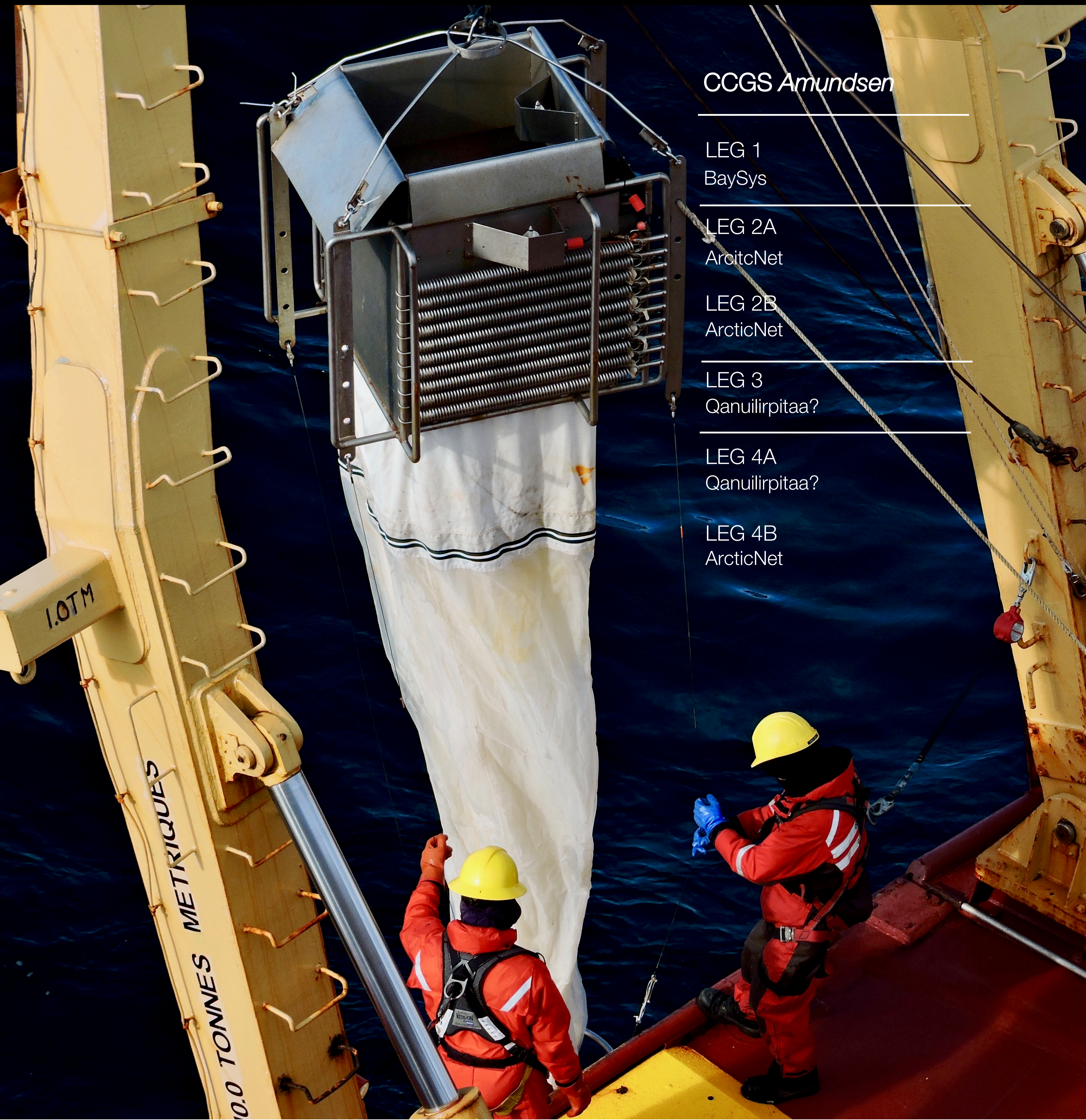
AMUNDSEN
SCIENCE

2017 | Expedition Report



CCGS Amundsen

LEG 1
BaySys

LEG 2A
ArcitcNet

LEG 2B
ArcticNet

LEG 3
Qanuilirpitaa?

LEG 4A
Qanuilirpitaa?

