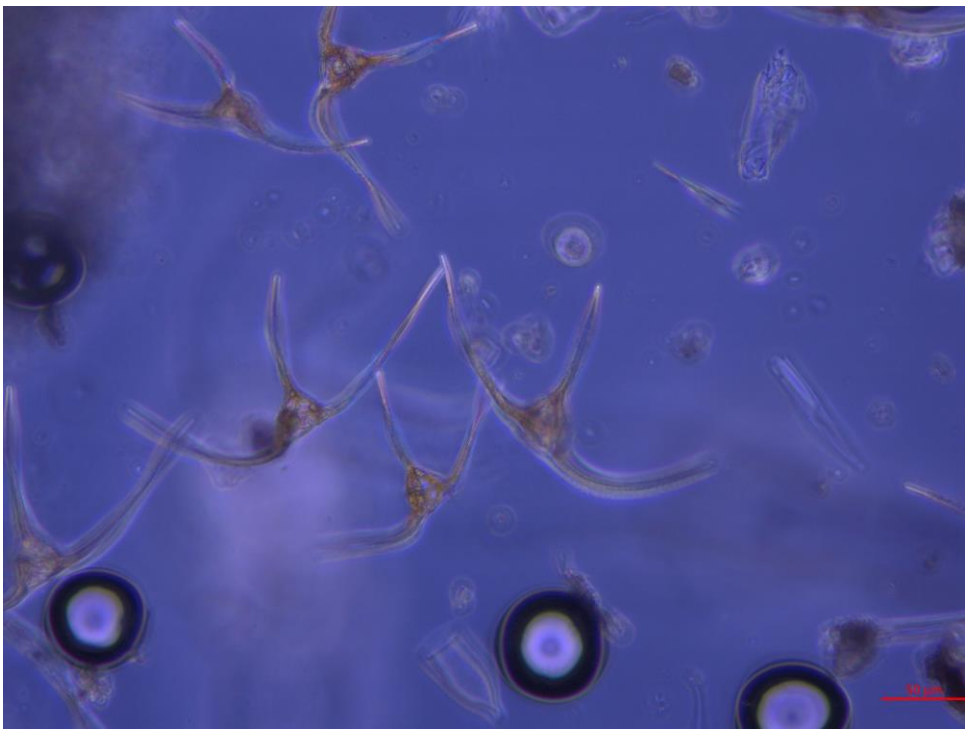


Figure 4.2.1*: Example of net phytoplankton composition (station J1), dominated by Ceratium arcticum*

4.3. *In situ* FRRF deployments

Rolf Gradinger (UiT)

A downward looking FRRF (Chelsea, Fast Repetition Rate Fluorometer) was deployed at all main stations (total of seven). The FRRF was mounted in a frame together with a CASTAWAY CTD and lowered at 0.2m/s down to a depth of 90m (for example see Fig. 4.3.1). Given the extremely low Chlorophyll concentrations (below 0.1ug/l), the estimations of quantum yields showed high variability. Nevertheless, the quantum yield could be estimated and were consistently less than 0.2. Values were nearly constant with depth as the low intensity red light illumination of the ship and the darkness of the polar winter eliminated fluorescence quenching, which largely impacted the spring and summer data.

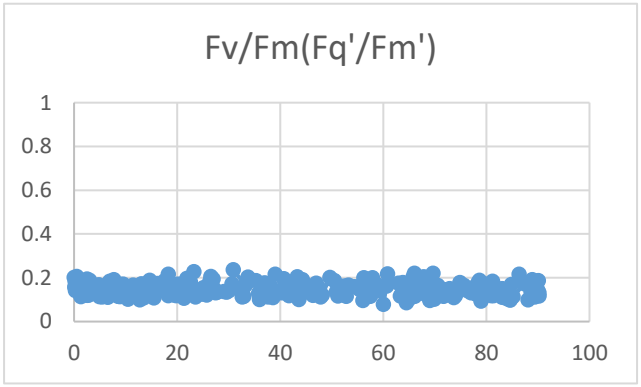


Figure 4.3.1: *Example for the vertical photosynthetic quantum yield estimates by the vertically profiling FRRF, station J1. X-axis: depth (m), y-axis: quantum yield*

4.4. Photophysiological properties of net phytoplankton

Rolf Gradinger (UiT)

Algal photophysiological properties (quantum yield and rapid response light curves) were determined using a PSI Aquapen instrument. Concentrations in the water samples were below detection limits, however these properties could be assessed for the more concentrated net phytoplankton samples. Samples were stored in darkness prior to measurements. All measurements were done in a dark cold room at 2degC. Concentrations in the net samples were high enough that several replicate measurements of yield and rapid response light curves could be done per sample.

Surprisingly, maximum quantum yields at all stations were high, exceeding values of 0.5 with highest values at the most Arctic stations J2 and J8 (example in Fig. 4.4.1). This indicates that net phytoplankton cells had a high potential to use light as soon as it would become available in spring for photosynthesis. Furthermore, the rapid response light curves, covering an irradiance range of 0 to 1000 µmol photon m^{-2} revealed that at all station the relative electron transport rate (ETR) increased up to a level of 400 µmol photon m^{-2}, when the ETR reached a maximum value (example in Fig. 4.4.2). Photoinhibition was not observed at any station.

I currently suggest that the strong difference in the quantum yield estimates between in situ FRRF and netplankton Aquqpen data likely can attributed dominance of living cells in the phytoplankton net sample, while the entire chl fraction in the water column might include dead material, as also indicated by the high phaeophytin values (see report phytoplankton group).

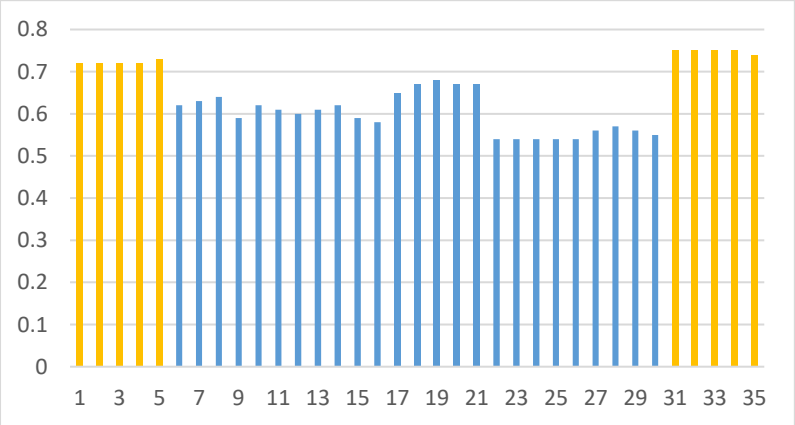


Figure 4.4.1: *Maximum photosynthetic quantum yield of all replicates/stations. Station J1 (replicates 1-5) and J8 (replicates 31-35) are marked in orange*

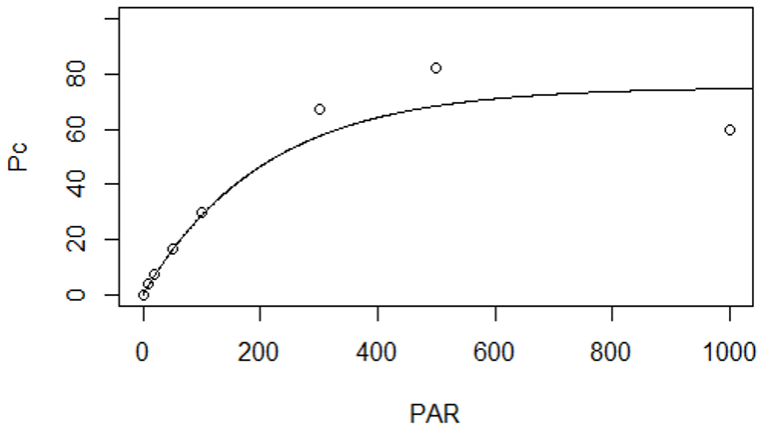


Figure 4.4.2: *Example of a rapid response light curve, showing relative electron transport rate on y-axis and irradiance (umol photons m^{-2} s^{-1}) on x axis*

4.5. "Frankenstein" sampling

Sünnje Basedow, Emilia Trudnowska, Maxime Geoffroy, Einat Sandbank

Data on the pelagic environment and community were also collected by a suite of instruments that were combined together on a vertical sampling rosette, called "Frankenstein". These instruments were: CTD-F, LISST, LOPC and WBAT. The Conductivity-Temperature-Depth sensor (CTD; SBE 19plusV2, Sea-Bird Scientific, USA) provides data on the physical environment for pelagic organisms. The Fluorescence sensor (F; EcoFl, Sea-Bird Scientific, USA) yields data on the fluorescence of phototrophic organisms and thus indicates the biomass of phytoplankton after calibration. The Laser In Situ Scattering Transmissiography (LISST, Sequoia Scientific, Inc., USA) uses laser light scattering in the water column to derive particle size and abundance of small particles (ca. 3-500 µm) and the Laser Optical Plankton Counter (LOPC, currently no longer in production) sends laser light across a sampling channel, which is then mirrored and received on a matrix of photodiodes, to calculate the size and transparency of larger particles and zooplankton (ca 250 µm to 3 mm equivalent spherical diameter). The Wideband Acoustic Transceiver (WBAT; Kongsberg Maritime AS) was connected to a 38 kHz split beam transducer (Model ES38-18DK; 36-45 kHz) and a 333 kHz single beam transducer (Model ES333-7CDK-single; 280-380 kHz), both operated in broadband mode split-beam wideband.

***Figure 4.5.1**: The "Frankenstein" sampling team.*

The "Frankenstein" platform was deployed ca 60 times, from surface to 10 m above bottom, max. 300 m:

1) along our transect **S1** from Arctic-type water masses (77.38 ºN) to Atlantic Water (77.5 ºN), 22 vertical profiles from surface to 10 m above the bottom were collected with 5 nautical miles (9.3 km) between them. During the cruise, these data provided an overview of the water mass and plankton distributions that were used to select the locations for detailed sampling at our full stations.

2) at each of our seven **full stations** (PF1, PF2, PF3, PF4, PF5, PF6, PF8), three consecutive vertical profiles were collected to calculate the average distribution across those profiles. One additional profile was sampled in two regions of special interest, PF2.5 and PF7.

3) to resolve a region with strong horizontal gradients in temperature and salinity a bit better, between 76.75 ºN (PF4) and 77.2 ºN (PF5) additional vertical profiles were collected. These 10 stations along **S2** were spaced 2.5 nautical miles (4.6 km) apart.

4) In our study region, pronounced changes in time were observed based on the data we collected along S1 and S2. To estimate the **temporal variation at station PF6**, we sampled one vertical profile every 45 minutes for 10 hours, from Jan 11 20:30 UTC to 06:12 UTC Jan 12, in total 14 profiles.

5) Finally, on the way from PF6 to PF8, we sampled one profile every 10 nautical miles (18.5 km) along the marginal ice zone (**S3**), six profiles in total.

Table 4.5.1: *Frankenstein deployments along section S1*

Name	StNr	Lat	Lon	Date	UTC	LISST	LOPC	WBAT	Profiles
S1_2	37	77.2783	30.1627	06.01.	10:28	x	x	x	1 to ca 180 m
S1_3	38	77.1927	30.1571	06.01.	11:57	x	x	x*	1 to ca 185 m
S1_4	39	77.1137	30.1637	06.01.	13:14	x	x	x	1 to ca 200 m
S1_5	40	77.0281	30.1565	06.01.	14:32	x	x	x	1 to ca 225 m
S1_6	41	76.9478	30.159	06.01.	15:40	x	x	x	1 to ca 240 m
S1_7	42	76.8636	30.1606	06.01.	18:34	x	x	x	1 to ca 255 m
S1_8	43	76.7778	30.1122	06.01.	19:35	x	x	x	1 to ca 245 m
S1_9	44	76.6941	30.0691	06.01.	20:38	x	x	x	1 to ca 250 m
S1_10	45	76.6126	30.0277	06.01.	21:33	x	-	x	1 to ca 280 m
S1_11	46	76.5303	29.9889	06.01.	22:33	x	x	x	1 to ca 275 m
S1_12	47	76.4463	29.9475	06.01.	23:30	x	x	x	1 to ca 280 m
S1_13	48	76.3598	29.9071	07.01.	00:26	x	x	x	1 to ca 280 m
S1_14	49	76.2724	29.8723	07.01.	01:23	x	x	x	1 to ca 280 m
S1_15	50	76.1855	29.8347	07.01.	02:16	x	x	x	1 to ca 290 m
S1_16	51	76.1025	29.7886	07.01.	03:07	x	x	x	1 to ca 300 m
S1_17	52	76.0165	29.7447	07.01.	04:01	x	x	x	1 to ca 300 m
S1_18	53	75.9299	29.7063	07.01.	04:48	x	x	x	1 to ca 295 m
S1_19	54	75.8455	29.6688	07.01.	05:43	x	x	x	1 to ca 295 m
S1_20	55	75.7556	29.6333	07.01.	06:37	x	x	x	1 to ca 300 m
S1_21	56	75.6719	29.5907	07.01.	07:27	x	x	x	1 to ca 300 m
S1_22	57	75.5845	29.5503	07.01.	08:19	x	x	x	1 to ca 300 m

* WBAT started sampling at ca. 50 m

Table 4.5.2: *Frankenstein deployments at* ***Full stations***

Name	StNr	Lat	Lon	Date	UTC	LISST	LOPC	WBAT	Profiles
PF1	25	77.3749	30.0415	06.01.	01:07	-	x	x	3 to ca 185 m
PF1	27	77.3619	30.1542	06.01.	03:59	x	x	-	1 to ca 180 m
PF2	73	75.5005	29.4918	07.01.	16:20	x	x	x	3 to ca 300 m
PF2.5	78	75.8503	29.5017	08.01.	00:14	x	x	-	1 to ca 280 m
PF3	92	76.1964	29.5003	08.01.	12:05	x	x	x	3 to ca 274 m
PF4	116	76.7544	29.5019	09.01.	11:48	x	x*	x	3 to ca 240 m
PF5	147	77.1765	29.4838	10.01.	16:07	x	x	x	3 to 195 m**
PF6	159	76.9918	29.3995	11.01.	10:27	x	x	x	3 to ca 230 m
PF8	202	76.3348	26.6684	13.01.	02:03	x	x	x	30 to ca 145 m

** Due to drift at the station, this sampling at PF5 was close to location S2_10 and data were included in the transect figures from S2

Table 4.5.3: *Frankenstein deployments along section S2*

Name	StNr	Lat	Lon	Date	UTC	LISST	LOPC	WBAT	Profiles
S2_1	121	76.7917	29.4975	09.01.	17:35	-	-	x	1 to ca 250 m
S2_1	122	76.7922	29.4969	09.01.	17:50	x	x	x	1 to ca 250 m
S2_2	123	76.8336	29.5019	09.01.	19:53	x	x	x	1 to ca 240 m
S2_3	124	76.8748	29.4942	09.01.	20:35	x	x	x	1 to ca 240 m
S2_4	125	76.9158	29.5103	09:01	21:19	x	x	x	1 to ca 250 m
S2_5	126	76.9575	29.4976	9.01	22:01	x	x	x	1 to ca 230 m
S2_6	127	77.003	29.5012	09.01.	22:37	x	x	x	1 to ca 230 m
S2_7	129	77.0427	29.5127	10.01.	00:58	x	x	x	1 to ca 220 m
S2_8	130	77.0842	29.471	10.01.	01:51	x	x	x	1 to ca 200 m
S2_9	131	77.1252	29.4903	10.01.	02:47	x	x	x	1 to ca 200 m
S2_10	132	77.1624	29.4984	10.01.	03:40	x	-	x	1 to ca 190 m
S2_11	133	77.1991*	29.4861	10.01.	04:51	x	x**	x	1 to ca 190 m

* at location PF5
** LOPC stopped logging on the way up

Table 4.5.4: *Frankenstein deployments to study temporal variation at PF6*

Name	StNr	Lat	Lon	Date	UTC	LISST	LOPC	WBAT	Profiles
P6_t1	166	76.9985	29.4841	11.01.	20:33	-	x	x	1 to ca 220 m
P6_t2	167	76.9849	29.4534	11.01.	21:16	-	x*	x	1 to ca 220 m
P6_t3	168	77.0065	29.5512	11.01.	22:01	-	x	-**	1 to ca 220 m
P6_t4	169	76.9971	29.5442	11.01.	22:45	-	x+	x	1 to ca 220 m
P6_t5	170	77.0068	29.4954	11.01.	23:30	-	x	x	1 to ca 220 m
P6_t6	171	76.9967	29.5028	12.01.	00:15	x	x	x	1 to ca 220 m
P6_t7	172	77.0099	29.4998	12.01.	00:58	x	x	x	1 to ca 220 m
P6_t8	173	77	29.5055	12.01.	01:42	x	x	x***	1 to ca 220 m
P6_t9	174	76.9972	29.5124	12.01.	02:29	x	x	x	1 to ca 220 m
P6_t10	175	76.9875	29.5188	12.01.	03:14	x	x	x	1 to ca 220 m
P6_t11	176	77.0097	29.5086	12.01.	03:59	x	x	x	1 to ca 220 m
P6_t12	177	76.9933	29.5059	12.01.	04:45	x	x	x	1 to ca 220 m
P6_t13	178	77.003	29.5121	12.01.	05:27	x	x	x	1 to ca 220 m
P6_t14	179	76.9861	29.4985	12.01.	06:12	x	x****	x	1 to ca 220 m

* LOPC stopped logging at ca 75 m on the way down
** polar bear distraction
*** WBAT logged only from ca. 90 m
**** LOPC stopped logging at ca 35 m on the way up
+ LOPC stopped logging at ca 20 m on the way down

Table 4.5.4: *Frankenstein deployments along section S3*

Name	StNr	Lat	Lon	Date	UTC	LISST	LOPC	WBAT	Profiles
S3_1	180	76.9907	28.7377	12.01.	08:20	x	x	x	1 to ca 210 m
S3_2	181	76.11	28.5255	12.01.	09:58	x	x*	x	1 to ca 135 m
S3_3	182	76.7416	28.4846	12.01.	11:29	x	x	x	1 to ca 135 m
S3_4	183	76.5906	28.4444	12.01.	12:46	x	x**	x	1 to ca 140 m
S3_5	184	76.5667	27.8247	12.01.	14:14	x	x	x	1 to ca 135 m
S3_6	185	76.4485	27.4294	12.01.	15:37	x	x	x	1 to ca 115 m
S3_7	187	76.3157	28.1795	12.01.	17:40	x	x	x	1 to ca 120 m

* LOPC stopped logging at 53 m on the way down
** LOPC stopped logging at bottom of profile (ca 140 m)

Preliminary results

Environmental data along our first transect (S1) showed strong gradients in temperature and salinity along the transect (Figure 4.5.1), and reveal that the deep polar front lay a bit north of the possible sampling. Final water mass analyses will be carried out once the salinity sensor is calibrated against water samples analysed at UiT.

LISST (Emilia Trudnowska, IOPAN, Poland) and LOPC (Sünnje Basedow, UiT, Norway) data will be used for several purposes: to analyse horizontal and vertical distributions of plankton and particles across the front with relatively high spatial resolution (WP1), and to create biovolume spectra in the size range 3 µm to 3 mm based on which several ecological processes can be estimated (WP2). From the WBAT (Maxime Geoffroy, Memorial University, Canada), spectra for larger organisms can be created and the potential to combine spectra from all three instruments will be explored.

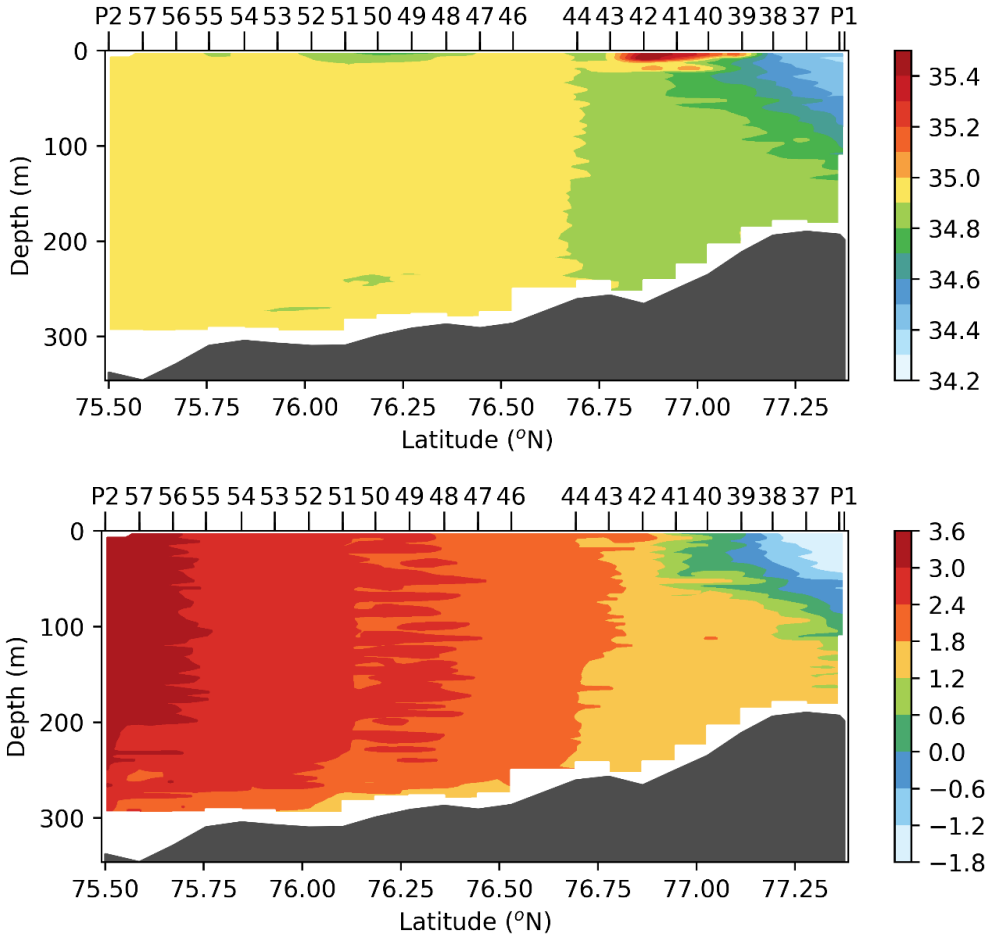


Figure 4.5.1. *Distribution across the polar front. Top: Salinity (psu), Bottom: In situ temperature (°C)*

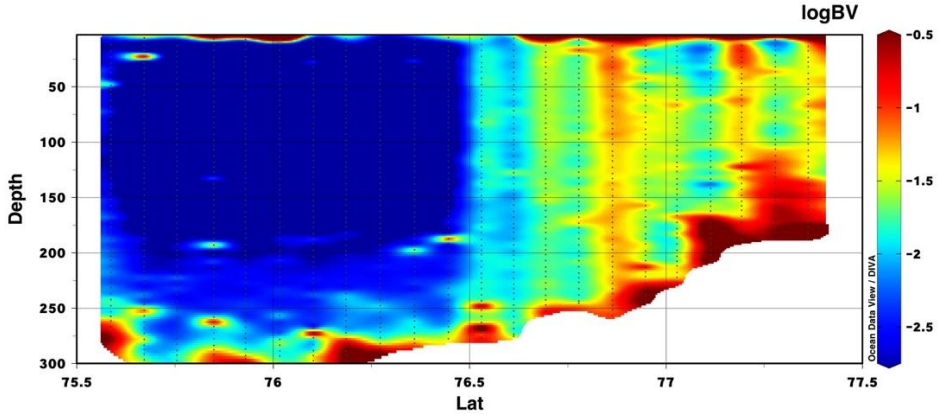


Figure 4.5.2: *Section of LISST – log (biovolume concentration) across depth and latitudinal steps, showing much higher concentrations at northern stations compared to the concentrations observed at southern stations.*

Acoustic probe (WBAT)

We deployed an acoustic probe composed of a Wideband Acoustic Transceiver (WBAT; Kongsberg Maritime AS) mounted on the LOPC rosette frame and connected to a 38 kHz split beam transducer (Model ES38-18DK; 36-45 kHz) and a 333 kHz single beam transducer (Model ES333-7CDK-single; 280-380 kHz), both operated in broadband mode (Figure 4.5.3). 63 WBAT deployments were completed with 17 hours and 50 minutes of acoustic data recorded. Deployments were either profiles of the water column or at fixed depths. Profile deployments were used at primary stations sampled in congruence with all other samplings, the two high-resolution transects, and the stationary temporal variation sampling. Fixed depth deployments were used when dense fish aggregations were encountered under sea ice and at the ice edge. Deployments at primary stations were comprised of three consecutive vertical profiles. Three transects were also completed while on route to stations; during these transects, deployments were completed with either 10, 5 or 2.5nm intervals, with a single acoustic profile. A sequence of profiles at a fixed location was conducted with 13 acoustic profiles set 45 minutes apart. Three stationary fixed-depth drops were also completed to try and identify dense fish aggregations under sea ice that we were unable to sample. All three drops were 30 minutes long and targeted dense fish school aggregations seen with the boat's EK60 echosounder. Only the WBAT and LISST were used during these fixed-depth deployments. Two out of the three stationary deployments were side-facing and the last was down-facing station number PF9. During profile and at stationary deployments, ping rate was set to 1 second, range to 50 m, pulse length to 2,048 µs, and power to 450 W at 38kHz and 50 W at 333 kHz. The WBAT was last calibrated in February 2023. For most deployments, the internal time of the WBAT was synchronized with the LOPC-CTD to extract the exact depth at each ping in post-processing. When the timing was not synchronized, the time difference was noted for correction (Table 4.5.5).

Table 4.5.5: *Primary stations WBAT deployments and settings.*

Date (UTC)	***Station***	***Boat ID***	***Duration***	***Type***	***Direction***	***Comments***	***Time Correction***
6/1/2024	PF1	25	0:31:57	Profile	Side		Half second delay
7/1/2024	PF2	73	0:46:39	Profile	Side		1 second delay
8/1/2024	PF3	92	0:45:18	Profile	Side	EK60 38kHz on active for a profile	2 second ahead
9/1/2024	PF4	116	0:39:05	Profile	Side	LOPC only worked for one profile	1 second delay
10/1/2024	PF5	147	0:31:33	Profile	Side	The boat log did not start at the right time	
11/1/2024	PF6	159	0:36:03	Profile	Side		2 second delay
13/1/2024	PF8	202	0:20:00	Profile	Side		1 second behind

Table 4.5.6: *Transect S1 stations WBAT deployments and settings. The transect was from the northernmost primary station to the southernmost primary station. Stations were set 5 nm apart.*

Date (UTC)	*Station*	*Boat ID*	*Duration*	*Type*	*Direction*	*Comments*	*Time Correction*
6/1/2024	S1_2	37	0:11:46	Profile	Side		Ahead 3 min 32 sec
6/1/2024	S1_3	38	0:16:19	Profile	Side	WBAT started at around 50 m	Half-a-second delay
6/1/2024	S1_4	39	0:10:10	Profile	Side		1 second delay
6/1/2024	S1_5	40	0:11:28	Profile	Side		2 second delay
6/1/2024	S1_6	41	0:11:58	Profile	Side		
6/1/2024	S1_7	42	0:12:14	Profile	Side		
6/1/2024	S1_8	43	0:16:33	Profile	Side		
6/1/2024	S1_9	44	0:14:24	Profile	Side		
6/1/2024	S1_10	45	0:18:39	Profile	Side	LOPC didn't work	
6/1/2024	S1_11	46	0:16:21	Profile	Side		
6/1/2024	S1_12	47	0:16:09	Profile	Side		
7/1/2024	S1_13	48	0:14:56	Profile	Side		
7/1/2024	S1_14	49	0:13:49	Profile	Side		
7/1/2024	S1_15	50	0:14:00	Profile	Side	EK60 38kHz remained on passive after the station	
7/1/2024	S1_16	51	0:14:30	Profile	Side		
7/1/2024	S1_17	52	0:14:00	Profile	Side		1 second delay
7/1/2024	S1_18	53	0:13:00	Profile	Side		1 second delay
7/1/2024	S1_19	54	0:14:00	Profile	Side		1 second delay
7/1/2024	S1_20	55	0:14:30	Profile	Side		
7/1/2024	S1_21	56	0:19:00	Profile	Side		
7/1/2024	S1_22	57	0:15:40	Profile	Side		1 second ahead

Table 4.5.7: *Transect S2 stations WBAT deployments and settings. Transect along a strong temperature gradient. Stations were set 2.5 nm apart.*

Date (UTC)	*Station*	*Boat ID*	*Duration*	*Type*	*Direction*	*Comments*	*Time Correction*
9/1/2024	S2_1	121	0:15:47	Profile	Side	LOPC and LISST didn't work	
9/1/2024	S2_1	122	0:15:14	Profile	Side	Repeat	
9/1/2024	S2_2	123	0:15:03	Profile	Side		1 second delay
9/1/2024	S2_3	124	0:16:12	Profile	Side		1 second delay
9/1/2024	S2_4	125	0:13:40	Profile	Side		
9/1/2024	S2_5	126	0:14:53	Profile	Side	Boat EK60 active at 30m on the way up	
9/1/2024	S2_6	127	0:13:18	Profile	Side	Boat EK60 active at 30m on the way up	
10/1/2024	S2_7	129	0:13:41	Profile	Side	Boat EK60 active at 30m on the way up	
10/1/2024	S2_8	130	0:11:29	Profile	Side		
10/1/2024	S2_9	131	0:10:34	Profile	Side		
10/1/2024	S2_10	132	0:17:25	Profile	Side	LOPC	
10/1/2024	S2_11	133	0:09:20	Profile	Side	Boat EK60 active until 50m on the way down	

Table 4.5.8: *Transect S3 stations WBAT deployments and settings. Transect was along the ice edge. Stations were set 10 nm apart.*

Date (UTC)	*Station*	*Boat ID*	*Duration*	*Type*	*Direction*	*Comments*	*Time Correction*
12/1/2024	S3_1	180	0:11:34	Profile	Side		1 second behind
12/1/2024	S3_2	181	0:09:29	Profile	Side	LOPC stopped at 53m on way down	
12/1/2024	S3_3	182	0:09:32	Profile	Side		1 second behind
12/1/2024	S3_4	183	0:08:29	Profile	Side	LOPC didn't log on the way up	
12/1/2024	S3_5	184	0:09:12	Profile	Side		
12/1/2024	S3_6	185	0:07:50	Profile	Side		
12/1/2024	S3_7	187	0:07:08	Profile	Side		

Table 4.5.9: *Stationary WBAT deployments and settings.*

Date (UTC)	*Station*	*Boat ID*	*Duration*	*Type*	*Direction*	*Comments*	*Time Correction*
10/1/2024	PF5.5	149	0:33:47	Stationary	Side	Stationary to look at TS of fish in dense fish schools under the ice	
11/1/2024	PF6.5	162	0:38:01	Stationary	Side	Held at 120 for 30 min	
13/1/2025	PF9	204	0:40:01	Stationary	Down	Held at 140 for 30 min	1 second behind

Table 4.5.10: *Temporal variation WBAT deployments and settings.*

Date (UTC)	*Station*	*Boat ID*	*Duration*	*Type*	*Direction*	*Comments*	*Time Correction*
11/1/2024	P6_T1	166	0:13:06	profile	Side	Boat EK60 active at 30m on the way up	1 second delay
11/1/2024	P6_T2	167	0:12:32	profile	Side	Boat EK60 active at 30m on the way up	1 second delay
11/1/2024	P6_T4	169	0:12:10	profile	Side	Lots of electrical noise, LOPC stopped at 20m,	1 second delay
11/2/2024	P6_T5	170	0:39:45	profile	Side	Lots of electrical noise, Boat EK60 is active at 35m on the way up	1 second delay
12/1/2024	P6_T6	171	0:12:46	profile	Side	Boat EK60 active at 35m on the way up	1 second delay
12/1/2024	P6_T7	172	0:11:14	profile	Side	Boat EK60 active at 35m on the way up	1 second delay
12/1/2024	P6_T8	173	1:40:43	profile	Side	started recording at 90m	
12/1/2024	P6_T9	174	0:10:00	Profile	Side		
12/1/2024	P6_T10	175	0:11:00	Profile	Side	Noise from ship thrusters	
12/1/2024	P6_T11	176	0:12:00	Profile	Side		
12/1/2024	P6_T12	177	0:11:00	Profile	Side		
12/1/2024	P6_T13	178	0:10:00	Profile	Side		
12/1/2024	P6_T14	179	0:09:00	Profile	Side		1 second behind

Acoustic analyses

Acoustic data will be examined and cleaned with Echoview®. WBAT acoustic profiles recorded will be calibrated to account for the change of sound speed with depth based on data collected by the CTD on the rosette. The CTD's logged temperature, salinity, and sound speed (Chen and Millero, 1977), will be used to derive the absorption coefficient at each frequency (Francois and Garrison, 1982). When necessary, Echoview's algorithms will be used to remove background noise and impulse noise (De Robertis and Higginbottom, 2007; Ryan et al., 2015). A minimum signal-to-noise ratio threshold of 10 dB will be applied. Samples with a lower signal to noise ratio are considered indistinguishable from background noise and excluded from the analysis with the background noise algorithm.

Preliminary results.

Due to the large amount of post-processing required for accurate interpretation of data collected by the WBAT (stationery and profiles), results are preliminary and qualitative only.

WBAT profiles show acoustic backscatter of many targets during transect S2. Some decrease with increasing latitude was observed at 38 kHz. Red circle indicates the dense schools of fish observed at the ice edge (Figure 4.5.3).