LEG 4B
ArcticNet

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Table of Content

List of Figures

List of Tables

Part II – Project reports

2017 Expedition Report

The 2017 Expedition Report is a collection of all the participating research teams' Cruise Reports assembled by the Chief Scientists at the end of the Leg 1, Leg 2, Leg 3 and Leg 4 of the CCGS *Amundsen* Expedition. The 2017 Expedition Report is divided into two parts:

Part I gives an overview of the expedition, shows the cruise track and the stations visited and provides a synopsis of operations conducted during each of the four legs.

Part II contains the reports submitted by participating science teams or researchers, with details on the specific objectives of their project, the field operations conducted and methodology used, and in some cases, preliminary results. When results are presented, they show the data as they were submitted at the end of the legs in 2017. The data presented in this report are illustrative only and have not been quality checked, thus parties interested in the results should contact the project leader or the researchers who collected the data.

The sections in Part II describing each project are organized with atmospheric, surface ocean and sea ice components first (sections 1 to 5), followed by water column properties, which include the mooring and buoy program, CTD-Rosette operations and physical properties (sections 6 and 7),as well as a suite of chemical and biological parameters (sections 8 to 16). Contaminants cycling in seawater are treated in sections 17 to 21. Subsequent sections cover benthos sampling (sections 22 to 26), seabed mapping (section 27), sediments sampling (sections 28 and 29) and ROV operations (section 30).

The four Appendices provide information about the location, date, time and type of sampling performed at each station visited by the ship, as well as a list of science participants onboard during each leg.

The core oceanographic data generated by the CTD-Rosette operations, as well as meteorological information (AAVOS) and data collected using the Moving Vessel Profiler (MVP), the ship-mounted current meter (SM-ADCP) and the thermosalinograph (TSG) are available in the Polar Data Catalogue (PDC) at www.polardata.ca.

Following ArcticNet's data policy, research teams must submit their metadata to the PDC and insure that their data are archived on the long-term, but it is not mandatory to use the PDC as a long-term archive as long as a link to the data is provided in the metadata (see www.arcticnet.ulaval.ca/Docs/data-policy for more details on data policy).

Part I – Overview and Synopsis of Operations

1 Overview of the 2017 *Amundsen* Expedition

1.1 Introduction

Recent warming trends in the Arctic over the last several decades suggest significant future impacts to northern coastal and marine environments, including to the peoples, communities and infrastructure of these areas. ArcticNet is a Network of Centres of Excellence of Canada that brings together scientists and managers in the natural, human health and social sciences with their partners from Inuit organizations, northern communities, federal and provincial agencies and the private sector to study the impacts of climate change and modernization in the coastal Canadian Arctic.

Since 2004, ArcticNet researchers have been conducting extensive multidisciplinary sampling programs in the Canadian Arctic using the Canadian research icebreaker CCGS *Amundsen*. The overarching goal of the ArcticNet marine-based research program is to study on a long-term basis how climate induced changes are impacting the marine ecosystem, contaminant transport, biogeochemical fluxes, and exchange processes across the ocean-sea ice-atmosphere interface in the Canadian Arctic Ocean. The knowledge generated from this multi-year program is being integrated into regional impact assessments to help decision makers and stakeholders develop effective adaptation strategies for the changing coastal Canadian Arctic.

The geographic scope of the ArcticNet marine-based research program includes the Beaufort Sea in the western Canadian Arctic, the Canadian Arctic Archipelago and Baffin Bay in the eastern Arctic, and extends into Hudson Bay, Ungava Bay and along the northern Labrador coast.

In the western Arctic, northern Baffin Bay and Hudson Bay, ArcticNet has established long-term oceanic observatories. Each observatory consists of a number of moorings equipped with instruments that gather continuous records of currents, temperature, conductivity, turbidity, dissolved oxygen and the vertical flux of carbon and contaminants. Some moorings are also equipped with autonomous hydrophones to record the acoustic background and the vocalizations of marine mammals.

On Friday 31 May 2017, the Amundsen left its homeport of Quebec City for a 134-day planned expedition to the Canadian Arctic in support of several research programs, including: ArcticNet's annual marine-based research program (see Phase 4 projects-http://www.arcticnet.ulaval.ca/research/current.php); BaySys, a project that aims the understanding of the variability and changes of freshwater-marine coupling in the Hudson Bay System as well as Qanuilirpitaa?, a health survey that document physical and mental health amongst Nunavik communities.