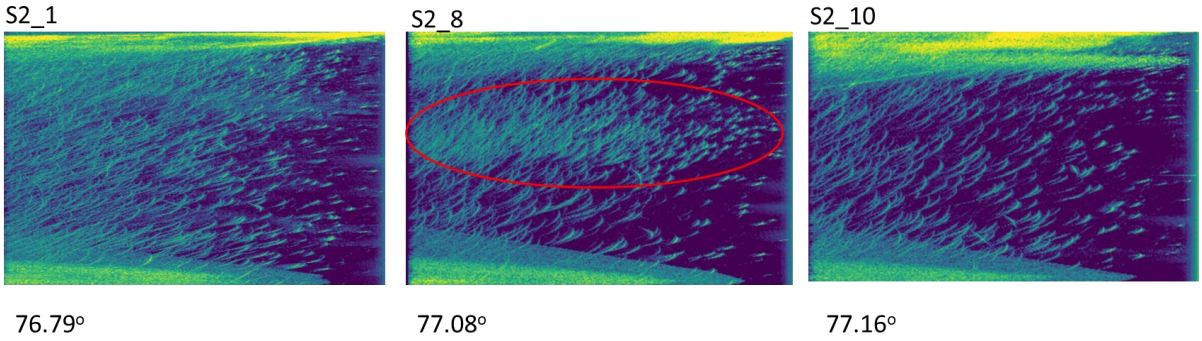


Figure 4.5.3. *WBAT echograms from three sites on transect S2.*

References

Chen, C., Millero, F.J., 1977. Speed of sound in seawater at high pressures. The Journal of the Acoustical Society of America 62, 1129–1135. https://doi.org/10.1121/1.381646

De Robertis, A., Higginbottom, I., 2007. A post-processing technique to estimate the signal-to-noise ratio and remove echosounder background noise. ICES Journal of Marine Science 64, 1282–1291. https://doi.org/10.1093/icesjms/fsm112

Francois, R.E., Garrison, G.R., 1982. Sound absorption based on ocean measurements. Part II: Boric acid contribution and equation for total absorption. The Journal of the Acoustical Society of America 72, 1879–1890. https://doi.org/10.1121/1.388673

Ryan, T.E., Downie, R.A., Kloser, R.J., Keith, G., 2015. Reducing bias due to noise and attenuation in open-ocean echo integration data. ICES Journal of Marine Science 72, 2482–2493. https://doi.org/10.1093/icesjms/fsv121

4.6. Mesozooplankton composition and Calanus lipid content

Malin Daase UiT,, Emilia Trudnowska IOPAN

Mesozooplankton species composition, abundance, biomass

To determine the mesozooplankton community composition, abundance and vertical distribution, a Multinet (MPS) (HydroBios Kiel, 180 µm, 0.25 m^2 opening area) was deployed at each main station. Samples were taken from 4 or 5 standard depth strata (bottom- 200-100-50-20-0 m) and fixed in 4% formalin in seawater solution. These samples will be analysed for community and *Calanus* stage composition at UiT. To estimate the biomass of the mesozooplankton community a WP2 net (HydroBios Kiel, 180 µm, 0.25 m^2 opening area) was taken from the entire water column. The sample was size fractionated into a 1000 µm and 180µm fraction by pouring it through a 1000 and 180 µm sieve. Each sample was rinsed with fresh water and placed in a pre-weighted weighing dish and dried at 60ºC in the drying oven. The dried samples will be weighed back at UiT.

Table 4.6.1*: Overview of samples taken for Mesozooplanton community analysis. Samples were fixed in 4% formalin.*

Event #	station	Lat (N)	Lat (min)	Long (E)	Long (min)	bottom depth (m)	Date (UTC)	Sample time (UTC)	Gear	Sample depth from (m)	Sample depth (to)
20	PF1	77	24.92	30	0.67	198	05.01.2024	22:36	Multinet	183	100
20	PF1	77	24.92	30	0.67	198	05.01.2024	22:36	Multinet	100	50
20	PF1	77	24.92	30	0.67	198	05.01.2024	22:36	Multinet	50	20
20	PF1	77	24.92	30	0.67	198	05.01.2024	22:36	Multinet	20	0
66	PF2	75	29.76	29	29.56	335	07.01.2024	12:51	Multinet	318	200
66	PF2	75	29.76	29	29.56	335	07.01.2024	12:51	Multinet	200	100
66	PF2	75	29.76	29	29.56	335	07.01.2024	12:51	Multinet	100	50
66	PF2	75	29.76	29	29.56	335	07.01.2024	12:51	Multinet	50	20
66	PF2	75	29.76	29	29.56	335	07.01.2024	12:51	Multinet	20	0
87	PF3	76	12.16	29	29.98	282	08.01.2024	10:06	Multinet	260	200
87	PF3	76	12.16	29	29.98	282	08.01.2024	10:06	Multinet	200	100
87	PF3	76	12.16	29	29.98	282	08.01.2024	10:06	Multinet	100	50
87	PF3	76	12.16	29	29.98	282	08.01.2024	10:06	Multinet	50	20
87	PF3	76	12.16	29	29.98	282	08.01.2024	10:06	Multinet	20	0
112	PF4	76	45.06	29	29.39	254	09.01.2024	10:18	Multinet	225	200
112	PF4	76	45.06	29	29.39	254	09.01.2024	10:18	Multinet	200	100
112	PF4	76	45.06	29	29.39	254	09.01.2024	10:18	Multinet	100	50
112	PF4	76	45.06	29	29.39	254	09.01.2024	10:18	Multinet	50	20
112	PF4	76	45.06	29	29.39	254	09.01.2024	10:18	Multinet	20	0
137	PF5	77	12.16	29	28.85	200	10.01.2024	08:52	Multinet	170	100
137	PF5	77	12.16	29	28.85	200	10.01.2024	08:52	Multinet	100	50
137	PF5	77	12.16	29	28.85	200	10.01.2024	08:52	Multinet	50	20
137	PF5	77	12.16	29	28.85	200	10.01.2024	08:52	Multinet	20	0
141	PF5	77	11.77	29	26.03	200	10.01.2024	10:36	WP2*	190	150
154	PF6	77	0.15	29	25.89	233	11.01.2024	08:30	Multinet	218	200
154	PF6	77	0.15	29	25.89	233	11.01.2024	08:30	Multinet	200	100
154	PF6	77	0.15	29	25.89	233	11.01.2024	08:30	Multinet	100	50
154	PF6	77	0.15	29	25.89	233	11.01.2024	08:30	Multinet	50	20
154	PF6	77	0.15	29	25.89	233	11.01.2024	08:30	Multinet	20	0
193	PF8	76	19.25	26	37.71	149	12.01.2024	22:54	WP2**	139	100
194	PF8	76	18.96	26	36.82	148	12.01.2024	23:09	WP2**	100	50
195	PF8	76	18.74	26	36.18	146	12.01.2024	23:21	WP2**	50	0

*Additional WP2 taken to sample closer to sea floor

**samples taken with WP2 instead of Multinet due to strong wind and shallow depth

***Table 4.6.2**: Overview of samples taken with WP2 net to estimate Mesozooplanton biomass. Samples were size fractioned into 1000µm and 180µm and dried at 50 C.*

Event #	station	Lat (N)	Lat (min)	Long (E)	Long (min)	bottom depth (m)	Date (UTC)	Sample time (UTC)	Sample depth from (m)	Sample depth (to)
22	PF1	77	23.53	30	1.84	194	06.01.2024	00:02	185	0
67	PF2	75	29.92	29	29.84	338	07.01.2024	13:34	325	0
88	PF3	76	11.94	29	29.49	280	08.01.2024	10:44	270	0
113	PF4	76	44.77	29	31.87	255	09.01.2024	10:56	245	0
139	PF5	77	11.88	29	26.76	199	10.01.2024	10:03	190	0
156	PF6	76	59.77	29	24.63	232	11.01.2024	09:33	225	0
196	PF8	76	18.53	26	35.52	145	12.01.2024	23:34	140	0

Calanus population lipid content

Copepods of the genus *Calanus* are key species in the energy transfer between primary producers and higher trophic levels and often dominate the mesozooplankton community in the Arctic and sub-Arctic Barents Sea.

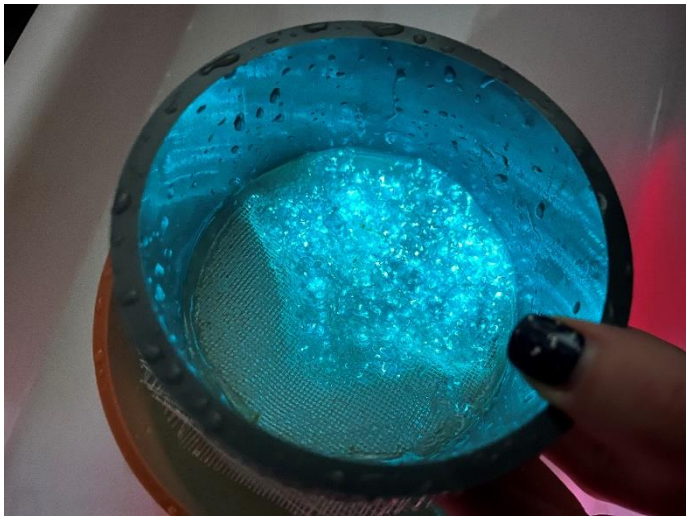
To estimate the lipid content of the *Calanus* community, two samples were taken with a WP2 (180 µm mesh size, 0.25 m^2 opening): one from ~10 m above sea floor to ca. 100 m above sea floor, and one from 50 m to surface. The samples were transferred into a measuring beaker and diluted with filtered sea water to a known volume (200–600 ml, depending on density of the sample). Quantitative subsamples were taken with a 5 mL pipette with an enlarged opening and transferred into a petri dish. Digital images (lateral view) were taken of all *Calanus* (living and dead) in each subsample using a Leica stereomicroscope with a camera (Leica DFC420). Subsample size was chosen to contain at least 100 *Calanus* from each sample. Copepodite stage of each individual was determined while taking the pictures. The digital images were used to measure lipid sac area, prosome length and prosome area of specimens using ImageJ, an open source graphics program (Rasband 1997−2009). Lipid content of individual *Calanus* specimens was calculated from lipid sac area according to Vogedes et al. (2010).

***Table 4.6.3**: Overview of samples taken for image analysis of lipid sac area with the WP2 net. Samples from the same stations were pooled after images were taken and fixed in ethanol*

Event #	station	Lat (N)	Lat (min)	Long (E)	Long (min)	bottom depth (m)	Date (UTC)	Sample time (UTC)	Sample depth from (m)	Sample depth (to)
23	PF1	77	23.25	30	1.90	195	06.01.2024	00:19	185	100
24	PF1	77	22.93	30	2.19	199	06.01.2024	00:39	50	0
68	PF2	75	29.94	29	29.42	336	07.01.2024	14:04	325	200
70	PF2	75	29.96	29	28.77	341	07.01.2024	14:44	50	0
89	PF3	76	12.17	29	29.54	279	08.01.2024	11:05	270	0
90	PF3	76	12.30	29	29.84	278	08.01.2024	11:26	50	0
114	PF4	76	44.93	29	31.31	253	09.01.2024	11:15	245	150
115	PF4	76	45.13	29	30.59	254	09.01.2024	11:35	50	0
140	PF5	77	11.82	29	26.37	200	10.01.2024	10:21	190	150
142	PF5	77	11.70	29	25.62	201	10.01.2024	10:54	50	0
157	PF6	76	59.66	29	24.43	237	11.01.2024	09:51	225	150
158	PF6	76	59.59	29	24.02	235	11.01.2024	10:09	50	0
197	PF8	76	18.40	26	35.13	147	12.01.2024	23:42	140	100
198	PF8	76	18.16	26	34.48	154	12.01.2024	23:55	50	0

Preliminary Results:

Community composition: At all stations, expect for the last one on Hopenbanken (PF8), we observed a high abundance of *Metridia longa*, whose presence was signaled already when the nets came out of the water by a strong blue bioluminescence. On Hopenbanken, we observed high abundance of *Pseudocalanus* spp.



A sample full of Metridia longa (Photo: Malin Daase)

Calanus community composition and population status: The *Calanus* community in the deep and surface layer was dominated by *C. finmarchicus* at all stations, except for the station on Hopenbanken (PF8) (Figure 4.6.1). Elevated contributions of *C. glacialis* were observed at the ice covered stations, i.e. PF8 and at the two northern most station of the main transect (PF1 and 5). *C. hyperboreus* abundance was overall low, with highest abundance found at PF3. At depth, abundance of *Calanus* peaked at station PF5 but did otherwise only vary little between stations. In the surface, *Calanus* abundance was very low at the ice covered stations, and but was similar to the abundance at depth in the open water stations.

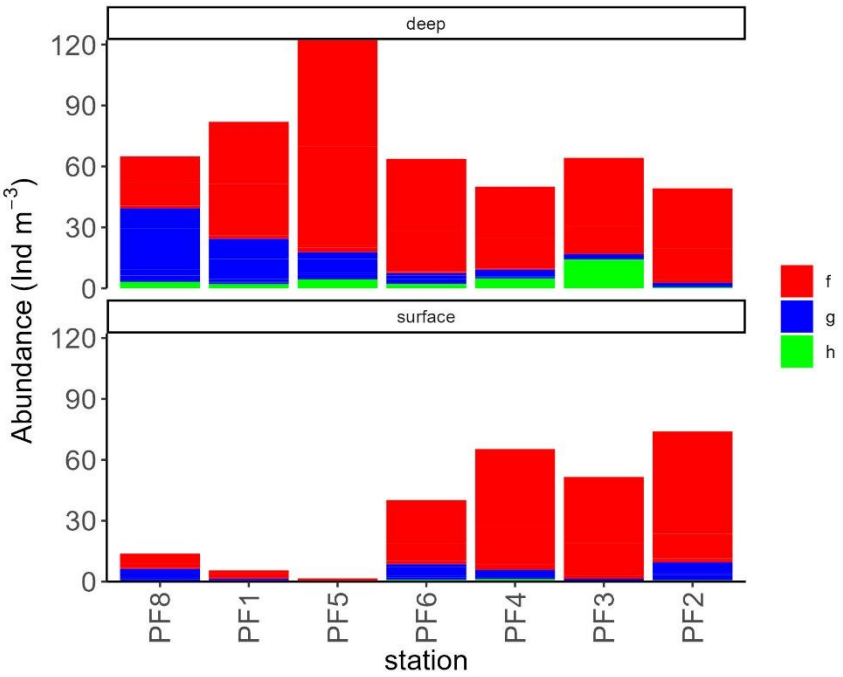


Figure 4.6.1: *Abundance of C. finmarchicus (f), C. glacialis (g) and C. hyperboreus (h) at depth (50-100 m over sea floor) and in surface waters (50-0 m) at the main stations.*

C. finmarchicus was mainly found as CV and to a smaller proportion as CIV. Several CIVs were frozen for genetic analysis to confirm the species of that stage (analyses will be done at UiT). *C. glacialis* was mainly found as CIVs along the transect, while a high abundance of CIII was observed on the bank. Adult males and females were all in the size range of *C. glacialis* and overall low in abundance. *C. hyperboreus* was mainly found as CIV (Figure 4.6.2)

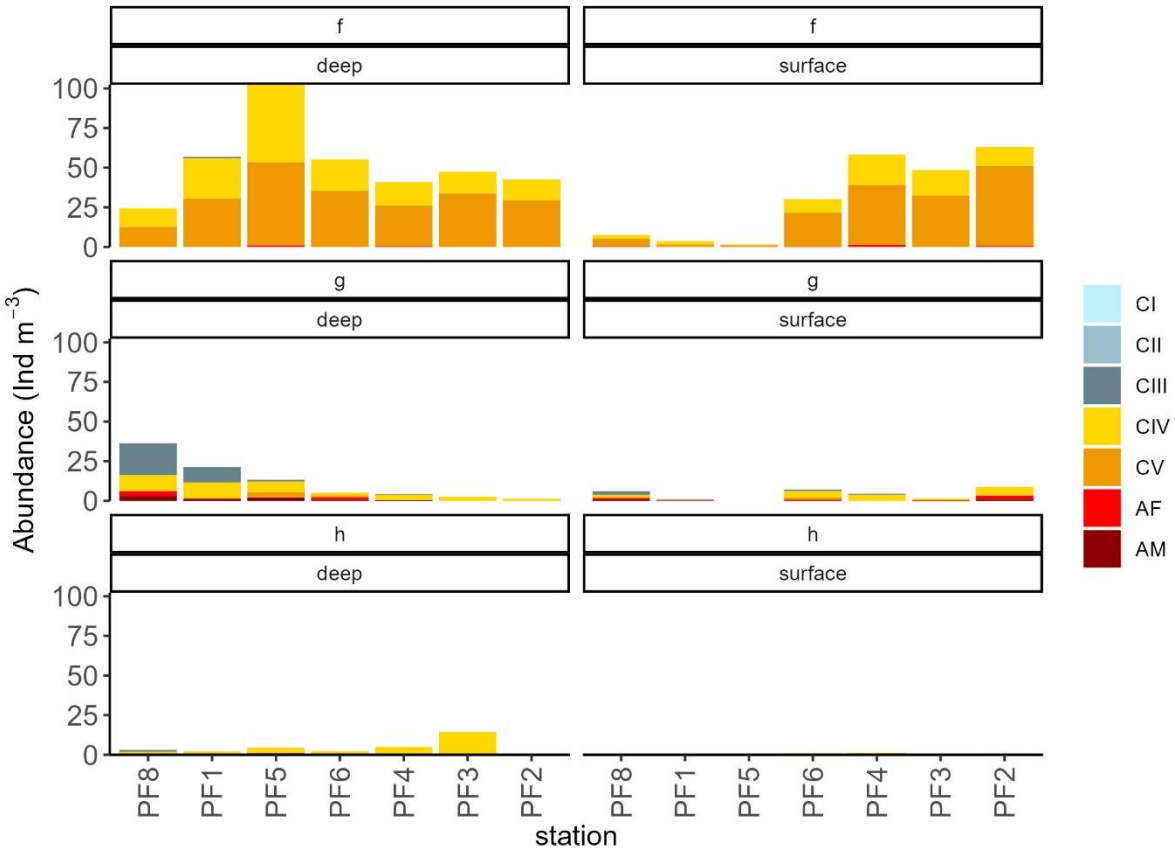


Figure 4.6.2 *Abundance and stage composition of C. finmarchicus (f), C. glacialis (g) and C. hyperboreus (h) at depth (50-100 m over sea floor) and in surface waters (50-0 m) at the main stations.*

Calanus lipid content: The spatial distribution of the total lipid content of the *Calanus* population largely reflected the patterns observed in abundance, with highest lipid biomass observed at PF5, and low lipid biomass in the surface at the ice covered stations (Figure 4.6.3).

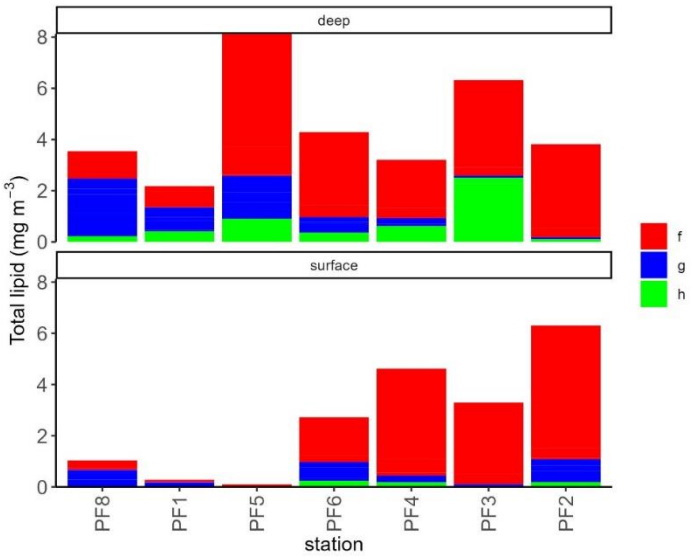


Figure 4.6.3: *Total lipid content of C. finmarchicus (f), C. glacialis (g) and C. hyperboreus (h) at depth (50-100 m over sea floor) and in surface waters (50-0 m) at the main stations.*

The lipid sac area to prosome area ratio (LAPA) provides an indication of the fullness of the individual *Calanus*. Overall, the does not seem to be a difference in LAPA between *Calanus* at depth and those in surface waters (Figure 4.6.4). *C. finmarchicus* CIV had somewhat lower LAPA in the ice covered stations (PF8 and PF1), but there are no obvious differences in LAPA along the rest of the transect. There seems to be a slight increase in LAPA of CVs of *C. finmarchicus* from south to north. Abundance of *C. glacialis* was low, so there is more noise in the data.

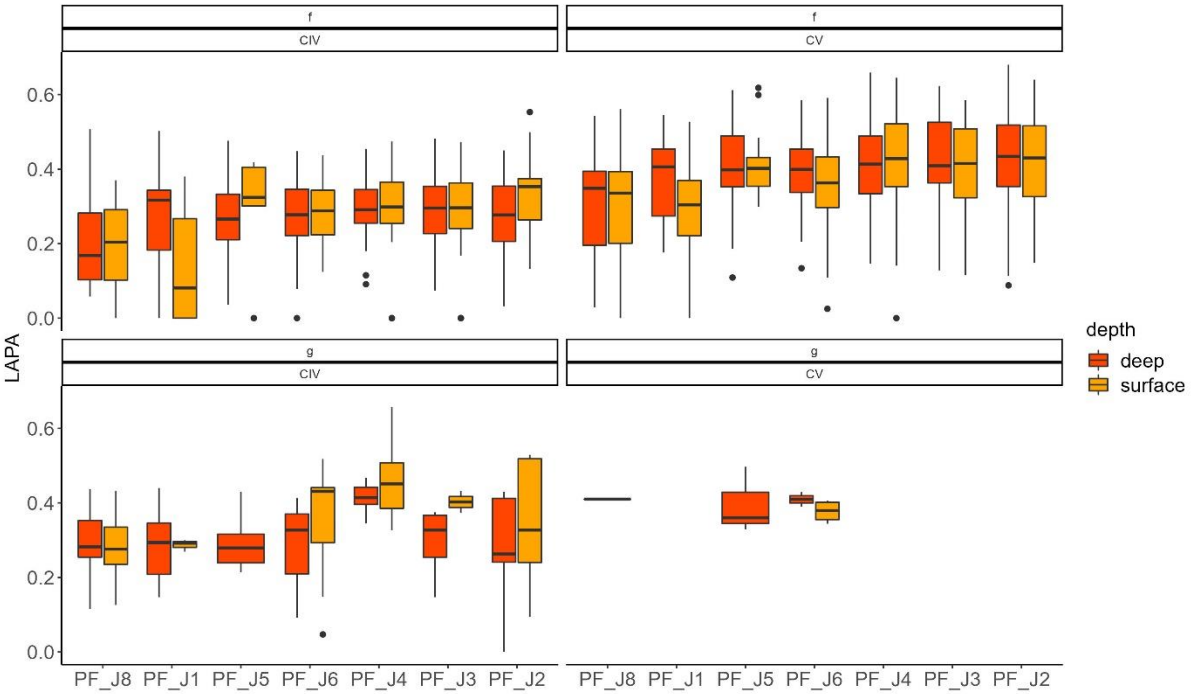


Figure 4.6.4: *Boxplot showing variability in lipid sac area to prosome area ratio (LAPA) of CIV and CVs of C. finmarchicus (f), and C. glacialis (g) in deep waters (50-100 m over sea floor) and in surface waters (50-0 m) at the main stations.*

Non-consumptive mortality can be high in *Calanus* during the polar night (Daase & Søreide 2021), and we found high abundance of dead *Calanus* mainly in the surface, especially at PF8 and PF5.

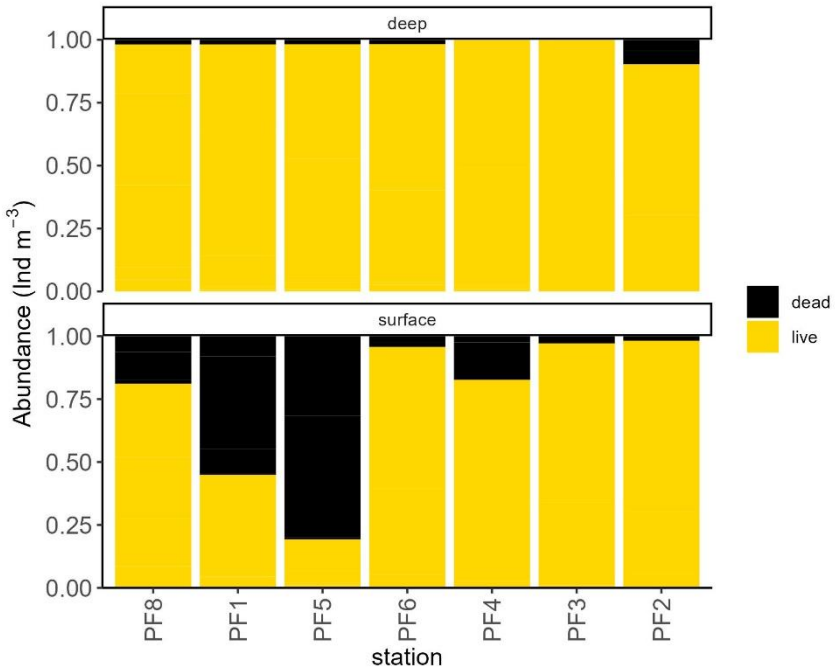


Figure 4.6.5: *Contribution of dead and alive Calanus observed at depth (50-100 m above sea floor) and in surface waters (50-0 m) at the main stations.*

Oh no! The frrf is on the schlauch!
(a tribute to the polish-german collaboration)

References:

Daase M, Søreide JE (2021) Seasonal variability in non-consumptive mortality of Arctic zooplankton. J Plankt Res 43:565-585. doi:10.1093/plankt/fbab042

Vogedes D, Varpe Ø, Søreide JE, Graeve M, Berge J, Falk-Petersen S (2010) Lipid sac area as a proxy for individual lipid content of arctic calanoid copepods. J Plankt Res 32:1471-1477. doi:10.1093/plankt/fbq068

4.7. Calanus Grazing Experiment

Florence Rappin, Lorenz Schick, Sünnje Basedow, Malin Daase

The experiment intends to characterize the grazing event by *Calanus* spp. occurring during the polar night across the front by looking at the fecal pellet production.
For each of the 7 full stations, 1 to 2 WP2 have been used to take samples from 10m above the seabed up to the sea surface. 60 *Calanus* from stage IV, V and female have been picked up randomly. They were incubated individually in chambers with false bottoms for 20h to 24h at 5°C in filtered seawater. After incubation the fecal pellets in each cup were counted. Copepods were photo-identified for lipid content analysis and frozen at -20°C for genetic examination. The 7th station will be analysed on return to UiT.
Unfortunately, due to the low number of females at each station, egg production could not be determined.

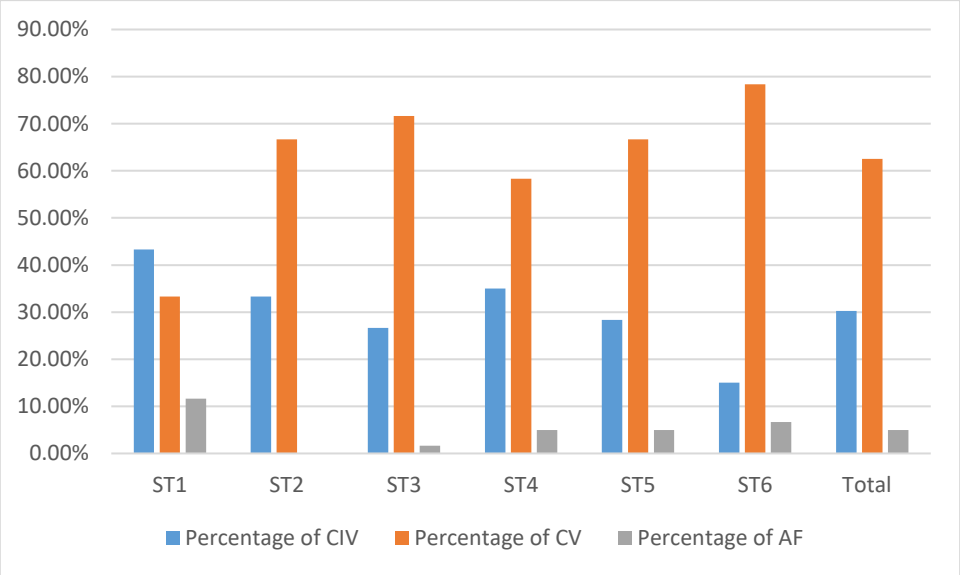


Figure 4.7.1. *Copepods stage picked in the 7 different stations*

Table 4.7.2. *Preliminary Results from the grazing experiment*

	ST1	ST2	ST3	ST4	ST5	ST6	Total
Faecal Pellet Count	37	18	21	17	15	9	117
Number Calanus defecating	13	15	16	12	11	8	75
Percentage of defecation	24,53%	25,00%	26,67%	20,00%	18,33%	13,33%	20,83%

Considering all stations, 22.94% of CIV defecate, 19.11% of CV defecate and 33.33% of Females defecate.

4.8. Macrozooplankton, pelagic fish, and acoustics

Frida Cnossen[1], Einat Sandbank[2], Ingvild Ytterhus Utengen[1], Maxime Geoffroy[2], Paul Renaud[1]
[1]Akvaplan-niva AS, Fram Centre, Tromsø, Norway; [2]Center for Fisheries and Ecosystems Research, Fisheries and Marine Institute of Memorial University of Newfoundland and Labrador, St. John's, Canada

Introduction

Oceanic fronts are defined by steep gradients in physical properties, but it is unresolved how tightly coupled these gradients are to the pelagic community structure across all size ranges and trophic levels. For many biota, the Barents Sea Polar Front represents thermal boundary between warm Atlantic and cold Arctic habitats[1-3] leading to variations in species composition, density, and functional traits (such as size and feeding mode) across the Polar Front. However, the Front does not constitute an absolute boundary as organisms are subjected to advection and mixing across frontal zones. Particularly on small scales, fronts and their biological manifestations can be highly dynamic and drifting organisms can be either concentrated or dispersed by the physical processes occurring at the Front. Higher densities of specific plankton size-fractions have been observed in frontal zones[4-6] with enhanced eddy formation along frontal zones[7] leading to patches of elevated plankton concentrations[6]. The Polar Front has been suggested to be an important feeding area for several fish species[8]. Which species aggregate, where and why they do so, and how this varies seasonally, however, is poorly understood. The main aim of the macrozooplankton, pelagic fish, and acoustics sampling is to define changes in terms of species composition, distribution, abundance and biomass across the Front. We relate this variability to the physical properties of the frontal structure. We also document stomach contents and trophic position of fish to assess how these intermediate predators contribute to the flow of energy across the ecosystem (e.g., wasp-waist control[9]). Finally, we use the acoustic-trawl datasets to better resolve the vertical and spatial distributions of macrozooplankton and pelagic fish.

Tucker Trawl

Macrozooplankton were sampled with a Tucker trawl (1 m^2 opening and 1000 µm mesh size; Figure 4.8.1) towed for 10 minutes at 2 knots at 6 process stations. Ice-cover prevented sampling at two of the main cruise stations. Each station was sampled at one or two depths, with the targeted depth(s) at each station was determined from the epipelagic sound-scattering layers identified in the echogram from the vessel's echosounder. Abundance data from the Tucker trawl samples were analysed per station. The length distribution of krill was measured from subsamples and each taxon/taxonomic group was dried onboard (60°C to constant mass) in pre-weighed dishes for dry weight determination.

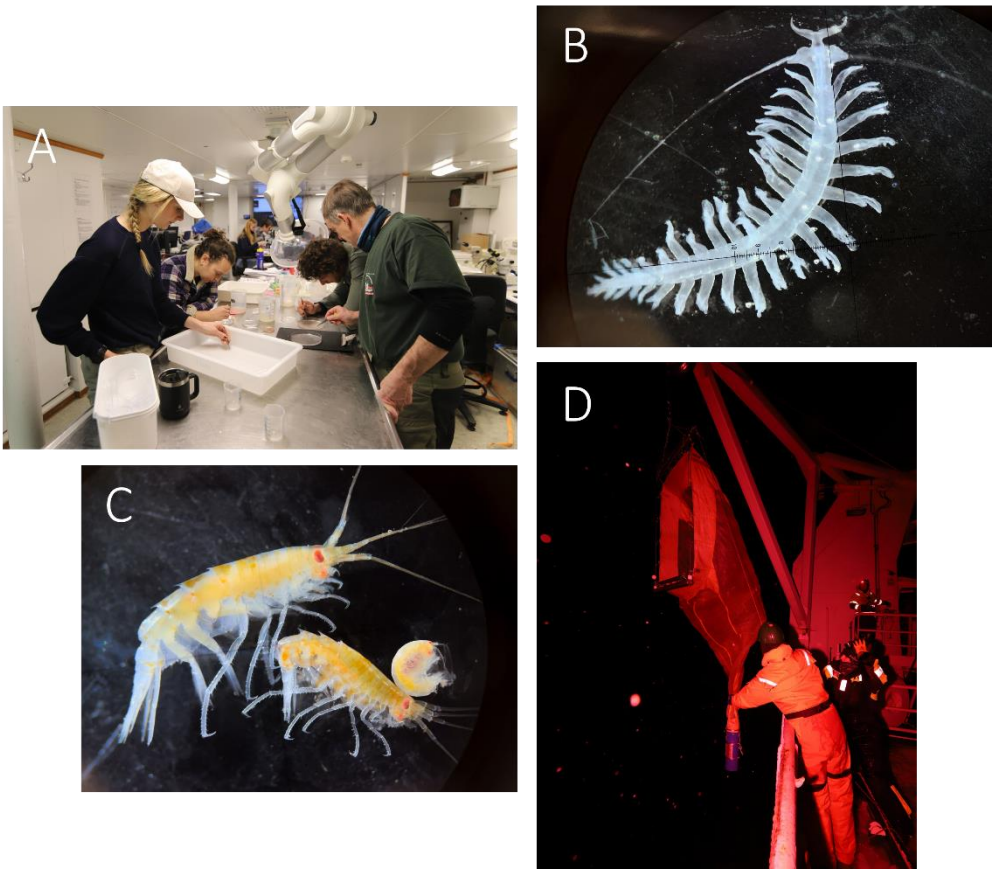


Figure 4.8.1*: Tucker trawl sampling in the dark under red light (D), sorting the catch (A), and two less common species that caught our interest (Tomopteris sp. (B) and Halirages fulvocinctus (C)).*

Harstad Pelagic Trawl

We deployed a Harstad pelagic trawl (Figure 4.8.2) within the sound scattering layer at five stations to ground-truth the acoustic signal and collect fish for stomach content, and stable isotope analysis. The Harstad trawl has an opening of approximately 18 m x 18 m and an effective height of 9-11 m and width of 10-12 m at 3 knots. The mesh size of the inner liner of the cod end is 10 mm. The Harstad trawl was towed at ca. 3 knots for roughly 15 min (20 min at Station J7). All organisms were identified to lowest taxonomic level possible onboard. We recorded the total number and weight of each species. Subsamples of 1-5 species per trawl were measured and weighed to assess the population structure (see 'Stomach contents' section) and to evaluate their acoustic-backscatter potential.