1.2 Regional settings

1.2.1 *Hudson Bay*

Hudson Bay is a virtually landlocked, immense inland sea that possesses unique characteristics among the world's oceans: a limited connection with the Arctic and Atlantic Oceans, a low salinity resulting from a high volume of freshwater inputs from numerous rivers that drain central North America, and it is completely ice covered in winter while summer is characterized by ice-free conditions. In Hudson Bay, research activities focused on the influence of riverine inputs into the Bay as part of the BaySys project.

1.2.2 *Baffin Bay*

Baffin Bay is located between Baffin Island and Greenland and connects the Arctic Ocean to the Northwest Atlantic. It is an important pathway for exchange of heat, salt and other properties between these two oceans. Baffin Bay's connection to the Arctic Ocean consists of three relatively narrow passages through the Canadian Arctic Archipelago (CAA). One of these passages, Nares Strait, is located between Ellesmere Island and Greenland and includes from south to north: Smith Sound, Kane Basin, Kennedy Channel, Hall Basin and Robeson Channel. Each winter, there is a prolonged period during which a land-fast ice arch spans the strait at the entrance to Robeson Channel and south of Kennedy Channel the southward flux of ice. However, in the past decade, variability in the formation of the ice arch has been observed with weaker conditions resulting in an increase in ice flux from the Arctic Ocean into Baffin Bay.

1.2.3 *Beaufort sea*

The Canadian Beaufort Sea/Mackenzie Shelf region of the Arctic Ocean has witnessed major changes in recent years, with decreasing sea ice cover and major shifts in sea-ice dynamics. The Beaufort Sea is characterized by a broad shelf onto which the Mackenzie River, the largest river in North America, carries large amounts of freshwater. The mixing of freshwater from the Mackenzie River and Arctic marine waters of the Beaufort Sea establishes an estuarine system over the shelf, with associated inputs of land-derived nutrients and freshwater biota. Along the Mackenzie Shelf stretches the Cape Bathurst polynya, an expanse of open water that exists year-round and is highly productive. This ecosystem is also exceptional since it provides habitat for some of the highest densities of birds and marine mammals in the Arctic.

1.2.4 *Canadian Arctic Archipelago*

The Canadian Arctic Archipelago (CAA) is a vast array of islands and channels that lies between Banks Island in the west and Baffin and Ellesmere Islands in the east. While transiting through the Northwest Passage, the science teams aboard the *Amundsen* extended their time series of atmosphere, ice and ocean data. This work is aimed at better understanding how the climate, ice conditions as well as ocean currents and biogeochemistry are changing under the effects of climate change and industrialization. With ice extent and volume shrinking in the Arctic, the Northwest Passage may be ice free and open to navigation during summer in the near future. Bathymetry data and sub-bottom information were collected while transiting through the

Northwest Passage to map the seafloor and identify potential geohazards and obstacles to the safe navigation of this new seaway.

1.2.5 *Labrador Sea*

Between Labrador and Greenland lies the Labrador Sea, a key region that includes the Labrador Current system. This strong current carries cold water down from Baffin Bay to offshore Newfoundland and, therefore, strongly influences the oceanographic conditions on the Atlantic Canadian Shelf. The Labrador Sea acts as a corridor for southward drifting icebergs and ice islands, inducing risks for activities and operations conducted offshore Newfoundland. From this perspective, gathering scientific knowledge about the area is of particular importance as to inform federal departments and the private sector about the risks associated with the exploration and exploitation of oil and gas.

1.3 2017 Expedition Plan

1.3.1 *General schedule*

Based on the scientific objectives, the expedition was divided into four separate legs: Leg 1, from 31 May to 6 July, was dedicated to the BaySys program; Leg 2, from 6 July to 17 August, was focused on reaching ArcticNet objectives; Leg 3, from 17 August to 14 September, was dedicated to a Health survey involving many Nunavimmiut communities and Leg 4, from 14 September to 12 October, was focused on completing the Health Survey and on conducting last oceanographic sampling on the way back to Quebec City. Due to unfortunate circumstances detailed in section 2, Leg 1 had to be cancelled.