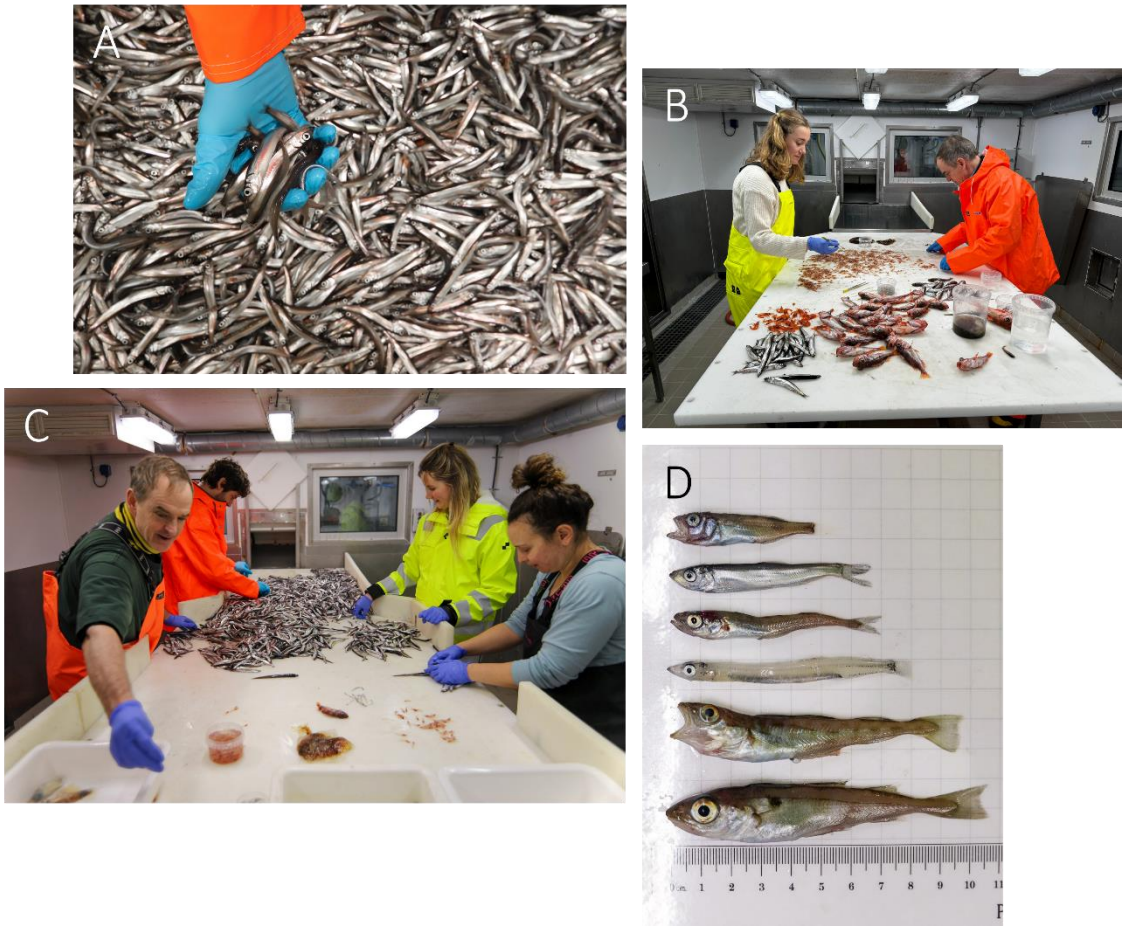


***Figure 4.8.2**: Capelin caught with the pelagic trawl at J4 (A), sorting and taking measurements of the trawl catch (B, C), and species caught at J7 (D).*

Bottom Trawl

A Campelen 1800 shrimp trawl equipped with rockhopper gear was deployed at 3 stations to assess the causes of the near-bottom acoustic signatures as well as collecting fish for population estimation and stomach content analysis (see 'Stomach contents' section). The horizontal opening of the trawl is approximately 17 m wide with a height of 4-5 m and a 22 mm cod-end mesh. Bottom trawls were deployed for 5-10 min.

Stable isotope collection

Some fish and invertebrate samples from both pelagic and bottom trawls were kept for stable isotope analysis (Table 4.8.1). When possible 50 capelin of two size classes were frozen individually for analysis. When catches of *Hyperia galba* amphipod were high they were also frozen for analysis. Small polar cod at select stations were also frozen for possible stable isotope analysis at a later time.

***Table 4.8.1**: Stations trawled where fish and invertebrates were saved for stable isotope analysis.*

Station	***Gear***	***Samples saved for stable isotopes***
J2	Pelagic trawl	Capelin and *H. galba*
J2	Bottom trawl	Capelin
J3	Bottom trawl	Capelin and polar cod
J3	Pelagic trawl	Capelin, polar cod and *H. galba*
J3	Bottom trawl	Capelin and polar cod
J4	Pelagic trawl	Capelin
J6.5	Bottom trawl	Capelin
J7	Pelagic trawl	Capelin

Stomach Contents

Fish caught by the Harstad pelagic trawl will be used for diet and stable isotope analysis. For large catches, subsamples of 20-100 individuals from each abundant species were taken to determine the length distributions of the species. The standard length, height at the anus (up to the nearest 1mm), and weight (up to the nearest 0.1g) were measured for all specimens in the subsample. The fish were then dissected onboard to remove stomachs, preserving the remainder of the fish at -20ºC for processing for stable isotope analysis back on shore. The stomachs were immediately preserved in 70% ethanol. For each individual stomach, the level of fullness (from 0: empty, to 4: full), prey composition (the count and % volume each prey item takes up in the stomach), and the level of digestion for each prey item (from 1: newly eaten, to 5: digested or non-identifiable) were then estimated and recorded.

Hull-mounted EK60

The keel-mounted Simrad EK60® split-beam echosounder continuously recorded hydroacoustic data at 18, 38, and 120 kHz. The ping rate was set to 1.2 seconds and pulse length to 1,024 µs. The echosounder is calibrated annually using the standard sphere method[10]. A Seabird 911 Plus CTD® recorded temperature and conductivity from a water depth of 5-6 m continuously throughout the cruise from which we could derive profiles of temperature and salinity, sound speed[11], and the coefficient of absorption at each frequency[12]. Due to acoustic probe sampling at 38 kHz the boat's hull-mounted 38 kHz transducer was used in passive mode and does not have continuous coverage throughout the cruise. Care was made not to exceed the necessary time the transducer had to be in passive mode.

Table 4.8.2. *Sampling operations conducted by the macrozooplankton, fish, and acoustics team. StNr=cruise station number.*

Date	Time	Station name	Gear	StNr	Speed (knots)	Latitude	Longitude	Trawl depth	Bottom Depth
(UTC)	(UTC)							(m)	(m)
06.01.2024	08:59:24	J1	Tucker Trawl	36	2.2	77 21.9	030 12.7	75	192.27
07.01.2024	10:25:22	J2	Tucker Trawl	62	1.9	75 30.0	029 31.4	150	342.69
07.01.2024	11:04:05	J2	Tucker Trawl	63	2.3	75 31.2	029 32.9	250	340.99
07.01.2024	17:57:00	J2	Pelagic trawl	74	3.3	75 31.0	029 31.4	250	345.46
07.01.2024	21:38:25	J2	Bottom trawl	77	3	75 29.5	029 30.0	345	344.95
08.01.2024	08:30:08	J3	Tucker Trawl	84	2.1	76 11.7	029 28.5	120	276.98
08.01.2024	09:04:29	J3	Tucker Trawl	85	2	76 12.5	029 32.0	220	281.21
08.01.2024	13:25:00	J3	Pelagic trawl	93	3.4	76 12.3	029 31.8	225	283.71
08.01.2024	20:56:00	J3	Bottom trawl	104	3.1	76 12.0	029 30.8	184	284.27
09.01.2024	08:19:39	J4	Tucker Trawl	108	2.1	76 45.0	029 28.8	100	252.83
09.01.2024	08:52:06	J4	Tucker Trawl	109	1.9	76 45.5	029 33.0	220	255.01
09.01.2024	12:55:00	J4	Pelagic trawl	117	2.7	76 45.6	029 34.9	130	256.87
09.01.2024	23:37:04	J6	Pelagic trawl	128	2.5	76 58.8	029 30.1	130	232.02
11.01.2024	16:51:52	J6.5	Tucker Trawl	164	2	76 50.0	029 25.3	140	243.58
11.01.2024	18:25:54	J6.5	Bottom trawl	165	3.2	76 49.3	029 24.3	244	243.76
12.01.2024	18:07:51	J7	Tucker Trawl	188	2.3	76 18.6	028 11.4	60	134.57
12.01.2024	19:07:00	J7	Pelagic trawl	189	3	76 18.5	028 12.0	60	138.78

Preliminary results

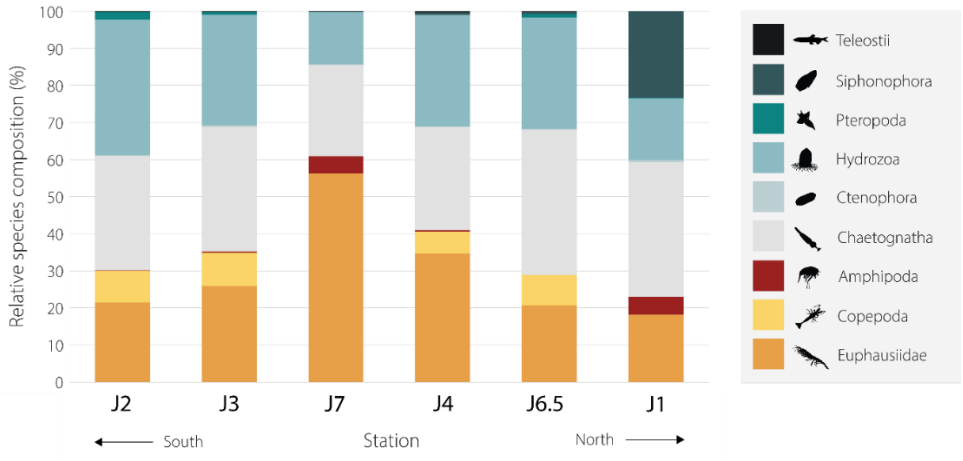


Figure 4.8.3: *relative species composition of the count of macrozooplankton sampled with the Tucker trawl.*

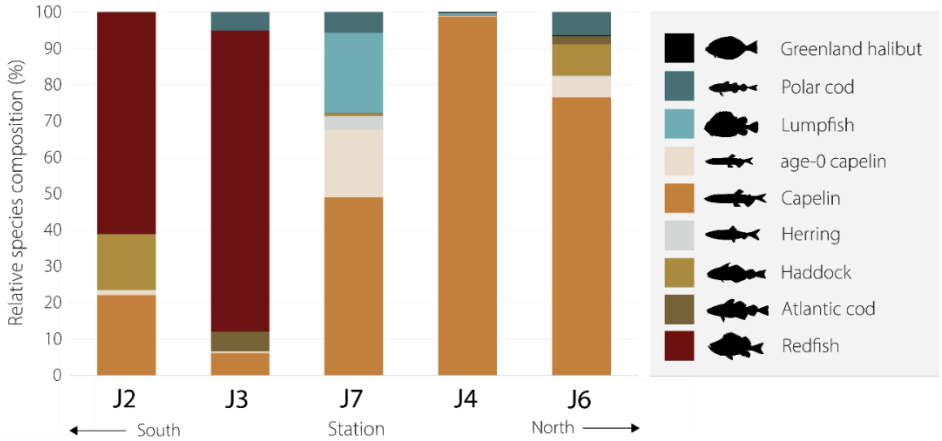


Figure 4.8.4*: relative species composition of the weight of fish sampled with the pelagic trawl.*

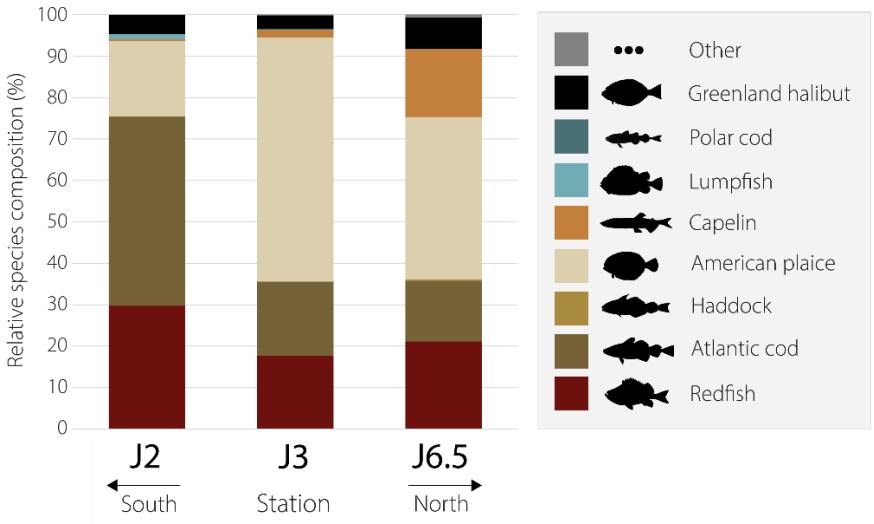


Figure 4.8.5*: relative species composition of the weight of fish sampled with the bottom trawl.*

Strong acoustic backscatter from dense schools of fish was observed under sea ice. These occurred starting at the sea ice margin and can be seen in the acoustic transects (Figure 4.8.6). Due to the ice cover, we were unable to conduct a pelagic trawl to identify the schooling fish. Acoustic analysis of both the hull-mounted EK60 and the WBAT probe were performed to try to identify which species of fish formed these dense schools.

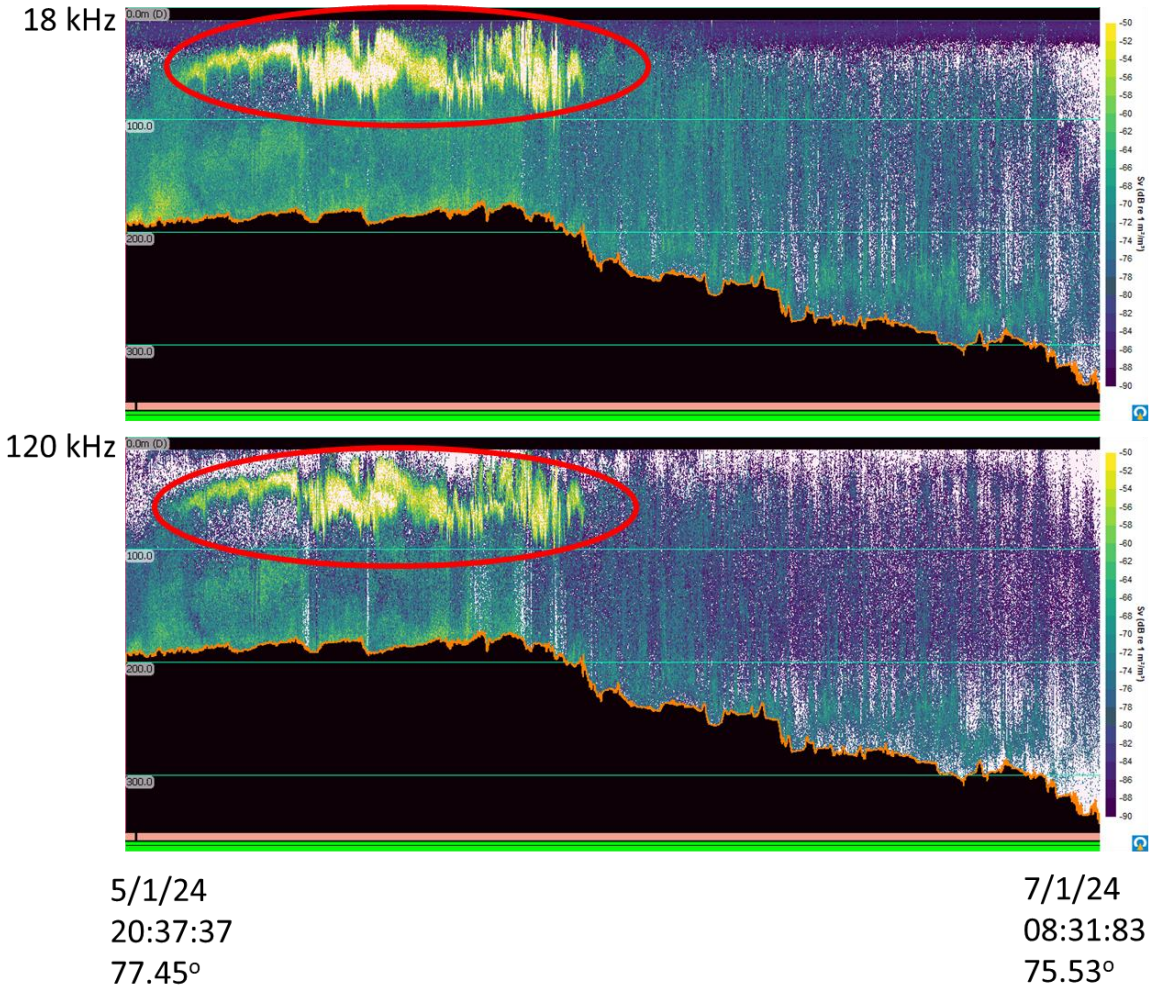


Figure 4.8.6. *EK60 echograms from 5/01/24-7/01/24, from the northernmost site to the southernmost site. The red circles indicate dense schools of fish observed at ice-edge. The echogram from the 38kHz transducer was left out as a large part of the time the transducer was in passive mode to allow for other acoustic sampling at that frequency.*

References

[1]Søreide JE et al. 2003. Mar Ecol Prog Ser 263:43-64
[2]Fossheim M et al. 2006. Mar Biol Res 2:260-269.
[3]Aarflot JM et al. 2018. ICES J Mar Sci 75:2342-2354.
[4]Basedow SL et al. 2010. J Plankton Res 32:1105-1119.
[5]Basedow SL et al. 2014. J Mar Syst 130:147-159.
[6]Trudnowska E et al. 2016. Mar Ecol Prog Ser 560:1-18.
[7]Porter M et al. 2020. Geophys Res Lett 47:e2019GL086281.
[8]Lien VS (ed). 2018. Fisken og Havet 8-2018. 75 pp.
[9]Cury et al. 2000.
[10] Demer, D.A. et al. 2015. Calibration of acoustic instruments. (Report). International Council for the Exploration of the Sea (ICES). https://doi.org/10.25607/OBP-185
[11] Chen, C., Millero, F.J., 1977. The Journal of the Acoustical Society of America 62, 1129–1135.
[12] Francois, R.E., Garrison, G.R., 1982. The Journal of the Acoustical Society of America 72, 1879–1890.

4.9. Response of pelagic organisms to artificial light

On board participants: Malin Daase, Maxime Geoffroy, Einat Sandbank

Objectives:

This year's light experiments are a direct continuation of the field experiments with artificial light conducted during the PNC 2020-2023. The aims of the experiments were twofold: 1) to document behavioural responses of pelagic fish and zooplankton and corresponding changes in acoustic backscatter while 'En Route'; and 2) to test the behavioural response of pelagic fish and zooplankton to different wavelengths (FishDisco). To ground truth the acoustic observations, fish and macrozooplankton samples were taken using pelagic and bottom trawls, as well as a variety of zooplankton nets (Tucker trawl, WP2 etc. see section 4.6 and 4.8). In addition to benefiting the Polar Front project, the artificial light experiments were conducted as part of the Deep Impact project.

Methods:

Objective 1: '**En Route' Light Experimen**t (3-5 January)

From 9PM (UTC) on January 3, 2024 until 3AM (UTC) on January 5, 2024 the ship was transiting northwards and was turning all lights on and off, including the search lights, on the hour. The hull-mounted EK60 echosounder (18, 38, and 120 kHz) was continuously operated. The 'En Route' on and off experiment was repeated on the way back to Tromsø, from 16h00 UTC on January 13th until reaching the coast of Norway.

Objective 2: Test the behavioural response of pelagic fish and zooplankton to different wavelengths (**FishDisco**^{TM})

A Wide Band Autonomous Transceiver (WBAT) connected to two sideward facing split beam transducers (38 kHz and 333 kHz), two custom composite LED lights with 8 different light colours (3 x red at 720 nm/660 nm/620 nm, green at 525 nm, "Aurora", blue at 465 nm, "Bioluminescence", and white), were mounted to the CTD rosette (Fig. 4.9.1). The rosette, with lights off, was then lowered with 0.5-1.0 m s^{-1} into the scattering layer (as identified from the onboard acoustics) where it was then held at constant depth. Then, we switched the lights on for 10 min followed by a period of 10 min darkness without any artificial light before repeating the cycle with a different light colour. The Fish Disco experiments were conducted from 3:35-6:15AM on January 9 and from 21:35-00:15 on January 10-11 (Table 4.9.1). The ship drifted at 0.5 kts on January 9 and 1 kts on January 10.

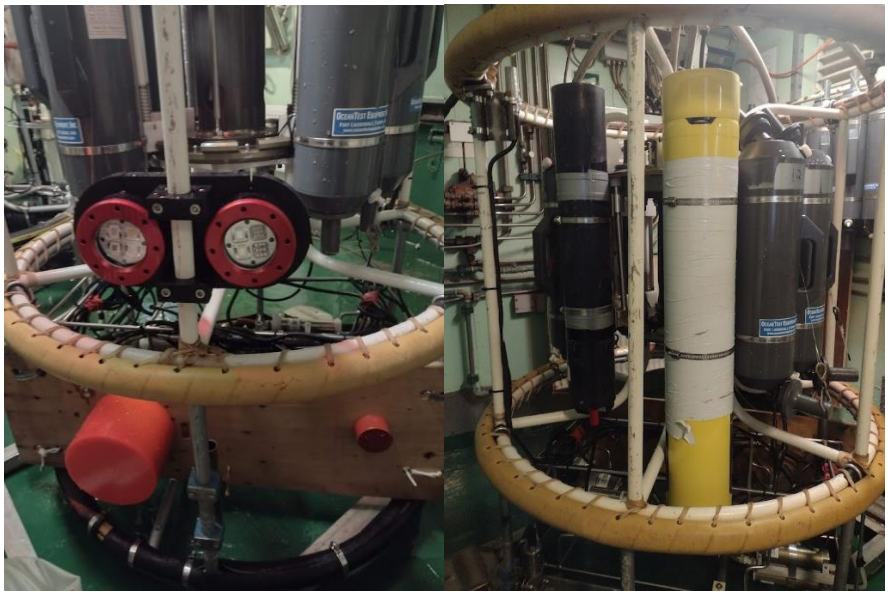


Figure 4.9.1. *Installation of the WBAT and light system (Fish Disco) on the Rosette (Image from previous survey in January 2023.*

Table 4.9.1. *Details of the Fish Disco experiment. Note that the WBAT stopped working after 1 hour during the Fish Disco experiment conducted on January 9*

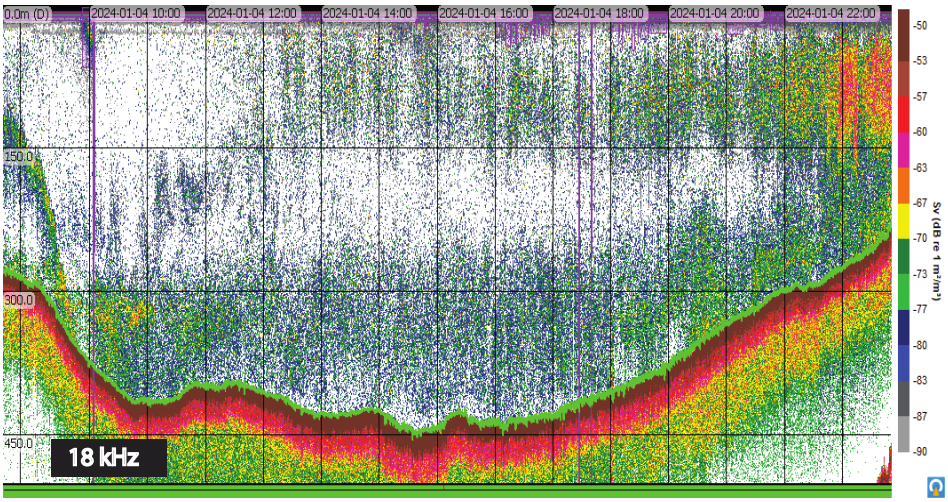
First FishDisco			**Second FishDisco**	
9 January. Polar Front of the Barents Sea			10 January. Polar Front of the Barents Sea	
Stnr 105			Stnr J6	
Start: 03:035 UTC			Start: 01:035 UTC	
03:35-03:45	Red 660		21:35-21:45	Red 660
03:45-03:55	off		21:45-21:55	off
03:55-04:05	Red 720		21:55-22:05	Red 720
04:05-04:15	off		22:05-22:15	off
04:15-04:25	Red 620		22:15-22:25	Red 620
04:25-04:35	off		22:25-22:35	off
04:35-04:45:30	White		22:35-22:45	White
04:45:30-04:55	off		22:45-22:55	off
04:55-05:05	Green		22:55-23:05	Green
05:05:05:15	off		23:05:23:15	off
05:15-05:25	Aurora		23:15-23:25	Aurora
05:25-05:35	off		23:25-23:35	off
05:35-05:45	Blue		23:35-23:45	Blue
05:45-05:55	off		23:45-23:55	off
05:55-06:05	Bioluminescence		23:55-00:05	Bioluminescence
06:05-06:15	off		00:05-00:15	off

Data management:
There is a copy of all acoustic data at UiT and MUN. All acoustic data should be downloaded on the acoustic repository by Daniel Vogedes and/or Tomasz Kopec, UiT.

Preliminary results and future analysis:
Objective 1: document behavioural responses of pelagic fish and zooplankton and corresponding changes in acoustic backscatter while 'En Route'. There was no significant reaction to the lights on the backscatter at 18 and 120 kHz (Fig. 4.9.2). Between 1PM and 10PM on January 4, there was a clear and consistent diminution in backscatter at 120 kHz in the top 100 m when the lights were turned on, and an increase when the lights were turned off (n=10; Fig. 4.9.3). The change in backscatter varied from 105% to 288 %. No reaction was seen below 100m. At the section of the transects where we observed a reaction to light the bottom depth was ca. 400 m, the starting position was (73˚27'N; 25˚15'E), and the end position was (74˚51'N; 26˚25'E). Data were analysed by Maxime Geoffroy will be included in the light avoidance paper led by Tom Langbehn.

Objective 2 test the behavioural response of pelagic fish and zooplankton to different wavelengths (FishDisco). We realised that the WBAT stopped working after 1 hour during the Fish Disco^{TM} experiment conducted on January 9. The experiment conducted on January 10 was completed successfully. Future analyses should thus focus on the January 10 experiment. Data will be analysed by Geoffroy, who will lead the paper based on this experiment.

A)



B)

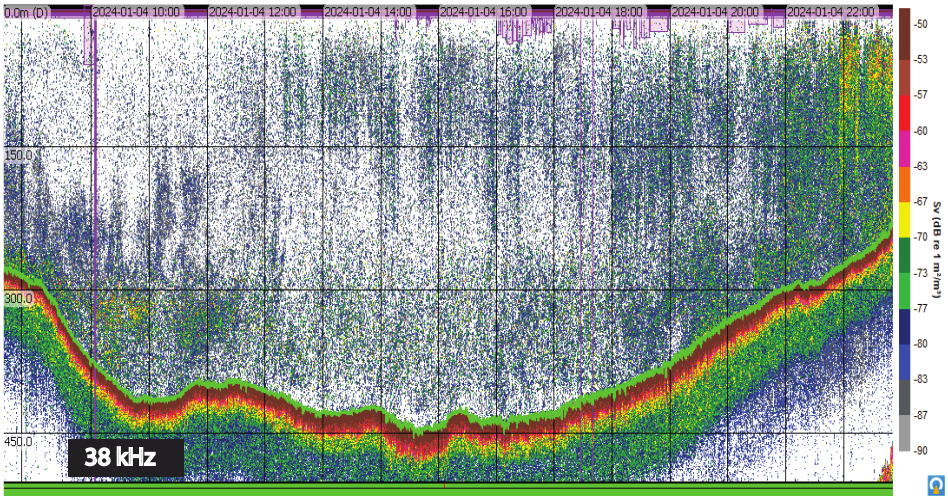


Figure 4.9.2. *Sub-sample of the en route echogram at A) 18 kHz and B) 38 kHz on January 4. Vertical lines are set in 1 h intervals, corresponding to time interval of lights on and off. No clear differences in backscatter between periods of lights on and lights off are visible.*

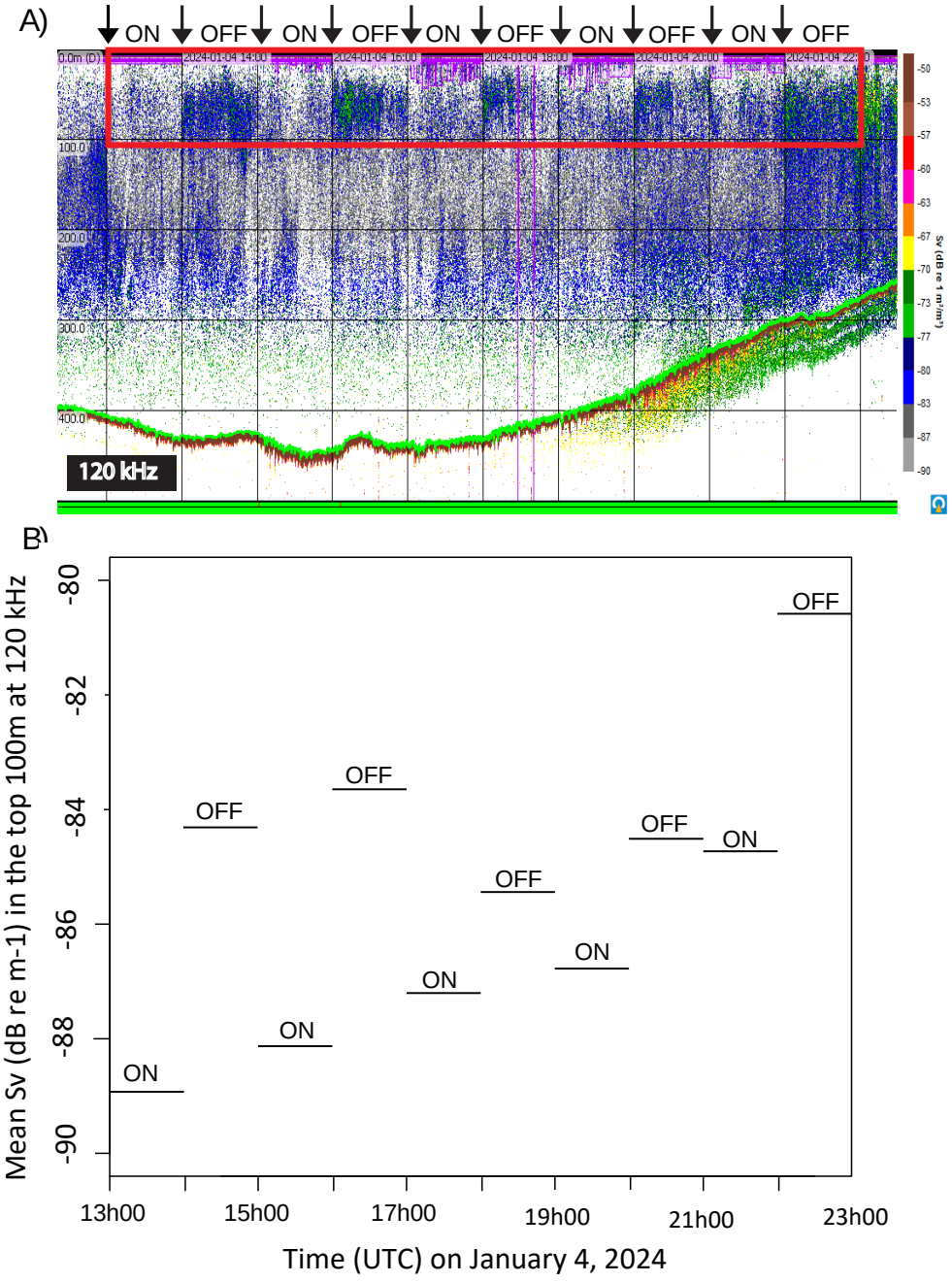


Figure 4.9.3: *A) Sub-sample of the en route echogram at 120 kHz showing the reaction to artificial light in the top 100 m and B) corresponding mean Sv (dB re m^{-1})*

4.10. Global change impacts on overwintering Arctic copepods

Mathieu Lutier, Sophie Albertsen, UiO

Determination of the thermal tolerance threshold of *Metridia longa*

The zooplankton community was sampled north of the polar front at 77.38°N 30.12°E on January 6 2024 from 5:53 to 7:27 UTC using WP2 net over the entire water column (~ 192-0 m). The thermal tolerance threshold of the dominant macrozooplankton species, *Metridia longa*, was then assessed during an 8-day incubation experiment.

Briefly, 100 *M. longa* were randomly collected from the sample and their life stage was assessed by counting the number of segments on the prosoma under a stereoscope. The composition was 70% copepodites V, 26% males and 4% of females. They were then incubated individually in 70 ml culture flasks filled with 50 ml of 1 µm filtered seawater (sampled in situ with the CTD). They were kept in darkness as much as possible and only briefly exposed to red light so as not to disrupt their winter physiology. On January 6, 2024 at 22:00 UTC, the flasks were placed in an incubator, Termaks© kjøleinkubator KB 8182 and stored at -1.6 °C. The temperature was then increased by 2°C on January 7, 2024 at 10:00 UTC, then continuously by 2°C every 12 hours until all copepods died. Survival was assessed every 12 hours by visual inspection and by gently pricking the copepods with a needle. Temperature changes were recorded with a HOBO© TidbiT v2 water temperature data logger. Survival data were then compared to temperature and tipping point, i.e. thermal tolerance threshold, assessed using piecewise linear regression (using the R package segmented v2.0 -1).