1.3.2 *Leg 1 – BaySys - 31 May to 6 July 2017 – Hudson Bay*

On 25 May, the research icebreaker CCGS *Amundsen* departed Quebec City for its annual scientific expedition to the Arctic six days ahead of schedule to accommodate Canadian Coast Guard (CCG) to manage exceptionally heavy ice conditions along the Newfoundland coast. Unfortunately, those unusual ice conditions delayed the boat in its course towards Hudson Bay. Regrettably, the delay of the Amundsen means the vessel would have arrived too late in Hudson Bay to meet the BaySys research objectives. Therefore, on 7 June, the BaySys Project Leader and Chief Scientist made the very difficult decision to cancel the BaySys program for this year. The BaySys scientific team demobilized from the ship by 11 June.

1.3.3 *Leg 2a – ArcticNet - 6 July to 13 July 2017 – Hudson Bay and Hudson Strait*

The Amundsen spent a week in the Hudson Bay to fulfill specific objectives of the ArcticNet Program and to initiate students to oceanography through the Schools on Board, northern youth mentoring field program. As scientists focused on the lab and deck operations, students assisted to lectures and got hands on training by helping with the different science activities. Operations consisted of opportunistic box coring as well as nets, Agassiz trawl and Rosette deployments. Helicopter flights were also part of this short leg in order to collect ice samples for GENICE project. Leg 2a ended on 13 July with a science rotation in Iqaluit.

1.3.4 *Leg 2b – ArcticNet HiBio - 13 July to 17 August 2017- Hudson Strait, Baffin Bay, Beaufort Sea and the Canadian Arctic Archipelago*

The ship left Iqaluit on 13 July for an ambitious leg of 5 weeks in the Hudson Strait, the Baffin Bay, the Beaufort Sea and the Canadian Arctic Archipelago. Highest priority operations during this leg were to conduct oceanographic sampling and coring operations in Frobisher Bay, to conduct ROV dives in support of the HiBio program as well as to deploy PRO-ICE floats in Baffin Bay and to conduct ice island operations. Many other planned operations and opportunistic operations were conducted during this fruitful leg, which also included a science rotation in Resolute on 5 August. On 17 August, the Amundsen reached Puvirnituq for a full rotation and the end of Leg 2.

1.3.5 *Leg 3 – Qanuilirpitaa? - 17 August to 14 September 2017- Hudson Bay, Hudson Strait and James Bay*

On 17 August, the CCGS *Amundsen* left Puvirnituq for a six-week leg along the coasts of Quebec and Newfoundland. Leg 3 focused on reaching the 2017 Nunavik Inuit Health Survey, Qanuilirpitaa? (How are we now?), objectives. Following-up the 2004 Nunavik Health Survey, Qanuilirpitaa? aimed to document physical and mental health outcomes in Nunavimmiut communities, as well as the social and cultural factors associated with these outcomes. To do so, Nunavimmiut were recruited and visited the Amundsen for a 2½ hour period that involved anthropometric measurements, collection of various biological samples, questionnaires and clinical tests (spirometry, dental examination). A CCG crew rotation in Kangiqsujuaq ended Leg 3 on 14 September.

1.3.6 *Leg 4a – Qanuilirpitaa? -14 September to 6 October 2017- Hudson Strait and James Bay*

The core of Leg 4a was essentially to continue what had been started during Leg 3 with the Nunavik Inuit Health Survey. Indeed, after a CCG crew rotation in Kangiqsujuaq on 14 September, the CCGS *Amundsen* pursued its journey to the different Nunavimmiut communities of the Quebec and of the Newfoundland coasts. Leg 3 and 4a together managed the visit of 14 communities before the end of the Health Survey on 6 October in Kuujjuaq.

1.3.7 *Leg 4b – ArcticNet/ DFO - 6 October to 12 October 2017- Labrador Sea*

After the science rotation in Kuujjuaq, the ship sailed towards the Labrador Sea for a one-week leg of oceanographic sampling operations. Those operations included mooring deployments in support of the HiBio Program, surface sampling at Saglek and oceanographic sampling operated by the Department of Fisheries and Oceans Canada. A pelagic bird survey was also conducted during this leg. The 2017 Amundsen Expedition ended with leg 4b as the ship docked its homeport in Quebec City on 12 October.