The thermal threshold of the overwintering community of *M. longa* is 19.9°C according to our results (Figure 1). This suggests a high tolerance of this species to marine heatwaves which are expected to become more intense, frequent and widespread in the Barents Sea in the near future with climate change. This thermal tolerance threshold will then be compared to other tolerance thresholds evaluated in other seasons (winter vs summer) and for other populations of *M. longa* (Oslofjord) and other copepod species (*Calanus finmarchicus, Calanus glacialis, Calanus hyperboreus*). This will assess local sensitivity and local adaptation to climate change in important copepod species to project how their ranges will evolve with ocean warming impacting the structure of marine ecosystems.

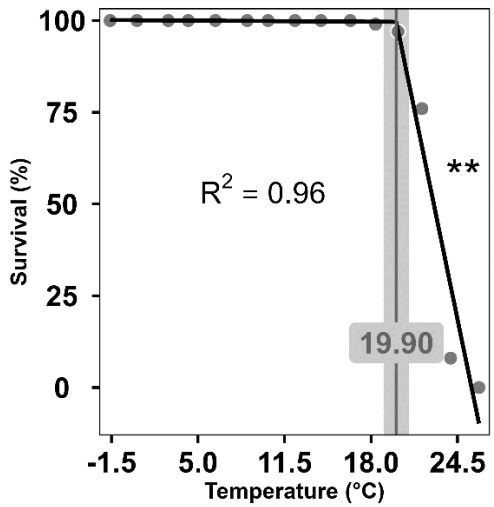


Figure 4.10.1. *Survival of the community of Metridia longa as a function of temperature of exposure. The tipping point and its 95% confidence interval is shown in grey. The significance level of the slopes are presented using symbols (p < 0.001 ***, p < 0.01 **, p < 0.05 *, p < 0.1 .*

Long-term experiments at the university of Oslo

The zooplankton community was sampled at 76.20°N 29.51°E on January 8, 2024 from 18:40 to 21:00 UTC using WP2 net over the entire water column (~ 270-0 m). The sample was then sorted to pick up 1300 female *M. longa* and 360 *C. hyperboreus*, copepodites CIV. These copepods were kept cold (< 0

°C) in the dark in cooling box and flown to the University of Oslo for further experiments from January to April 2024. These experiments will follow the one carried out on board (see previous section) and evaluate how tolerance thresholds to environmental stress (temperature, pH) are impacted in a multi-stress context (copper, temperature).
The first experiment consists of exposing *M. longa* to 15 pH conditions and 2 temperatures. The second involves exposing *C. hyperboreus* to 5 temperature conditions and 2 copper conditions. The same experiment will be carried out on *C. hyperboreus* collected in the Oslofjord to see if there is local adaptation to environmental changes in these genetically isolated populations.

4.11. Video Plankton Recorder

Fredrika Norrbin

Aims

Finding patterns of depth distribution of different taxa of zooplankton and identifying preferences for depth, salinity and temperature of some major groups. Planning to use data together with VPR data from some previous cruises to the Barents Sea (May 2014, August 2016, July 2019) as a deep winter example.

Method

The digital autonomous Video Plankton Recorder (daVPR) consists of an underwater digital video camera with a macro lens and a Xenon strobe synchronized to the frame rate, ca. 20 images s^{-1}. It is also equipped with a Seabird SBE49 CTD and a Wetlabs Ecopuck (fluorometer/turbidimeter). It uses a 24 V Ni-Me-hydride rechargeable battery and stores the data on detachable flash drives. The VPR was deployed using the hydrography winch, towing it vertically at a speed of ca 0.8 m s^{-1}, collecting several profiles from the surface to ca 10 m above the bottom. The camera settings currently used gave image dimensions of ca. 21 x 30 mm (40 ml volume), each pixel representing ca. 22 µm.

Images and environmental data are compressed and written to zip-files, which are processed after download. The program *Autodeck* (Seascan, Inc., USA) is used to extract images of objects (regions of interest; ROIs) from the compressed file. Autodeck bundles the images with the CTD and Ecopuck data. All data, identified by the time of day in milliseconds (UTC), and exact depth, temperature etc., are later interpolated for each ROI image in *Matlab* (Mathworks, Inc.). Training images are selected using the freeware *Irfanview* (I. Skiljan, Austria). These are used to build an automatic classifier for major taxa using the software *Visual Plankton* (provided by C.S. Davis, Woods Hole Oceanographic Institution, USA). Smaller quantities of data with more detailed taxon information can easily be sorted manually, which has been done here. The Polar Front data set was not very big, with few dominant plankton groups and little marine snow.
All image data will have been sorted by the end of the cruise, but abundance values and further calculation will not be finished. It is still possible to get a qualitative idea of which the main groups are.

Main taxa observed: *Calanus* spp and *Metridia longa* were the dominant copepod species in the VPR tows. Among smaller copepods, *Pseudocalanus* spp. were common in the northern locations. Appendicularians of the genus *Oikopleura* were observed at most stations, and their activity was evidenced by numerous shed houses. Ostracods, possibly *Boroecia* sp were also observed in deeper locations. Both *Eukrohnia* and *Parasagitta* chaetognaths occurred at many stations. Among the gelatinous species, either *Aeginopsis* or *Aglantha* dominated among the hydrozoa, and some siphonophores were observed. Small *Mertensia* ctenophores, and numerous cydippid larvae/juveniles were also observed at most stations. Finally, a small type of Rhizaria, resembling the group Medusettidae were observed, especially in the colder locations.

Table 4.11.1. *Sampling details for the VPR tows. Data retrieved during sampling from the information screen, not the station log. The rig was always lowered to 10 m above the bottom, and turned 1-2 m below the surface to avoid waves (bubble formation) and freezing of the CTD.*

Date	Station name	VPR #	Vessel st #	Time start (UTC)	Time finish (UTC)	Lat start	Lon start	Depth bottom (m)	# of legs (U/D)
06.01.2024	J1	1	34	07:00	08:02	77°22.09'	30°07.72'	193-196	8
07.01.2024	J2	2	75	19:06	20:33	75°30.29'	29°30.34'	338-343	6
08.01.2024	J3	3	95	14:56	16:56	76°11.9'	29°29.54'	275-280	11
09.01.2024	J4	4	119	14:29	16:05	76°44.84'	29°30.00'	251-260	9
10.01.2024	J5	5	143	11:56	12:50	77°12.04'	29°33.82'	204	6
10.01.2024	J5	6	146	14:56	16:02	77°11.06'	29°30.08'	202	7
11.01.2024	J6	7	160	11:50	13:20	77°00.42'	29°31.11'	222-232	9
13.01.2024	J8	8	203	02:53	04:08	76°19.23'	29°39.74'	145-151	11

5. Outreach

During the cruise, we published 6 blogs on the projects website
https://akvaplan.no/en/project/polarfront

Science shines in the freezing cold winter Barents Sea (Rolf Gradinger)
https://akvaplan.no/en/blog/2024-01-10/science-shines-in-the-freezing-cold-winter-barents-sea

Science, inspiration, and voyages of discovery (Paul Renaud)
https://akvaplan.no/en/blog/2024-01-12/science-inspiration-and-voyages-of-discovery

Pancakes in the polar night (*Ingvild Ytterhus Utengen and Frida Cnossen)*
https://akvaplan.no/en/blog/2024-01-14/pancakes-in-the-polar-night

Searching for macrozooplankton and fish in the Dark of Night (Maxime Geoffroy, Frida Cnossen, Einat Sandbank, Ingvild Ytterhus Utengen, and Paul Renaud)
https://akvaplan.no/en/blog/2024-01-15/searching-for-macrozooplankton-and-fish-in-the-dark-of-night

Not all zooplankton are copepods... (Fredrika Norrbin)
https://akvaplan.no/en/blog/2024-01-15/not-all-zooplankton-are-copepods

Forskning i polarnatten med "Frankenstein" (Sünnje Basedow)
https://akvaplan.no/en/blog/2024-01-18/forskning-i-polarnatten-med-frankenstein

Yes, January in the Barents Sea can be this calm! (Photo: Malin Daase)

Appendix: Event log

Overview of all sampling events during the PolarFront Cruise January 2024

Note that some groups some named the stations “PF” while others opted to call them “J” (for January). However, the numbers are consistent between groups. i.e. stations with the same number are the same (e.g. PF1 and J1 are the same station).

Event #	Station	Lat °N	Long°E	Bottom depth (m)	Sampling date (UTC)	Sampling time UTC (start)	Gear	Sampling depth (m)		Sample type	Sample staff	Preservation method
								from	to			
2		71.37	22.24	356	04.01.2024	00:59	Lights on					
3		71.68	22.80	394	04.01.2024	03:00	Lights on					
4		72.00	23.39	297	04.01.2024	05:00	Lights on					
5		72.31	23.98	265	04.01.2024	07:00	Lights on					
6		72.63	24.58	288	04.01.2024	09:00	Lights on					
7		72.95	24.85	420	04.01.2024	11:00	Lights on					
8		73.30	25.13	413	04.01.2024	13:00	Lights on					
9		73.63	25.40	434	04.01.2024	15:00	Lights on					
10		73.95	25.66	441	04.01.2024	16:59	Lights on					
11		74.24	25.90	414	04.01.2024	19:00	Lights on					
12		74.55	26.16	342	04.01.2024	21:00	Lights on					
13		74.89	26.46	284	04.01.2024	23:00	Lights on					
14		75.18	26.71	218	05.01.2024	01:00	Lights on					
15		75.45	26.96	217	05.01.2024	03:00	Lights on					
16	PF1	77.44	30.00	202	05.01.2024	21:05	CTD with water			filtration	Anna	
17	PF1	77.43	30.00	203	05.01.2024	21:30	CTD with water			filtration	Anna	
18	PF1	77.43	30.00	198	05.01.2024	21:49	FRRF				Rolf	
19	PF1	77.42	30.01	202	05.01.2024	22:00	Phytoplankton net			community	Rolf	
20	PF1	77.42	30.01	198	05.01.2024	22:36	Multinet	183	100	community	Malin	4%formalin
20	PF1	77.42	30.01	198	05.01.2024	22:36	Multinet	100	50	community	Malin	4%formalin
20	PF1	77.42	30.01	198	05.01.2024	22:36	Multinet	50	20	community	Malin	4%formalin
20	PF1	77.42	30.01	198	05.01.2024	22:36	Multinet	20	0	community	Malin	4%formalin
21	PF1	77.41	30.02	200	05.01.2024	23:10	CTD with water			filtration	Anna	
22	PF1	77.39	30.03	194	06.01.2024	00:02	WP2 180µ	185	0	Biomass	Malin	dry weight, 1000 &180µ
23	PF1	77.39	30.03	195	06.01.2024	00:19	WP2 180µ	185	100	lipids	Malin	pictures, rest in ethanol
24	PF1	77.38	30.04	199	06.01.2024	00:39	WP2 180µ	50	0	lipids	Malin	pictures, rest in ethanol
25	PF1	77.37	30.04	199	06.01.2024	01:06	Frankenstein				Sünnje	
26	PF1	77.36	30.05	193	06.01.2024	01:47	WP2 180µ	fail				
27	PF1	77.36	30.15	193	06.01.2024	03:59	Frankenstein				Sünnje	
28	PF1	77.36	30.16	193	06.01.2024	04:16	WP2 180µ			incubations	Florence/Lorenz	live
29	PF1	77.35	30.16	192	06.01.2024	04:38	WP2 180µ			incubations	Florence/Lorenz	live
30	PF1	77.35	30.16	191	06.01.2024	05:14	WP2 180µ			experiments	Mathieu	live
31	PF1	77.38	30.12	201	06.01.2024	05:49	WP2 180µ			experiments	Mathieu	live

32	PF1	77.38	30.12	200	06.01.2024	06:09	WP2 180µ			experiments	Mathieu	live
33	PF1	77.37	30.13	197	06.01.2024	06:27	WP2 180µ			experiments	Mathieu	live
34	PF1	77.37	30.13	194	06.01.2024	06:57	VPR			community	Freddy	
35	PF1	77.36	30.15	188	06.01.2024	08:18	VanVeen Grab				Rolf	
36	PF1	77.36	30.21	192	06.01.2024	08:59	Tucker Trawl	75		community	Frida	dry weight
37	S1_2	77.28	30.16	190	06.01.2024	10:28	Frankenstein				Sünnje	
38	S1_3	77.19	30.16	194	06.01.2024	11:57	Frankenstein				Sünnje	
39	S1_4	77.11	30.16	211	06.01.2024	13:14	Frankenstein				Sünnje	
40		77.03	30.16	235	06.01.2024	14:32	Frankenstein				Sünnje	
41		76.95	30.16	250	06.01.2024	15:40	Frankenstein				Sünnje	
42		76.86	30.16	266	06.01.2024	18:34	Frankenstein				Sünnje	
43		76.78	30.11	257	06.01.2024	19:35	Frankenstein				Sünnje	
44		76.69	30.07	261	06.01.2024	20:38	Frankenstein				Sünnje	
45		76.61	30.03	290	06.01.2024	21:33	Frankenstein				Sünnje	
46		76.53	29.99	287	06.01.2024	22:33	Frankenstein				Sünnje	
47		76.45	29.95	291	06.01.2024	23:30	Frankenstein				Sünnje	
48		76.36	29.91	287	07.01.2024	00:26	Frankenstein				Sünnje	
49		76.27	29.87	292	07.01.2024	01:23	Frankenstein				Sünnje	
50		76.19	29.83	300	07.01.2024	02:16	Frankenstein				Sünnje	
51		76.10	29.79	310	07.01.2024	03:07	Frankenstein				Sünnje	
52		76.02	29.74	310	07.01.2024	04:01	Frankenstein				Sünnje	
53		75.93	29.71	308	07.01.2024	04:52	Frankenstein				Sünnje	
54		75.85	29.67	305	07.01.2024	05:44	Frankenstein				Sünnje	
55		75.76	29.63	310	07.01.2024	06:37	Frankenstein				Sünnje	
56		75.67	29.59	329	07.01.2024	07:27	Frankenstein				Sünnje	
57		75.59	29.55	346	07.01.2024	08:19	Frankenstein				Sünnje	
58	PF_J2	75.50	29.50	337	07.01.2024	09:16	CTD with water				Anna	
59	PF_J2	75.50	29.50	339	07.01.2024	09:40	FRRF				Rolf	
60	PF_J2	75.50	29.51	341	07.01.2024	09:49	Phytoplankton net			community	Rolf	
61	PF_J2	75.50	29.51	344	07.01.2024	09:56	Phytoplankton net			community	Rolf	
62	PF_J2	75.50	29.52	343	07.01.2024	10:25	Tucker Trawl	150			Einat	dry weight
63	PF_J2	75.52	29.55	341	07.01.2024	11:04	Tucker Trawl	250			Einat	dry weight
64	PF_J2	75.50	29.50	339	07.01.2024	11:58	CTD with water	fail				
65	PF_J2	75.50	29.50	335	07.01.2024	12:14	CTD with water			filtration	Anna	
66	PF_J2	75.50	29.49	335	07.01.2024	12:51	Multinet	318	200	community	Malin	4%formalin
66	PF_J2	75.50	29.49	335	07.01.2024	12:51	Multinet	200	100	community	Malin	4%formalin
66	PF_J2	75.50	29.49	335	07.01.2024	12:51	Multinet	100	50	community	Malin	4%formalin
66	PF_J2	75.50	29.49	335	07.01.2024	12:51	Multinet	50	20	community	Malin	4%formalin
66	PF_J2	75.50	29.49	335	07.01.2024	12:51	Multinet	20	0	community	Malin	4%formalin
67	PF_J2	75.50	29.50	338	07.01.2024	13:34	WP2 180µ	325	0	Biomass	Malin	dry weight, 1000 &180µ
68	PF_J2	75.50	29.49	336	07.01.2024	14:04	WP2 180µ	325	200	lipids	Malin	pictures, rest in ethanol
69	PF_J2	75.50	29.48	341	07.01.2024	14:36	WP2 180µ	fail				
70	PF_J2	75.50	29.48	341	07.01.2024	14:44	WP2 180µ	50	0	lipids	Malin	pictures, rest in ethanol