2 Leg 1 - 31 May to 6 July 2017 – Hudson Bay

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2.1 Introduction and Objectives

Led by the University of Manitoba, the Centre for Earth Observation Science (CEOS) and Manitoba Hydro, BaySys project focus on the understanding of the relative contributions of climate change and regulation on the Hudson Bay system. To do so, five research teams are organized to investigate the following interconnected subsystems:

- Marine/Climate Systems
- Freshwater
- Marine Ecosystem
- Carbon Cycling
- Contaminants

The role of freshwater in Hudson Bay is investigated through field-based experimentation coupled with climatic-hydrological-oceanographic -biogeochemical modeling.

In that perspective, BaySys teams left Quebec City onboard the CCGS *Amundsen* on 25 May for a 6-week leg in the Hudson Bay six days ahead of schedule to accommodate Canadian Coast Guard (CCG) to manage exceptionally heavy ice conditions along the Newfoundland coast. Unfortunately, these unusual conditions persisted and the *Amundsen* was required to further support these operations until another icebreaker would be available.

As the BaySys project hoped to survey the receding ice cover and vernal productivity during spring freshet in Hudson Bay, the delay of the *Amundsen* means the vessel would have arrived too late in Hudson Bay to meet the BaySys research objectives. Therefore, on June 7, the BaySys Project Leader and Chief Scientist made the very difficult decision to cancel the BaySys program for this year.

While Amundsen Science recognizes that the cancellation of the BaySys program was due to circumstances beyond its control, every effort was made to develop a viable option to allow this valuable work to proceed. It is well understood that the decision to terminate the program this year will have significant impacts on the program partners and, most especially, the large number of students involved.

Amundsen Science and the BaySys research teams plan to conduct BaySys in 2018 in close collaboration with CCG.

3 Leg 2a - 6 July to 13 July, 2017 – Hudson Bay and Hudson Strait

Chief Scientist: Jean-Éric Tremblay[1] (Jean-Eric.Tremblay@bio.ulaval.ca)
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3.1 Introduction and Objectives

Leg 2a of the 2017 Amundsen Expedition took place from 6 July to 13 July. This leg focused on the ArcticNet marine science and Schools on Board programs with scientific operations and lectures conducted in the Hudson Bay and along the Hudson Strait (Figure 3.1).

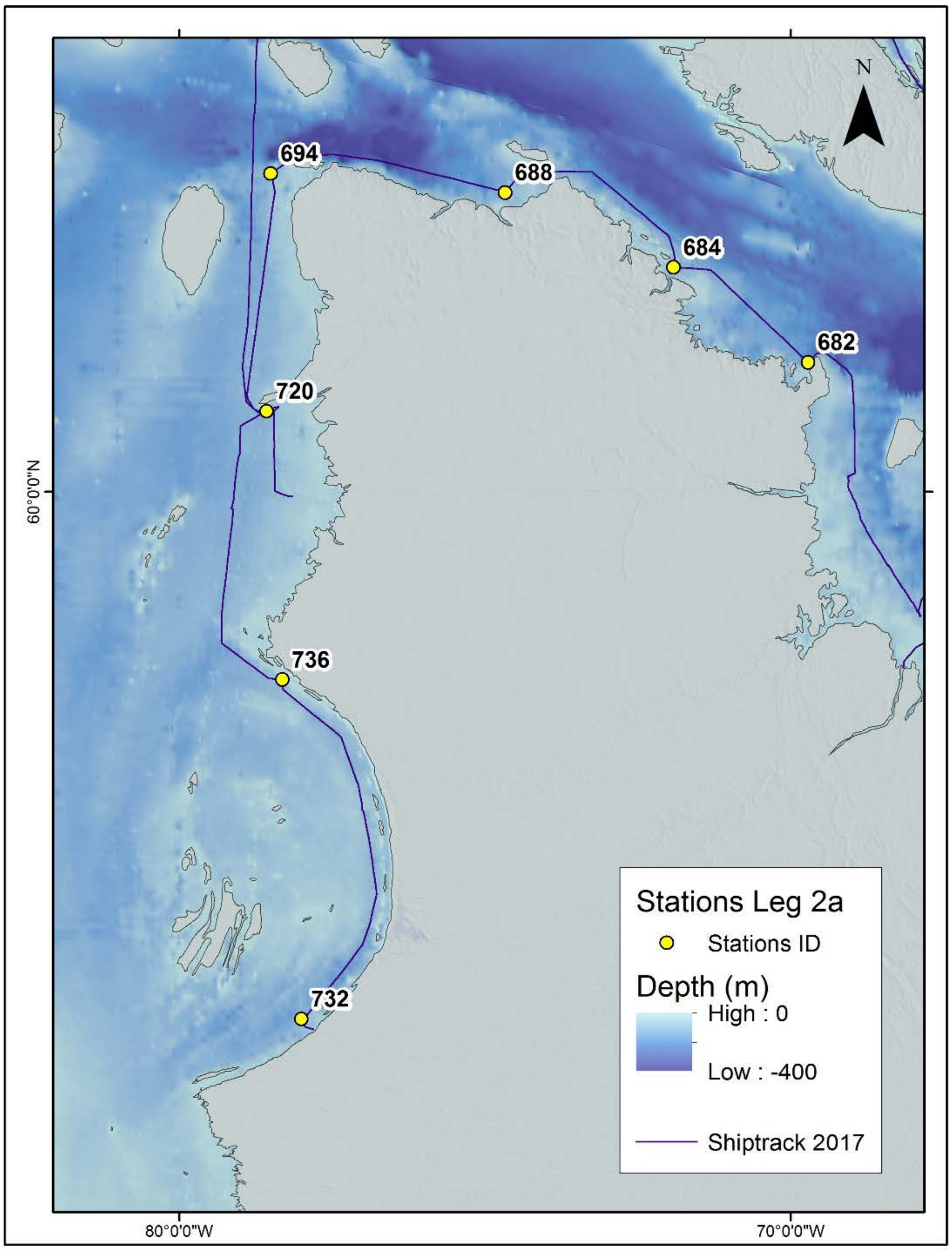

Figure 3.1 Cruise track and stations – Leg 2a

Specific objectives of Leg 2a were to:

- Provide high-quality lectures and hands-on training to Schools on Board Program participants;
- Conduct opportunistic box core deployment;
- Conduct additional CTD-Rosette cast for surface water sampling;
- Conduct ice sampling operations for the GENICE project.

3.2 Synopsis of operations

This section provides a general synopsis and timeline of operations during Leg 2a. Detailed cruise reports provided by onboard participants and including specific objectives, methodology and preliminary results for projects conducted during this leg are available in Part II of this report. During this leg, the *Amundsen* traveled from Churchill (6 July) to Iqaluit (13 July) and 7 stations were visited with an overall tally of operations and activities as follows:

- 7 CTD-Rosette casts
- 5 Box Core
- 8 Agassiz Trawl
- 14 DSN
- 5 Niskin
- 6 PNF
- 7 Secchi Disk

A detailed scientific log for all sampling operations conducted during Leg 2a with the positions and depths of the visited stations is available in Appendices 1 and 2.

3.2.1 *Timeline of Operations*

The aircraft departed on 7 July at 10 am after a 24-hour delay. Safety and operational briefings as well as familiarization tours for the crew and the scientists were provided. The ship lifted anchor at 17h00 and sailed towards station 732. Operations started shortly after 18h00 and were all completed with the two deck crews so that everyone could practice together. One rosette, one monster net, two tuckers, one Agassiz trawl and three box cores were performed. These operations proceeded a little slower than usual since this was the shakedown station and some new crew members had to be trained. Operations finished at 23h45 and the ship sailed directly to station 736, which was reached by 17h00 on 8 July. The zodiac was launched at station 736Z, while deck operations continued with a rosette, net tows and an Agassiz trawl deployments. The Amundsen then sailed towards station 720. While the Rosette was down, communication problems were experienced and it became difficult to fire the bottles. The cast took longer than usual but was nevertheless successfully completed. Thomas noticed that there was water inside the cable, most probably due to an imperfect splice. While the ship transit during the night, Thomas proceeded to cut 100 m of cable and remade the splice. The rosette worked perfectly afterward.

On 9 July, rising winds and swells slowed the transition during the night. The ship arrived on site at 11h30 and leaders assessed the feasibility of doing a rosette cast, which was complicated by the presence of swell arriving from two directions. The decision was made to move 2 miles North to find partially sheltered conditions closer to Smith Island. Station 720 was done there in 90 m of water. During the night (at 01h50), the TSG software failed and did not record underway data until just before breakfast, when the problem was discovered. It was then reset and started working again. There was also a pressure drop in the pump that supplies seawater to the forward lab – which affected the flow for the instruments. Thomas realized the line was partly plugged by detritus that the ship most probably acquired close to land in the South.