71	PF_J2	75.50	29.51	344	07.01.2024	15:04	WP2 180µ	325	0	FPR	Florence/Lorenz	incubations
72	PF_J2	75.50	29.50	339	07.01.2024	15:36	WP2 180µ	325	0	FPR	Florence/Lorenz	incubations
73	PF_J2	75.50	29.49	338	07.01.2024	16:20	Frankenstein				Sünnje	
74	PF_J2	75.52	29.52	345	07.01.2024	17:57	Pelagic Trawl	250		community	Frida	
75	PF_J2	75.51	29.51	343	07.01.2024	19:06	VPR			community	Freddy	
76	PF_J2	75.49	29.47	340	07.01.2024	20:44	VanVeen Grab			resting spores	Rolf	
77	PF_J2	75.49	29.50	345	07.01.2024	21:38	Bottom trawl			community	Max	
78	PF_J2.5	75.85	29.50	291	08.01.2024	00:14	Frankenstein				Sünnje	
79	PF_J2.5	75.85	29.49	295	08.01.2024	00:34	WP2 180µ	80	0	community	Sünnje	4%formalin
80	PF_J2.5	75.85	29.50	293	08.01.2024	00:43	WP2 180µ	80	0	community	Sünnje	pictures, rest in ethanol
81	PF_J3	76.20	29.50	280	08.01.2024	07:32	CTD with water			filtration	Anna	
82	PF_J3	76.20	29.50	281	08.01.2024	07:49	FRRF				FRRF	
83	PF_J3	76.20	29.50	281	08.01.2024	07:58	Phytoplankton net			community	Phytoplankton	
84	PF_J3	76.19	29.47	277	08.01.2024	08:30	Tucker Trawl	120		community	Einat	dry weight
85	PF_J3	76.21	29.53	281	08.01.2024	09:04	Tucker Trawl	220		community	Einat	dry weight
86	PF_J3	76.20	29.50	282	08.01.2024	09:49	CTD with water			filtration	Anna	
87	PF_J3	76.20	29.50	282	08.01.2024	10:06	Multinet	260	200	community	Malin	4%formalin
87	PF_J3	76.20	29.50	282	08.01.2024	10:06	Multinet	200	100	community	Malin	4%formalin
87	PF_J3	76.20	29.50	282	08.01.2024	10:06	Multinet	100	50	community	Malin	4%formalin
87	PF_J3	76.20	29.50	282	08.01.2024	10:06	Multinet	50	20	community	Malin	4%formalin
87	PF_J3	76.20	29.50	282	08.01.2024	10:06	Multinet	20	0	community	Malin	4%formalin
88	PF_J3	76.20	29.49	280	08.01.2024	10:44	WP2 180µ	270	0	Biomass	Malin	dry weight, 1000 &180µ
89	PF_J3	76.20	29.49	279	08.01.2024	11:05	WP2 180µ	270	0	lipids	Malin	pictures, rest in ethanol
90	PF_J3	76.20	29.50	278	08.01.2024	11:26	WP2 180µ	50	0	lipids	Malin	pictures, rest in ethanol
91	PF_J3	76.21	29.50	278	08.01.2024	11:33	WP2 180µ	270	0	FPR	Sünnje	incubations
92	PF_J3	76.20	29.50	285	08.01.2024	12:05	Frankenstein				Sünnje	
93	PF_J3	76.20	29.53	284	08.01.2024	13:25	Pelagic Trawl	225		community	Frida	
94	PF_J3	76.20	29.51	281	08.01.2024	14:23	FRRF				FRRF	
95	PF_J3	76.20	29.49	281	08.01.2024	14:56	VPR			community	Freddy	
96	PF_J3	76.20	29.51	283	08.01.2024	17:15	WP2 180µ	260	0		Mathieu	incubations
97	PF_J3	76.20	29.49	279	08.01.2024	17:51	WP2 180µ	260	0		Mathieu	incubations
98	PF_J3	76.20	29.47	279	08.01.2024	18:16	WP2 180µ	260	0		Mathieu	incubations
99	PF_J3	76.20	29.46	275	08.01.2024	18:39	WP2 180µ	260	0		Mathieu	incubations
100	PF_J3	76.20	29.45	273	08.01.2024	19:00	WP2 180µ	260	0		Mathieu	incubations
101	PF_J3	76.20	29.44	271	08.01.2024	19:22	WP2 180µ	260	0		Mathieu	incubations
102	PF_J3	76.20	29.43	270	08.01.2024	19:45	WP2 180µ	260	0		Mathieu	incubations
103	PF_J3	76.20	29.43	266	08.01.2024	20:05	WP2 180µ				Mathieu	incubations
104	PF_J4	76.20	29.51	284	08.01.2024	20:56	Bottom trawl			community	Max	
105	PF_J4	76.75	29.55	255	09.01.2024	03:28	FishDisco				Max	
106	PF_J4	76.75	29.50	252	09.01.2024	07:30	CTD with water			filtration	Anna	
107	PF_J4	76.75	29.49	253	09.01.2024	07:48	Phytoplankton net			community	Rolf	
108	PF_J4	76.75	29.48	253	09.01.2024	08:19	Tucker trawl	110		community	Einat	

109	PF_J4	76.76	29.55	255	09.01.2024	08:52	Tucker trawl	220		community	Einat	dry weight
110	PF_J4	76.75	29.51	254	09.01.2024	09:41	FRRF				Rolf	
111	PF_J4	76.75	29.50	252	09.01.2024	10:00	CTD with water			filtration	Anna	
112	PF_J4	76.75	29.49	254	09.01.2024	10:18	Multinet	225	200	community	Malin	4%formalin
112	PF_J4	76.75	29.49	254	09.01.2024	10:18	Multinet	200	100	community	Malin	4%formalin
112	PF_J4	76.75	29.49	254	09.01.2024	10:18	Multinet	100	50	community	Malin	4%formalin
112	PF_J4	76.75	29.49	254	09.01.2024	10:18	Multinet	50	20	community	Malin	4%formalin
112	PF_J4	76.75	29.49	254	09.01.2024	10:18	Multinet	20	0	community	Malin	4%formalin
113	PF_J4	76.75	29.53	255	09.01.2024	10:56	WP2 180µ	245	0	Biomass	Malin	dry weight, 1000 &180µ
114	PF_J4	76.75	29.52	253	09.01.2024	11:15	WP2 180µ	245	150	lipids	Malin	pictures, rest in ethanol
115	PF_J4	76.75	29.51	254	09.01.2024	11:35	WP2 180µ	50	0	lipids	Malin	pictures, rest in ethanol
116	PF_J4	76.75	29.50	253	09.01.2024	11:48	Frankenstein				Sünnje	incubations
117	PF_J4	76.76	29.58	257	09.01.2024	12:55	Pelagic Trawl	130		community	Frida	
118	PF_J4	76.75	29.51	254	09.01.2024	13:53	WP2 180µ	245	0	incubations	Florence/Lorenz	
119	PF_J4	76.75	29.50	252	09.01.2024	14:29	VPR			community	Freddy	
120	PF_J4	76.75	29.50	253	09.01.2024	16:45	VanVeen Grab				Rolf	
121	S2_1	76.79	29.50	263	09.01.2024	17:35	Frankenstein				Sünnje	
122	S2_1	76.79	29.50	262	09.01.2024	19:12	Frankenstein				Sünnje	
123	S2_2	76.83	29.50	250	09.01.2024	19:53	Frankenstein				Sünnje	
124	S2_3	76.87	29.50	247	09.01.2024	20:35	Frankenstein				Sünnje	
125	S2_4	76.92	29.51	260	09.01.2024	21:19	Frankenstein				Sünnje	
126	S2_5	76.96	29.50	241	09.01.2024	21:58	Frankenstein				Sünnje	
127		77.00	29.50	230	09.01.2024	22:37	Frankenstein				Sünnje	
128	PF6	76.98	29.50	232	09.01.2024	23:37	Pelagic Trawl	130			Frida	
129	S2_7	77.04	29.52	225	10.01.2024	00:58	Frankenstein				Sünnje	
130	S2_8	77.08	29.47	212	10.01.2024	01:51	Frankenstein				Sünnje	
131	S2_9	77.13	29.49	208	10.01.2024	02:47	Frankenstein				Sünnje	
132	S2_10	77.16	29.49	207	10.01.2024	03:40	Frankenstein				Sünnje	
133	PF_J5	77.20	29.49	201	10.01.2024	04:51	Frankenstein				Sünnje	
134	PF_J5	77.21	29.52	201	10.01.2024	07:48	CTD with water			filtration	Anna	
135	PF_J5	77.21	29.51	200	10.01.2024	08:08	FRRF				FRRF	
136	PF_J5	77.20	29.50	199	10.01.2024	08:26	Phytoplankton net			community	Phytoplankto	
137	PF_J5	77.20	29.48	200	10.01.2024	08:52	Multinet	170	100	community	Malin	4%formalin
137	PF_J5	77.20	29.48	200	10.01.2024	08:52	Multinet	100	50	community	Malin	4%formalin
137	PF_J5	77.20	29.48	200	10.01.2024	08:52	Multinet	50	20	community	Malin	4%formalin
137	PF_J5	77.20	29.48	200	10.01.2024	08:52	Multinet	20	0	community	Malin	4%formalin
138	PF_J5	77.20	29.46	198	10.01.2024	09:24	CTD with water			filtration	Anna	
139	PF_J5	77.20	29.45	199	10.01.2024	10:03	WP2 180µ	190	0	Biomass	Malin	dry weight, 1000 &180µ
140	PF_J5	77.20	29.44	200	10.01.2024	10:21	WP2 180µ	190	150	lipids	Malin	pictures, rest in ethanol
141	PF_J5	77.20	29.43	200	10.01.2024	10:36	WP2 180µ	190	150	community	Malin	4% formalin
142	PF_J5	77.20	29.43	201	10.01.2024	10:54	WP2 180µ	50	0	lipids	Malin	pictures, rest in ethanol
143	PF_J5	77.20	29.56	202	10.01.2024	11:55	VPR			community	Freddy	
144	PF_J5	77.19	29.52	202	10.01.2024	14:03	WP2 180µ	190	0	incubations	Florence/Lorenz	

145	PF_J5	77.19	29.51	201	10.01.2024	14:26	WP2 180µ	190	0	incubations	Florence/Lorenz	
146	PF_J5	77.18	29.50	202	10.01.2024	14:56	VPR			community	Freddy	
147	PF_J5	77.18	29.48	205	10.01.2024	16:11	Frankenstein				Sünnje	
148	PF_J5	77.17	29.47	207	10.01.2024	16:47	VanVeen Grab				Rolf	
149		77.09	29.49	208	10.01.2024	18:11	Frankenstein				Einat	WBAT
150	PF_J6	77.00	29.49	230	10.01.2024	20:51	FishDisco				Max	Fish Disco
151	PF_J6	77.01	29.46	230	11.01.2024	07:30	CTD with water			filtration	Anna	
152	PF_J6	77.01	29.45	230	11.01.2024	07:49	FRRF				Rolf	FRRF
153	PF_J6	77.00	29.44	234	11.01.2024	08:07	Phytoplankton net			community	Rolf	Phytoplankton
154	PF_J6	77.00	29.43	233	11.01.2024	08:30	Multinet	218	200	community	Malin	4%formalin
154	PF_J6	77.00	29.43	233	11.01.2024	08:30	Multinet	200	100	community	Malin	4%formalin
154	PF_J6	77.00	29.43	233	11.01.2024	08:30	Multinet	100	50	community	Malin	4%formalin
154	PF_J6	77.00	29.43	233	11.01.2024	08:30	Multinet	50	20	community	Malin	4%formalin
154	PF_J6	77.00	29.43	233	11.01.2024	08:30	Multinet	20	0	community	Malin	4%formalin
155	PF_J6	77.00	29.41	233	11.01.2024	09:22	CTD with water			filtration	Anna	
156	PF_J6	77.00	29.41	232	11.01.2024	09:33	WP2 180µ	225	0	Biomass	Malin	dry weight, 1000 &180µ
157	PF_J6	76.99	29.41	237	11.01.2024	09:51	WP2 180µ	225	150	lipids	Malin	pictures, rest in ethanol
158	PF_J6	76.99	29.40	235	11.01.2024	10:09	WP2 180µ	50	0	lipids	Malin	pictures, rest in ethanol
159	PF_J6	76.99	29.40	237	11.01.2024	10:27	FRRF				Rolf	FRRF
160	PF_J6	77.01	29.54	232	11.01.2024	11:38	VPR			community	Freddy	
161	PF_J6	76.99	29.55	231	11.01.2024	13:51	WP2 180µ	225	0		Sünnje	incubations
162	PF_J6	76.98	29.56	233	11.01.2024	14:40	Frankenstein				Sünnje	
163	PF_J6	76.97	29.56	232	11.01.2024	15:10	VanVeen Grab				Rolf	
164	PF6.5	76.83	29.42	244	11.01.2024	16:51	Tucker Trawl	150		community	Einat	dry weight
165	PF6.5	76.82	29.40	244	11.01.2024	18:25	Bottom trawl			community	Max	
166	PF6_T1	77.00	29.48	233	11.01.2024	20:32	Frankenstein				Sünnje	
167	PF6_T2	76.99	29.46	237	11.01.2024	21:16	Frankenstein				Sünnje	
168	PF6_T3	77.01	29.55	230	11.01.2024	22:01	Frankenstein				Sünnje	
169	PF6_T4	77.00	29.54	229	11.01.2024	22:45	Frankenstein				Sünnje	
170	PF6_T5	77.01	29.50	233	11.01.2024	23:30	Frankenstein				Sünnje	
171	PF6_T6	77.00	29.50	234	12.01.2024	00:15	Frankenstein				Sünnje	
172	PF6_T7	77.01	29.50	229	12.01.2024	00:58	Frankenstein				Sünnje	
173	PF6_T8	77.00	29.51	231	12.01.2024	01:42	Frankenstein				Sünnje	
174	PF6_T9	77.00	29.51	232	12.01.2024	02:29	Frankenstein				Sünnje	
175	PF6_T10	76.99	29.52	236	12.01.2024	03:14	Frankenstein				Sünnje	
176	PF6_T11	77.01	29.51	230	12.01.2024	03:59	Frankenstein				Sünnje	
177	PF6_T12	76.99	29.51	231	12.01.2024	04:45	Frankenstein				Sünnje	
178	PF6_T13	77.00	29.51	231	12.01.2024	05:27	Frankenstein				Sünnje	
179	PF6_T14	76.99	29.50	236	12.01.2024	06:12	Frankenstein				Sünnje	
180	PF6_T15	76.99	28.74	224	12.01.2024	08:21	Frankenstein				Sünnje	
181	PF6_T16	76.91	28.43	147	12.01.2024	09:58	Frankenstein				Sünnje	
182	PF6_T17	76.74	28.48	149	12.01.2024	11:28	Frankenstein				Sünnje	
183	PF6_T18	76.59	28.44	153	12.01.2024	12:46	Frankenstein				Sünnje	

184	PF6_T19	76.57	27.82	147	12.01.2024	14:14	Frankenstein				Sünnje	
185	PF6_T20	76.45	27.44	123	12.01.2024	15:37	Frankenstein				Sünnje	
186	PF6_T21	76.32	28.19	137	12.01.2024	17:26	CTD with water					
187	PF7	76.32	28.18	136	12.01.2024	17:40	Frankenstein				Sünnje	
188	PF7	76.31	28.19	135	12.01.2024	18:07	Tucker Trawl	60		community	Einat	dry weight
189	PF7	76.31	28.20	139	12.01.2024	19:07	Pelagic Trawl	60		community	Frida	
190	PF8	76.34	26.68	133	12.01.2024	22:07	CTD with water			filtration	Anna	
191	PF8	76.33	26.66	139	12.01.2024	22:18	FRRF				Rolf	
192	PF8	76.33	26.64	145	12.01.2024	22:40	Phytoplankton net			community	Rolf	
193	PF8	76.32	26.63	149	12.01.2024	22:54	WP2 180µ	139	100	community	Malin	4%formalin
194	PF8	76.32	26.61	148	12.01.2024	23:09	WP2 180µ	100	50	community	Malin	4%formalin
195	PF8	76.31	26.60	146	12.01.2024	23:21	WP2 180µ	50	0	community	Malin	4%formalin
196	PF8	76.31	26.59	145	12.01.2024	23:34	WP2 180µ	140	0	Biomass	Malin	dry weight, 1000 &180µ
197	PF8	76.31	26.59	147	12.01.2024	23:42	WP2 180µ	140	100	lipids	Malin	pictures, rest in ethanol
198	PF8	76.30	26.57	154	12.01.2024	23:55	WP2 180µ	50	0	lipids	Malin	pictures, rest in ethanol
199	PF8	76.30	26.57	154	13.01.2024	00:03	WP2 180µ	140	0	incubations	Florence/Lorenz	
200	PF8	76.30	26.56	156	13.01.2024	00:20	CTD					
201	PF8	76.34	26.67	131	13.01.2024	01:49	CTD with water			filtration	Anna	
202	PF8	76.33	26.67	138	13.01.2024	02:03	Frankenstein				Sünnje	
203		76.32	26.66	146	13.01.2024	02:53	VPR			community	Freddy	
204		76.06	26.88	205	13.01.2024	07:08	Frankenstein				Einat	
205		74.76	25.29	236	13.01.2024	17:00	Lights on					
206		74.45	24.91	314	13.01.2024	19:02	Lights on					
207		74.15	24.55	442	13.01.2024	21:00	Lights on					
208		73.85	24.19	448	13.01.2024	23:00	Lights on					
209		73.55	23.85	445	14.01.2024	01:00	Lights on					
210		73.26	23.51	398	14.01.2024	03:00	Lights on					
211		72.97	23.18	391	14.01.2024	05:00	Lights on					
212		72.67	22.85	385	14.01.2024	07:00	Lights on					
213		72.36	22.52	315	14.01.2024	09:00	Lights on					
214		72.06	22.19	374	14.01.2024	11:00	Lights on					
215		71.76	21.88	362	14.01.2024	13:00	Lights on					
216		71.46	21.57	360	14.01.2024	15:00	Lights on					
217		71.17	21.27	207	14.01.2024	17:00	Lights on					