The next day, the usual suite of short basic operations was accomplished at station 694. The ship then proceeded to station 688, where usual operations were performed, including a Zodiac trip inshore. A boat drill was performed underway before starting the station. In addition, several presentations were given for the students of Schools on Board, who have been integrated to many sampling activities in the past days. A meeting with the crew was also led to discuss potential ice sampling procedures for the GENICE group.

On 11 July, short basic stations 684 and 682 (zodiac) were conducted. Additional presentations were given to the Schools on Board students. Station 676 operations began at midnight, with triplicate box cores deployments. The last station (672) was conducted in the late morning of 12 July. Stations 674 and 670 were cancelled by lack of time and the ship sailed directly from station 672 to Iqaluit.

The ice slowed the progress somewhat when entering Frobisher Bay and the helicopter was launched with 3 participants from the GENICE group (first science flight of the leg) in an attempt to find a suitable ice floe for their sampling. They found none. The *Amundsen* arrived in Iqaluit at 16h30 on 13 July, set the anchor and began helicopter operations to disembark 24 scientists and embark 27 others.

4 Leg 2b – 13 July to 17 August 2017 – Hudson Strait, Baffin Bay, Baffin Island Coast, Beaufort Sea and the Canadian Arctic Archipelago

Chief Scientists: Jean-Éric Tremblay[1] (Jean-Eric.Tremblay@bio.ulaval.ca) and Martine Lizotte[2] (Martine.Lizotte@qo.ulaval.ca)
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4.1 Introduction and Objectives

Leg 2b was carried out from 13 July to 17 August. This leg, conducted in the waters of the Hudson Strait, the Baffin bay, the Beaufort Sea and the Canadian Arctic Archipelago (figure 4.1), focused on ArcticNet's Phase IV research programs including the Hidden Biodiversity and Vulnerability of Hard-Bottom and Surrounding Environments in the Canadian Arctic (HiBio) project.

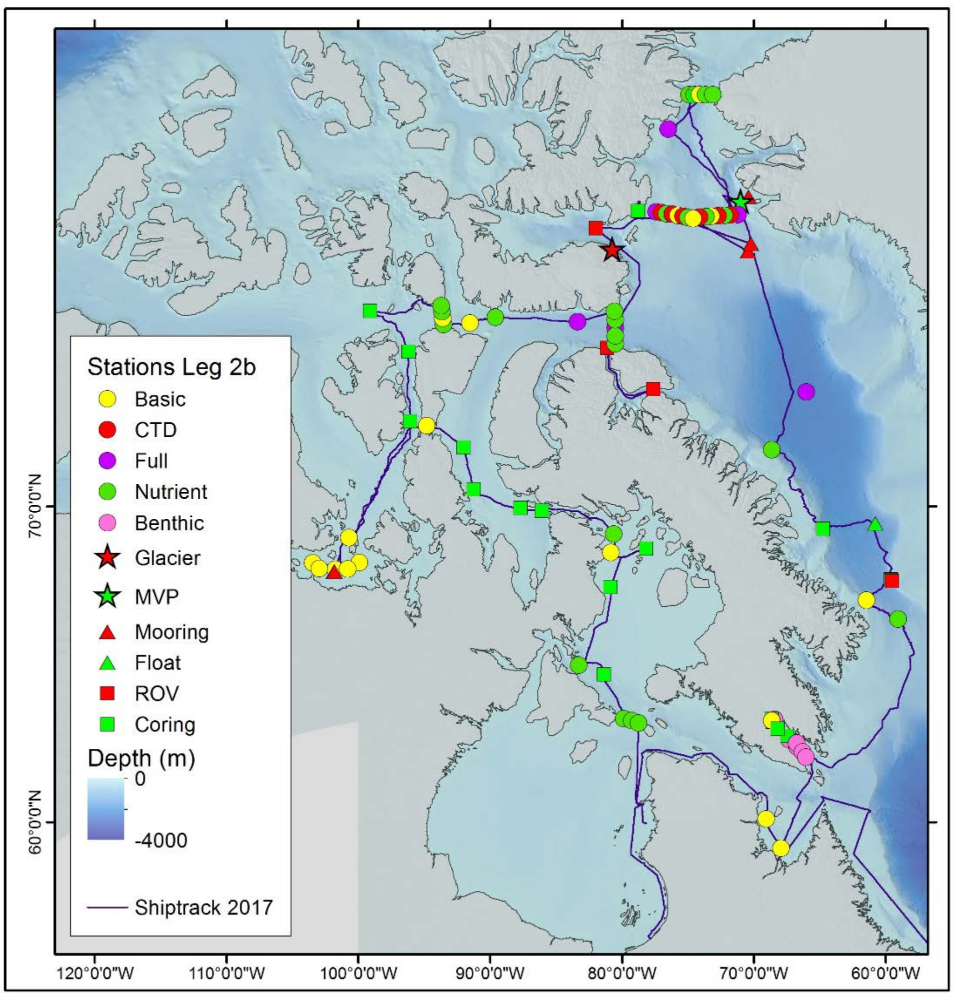

Figure 4.1 Cruise track and stations – Leg 2b

The highest priority operations during Leg 2b were to:

- Conduct oceanographic sampling operations and coring operations in Inner and Outer Frobisher Bay, in Baffin Bay, in Queen Maud Gulf and in Victoria Strait;
- Characterize the habitat of Inner and Outer Frobisher Bay;
- Conduct multibeam and sub-bottom seafloor surveys;
- Conduct four ROV dives;
- Conduct ice island operations on Baffin Island near Qikiqtarjuaq, including multibeam sonar surveys of the old (2016) and new (2017) grounding sites;
- Deploy four PRO-ICE floats in Baffin Bay for the GreenEdge project
- Recover and re-deploy three moorings (BA05, BA06 and WF1);
- Conduct glacier, oceanographic and coring operations at Trinity & Wykeham Glacier on Ellesmere Island;
- Conduct on-ice glacier operations, including the installation of on-ice stations and time lapse cameras;
- Deploy a GPS tracking units on icebergs using the helicopter.

4.2 Synopsis of operations

This section provides a general synopsis and timeline of operations during Leg 2b. Detailed cruise reports provided by onboard participants and including specific objectives, methodology and preliminary results for projects conducted during this leg are available in Part II of this report. During this leg, the *Amundsen* traveled from Iqaluit (13 July) to Puvirnituq (17 August) and 92 stations were visited with an overall tally of operations and activities as follows:

- 89 CTD-rosette casts
- 25 5NVS
- 25 Agassiz trawl deployments
- 9 beam trawl deployments
- 1 benthic frame deployment
- 69 box cores
- 4 float deployments
- 24 DSN
- 9 gravity cores
- 4 Hydrobios deployments
- 9 manta net deployments
- 3 mooring deployments, 3 mooring recoveries and 3 triangulations
- 2 niskin deployments
- 13 piston cores
- 25 plankton net deployments
- 20 PNF deployments and 18 Secchi disk deployments
- 4 remotely operated vehicle (ROV) deployments
- 1 MVP profile
- 1 lander deployment
- 1 IKMT deployment

A detailed scientific log for all sampling operations conducted during Leg 2b with the positions and depths of the visited stations is available in Appendices 1 and 2.

4.2.1 *Timeline of Operations*

The ship left anchor at 22h00 on 13 July, marking the beginning of 2017 Leg 2a. The first mapping area was reached the next day. The mapping was done, but with partial success due to the presence of stray ice floes and the failure of the computer equipment near the end. Three stations were completed the same day (OF-B2, OF-S23 and OF-B6) along with a familiarization tour and a safety briefing for coring operations.

On 15 July, basic station A16 was sampled. Given the time window available to get to Disko Fan on time, Evan Edinger and I (JET) streamlined the program to include only stations Bell11, OF-S22, OF-B9, OF-B14 and OF-B5 after A16. OF-B14 and OF-B5 were completed the next day, 16 July, among compact ice floes. The ship then started its transit towards station. Once underway and while still close to land, the helicopter took off to drop a beacon on an iceberg close to Resolution Island. In the afternoon a ROV safety/operational briefing was held.

17 July was spent transiting North in heavy fog, which slowed the ship down significantly. Nutrient station BB1was finally completed on 18 July. The afternoon of the same day was spent doing a basic station at a position close to the station 180 of previous years. By dinner time the weather had not improved and the ship sailed toward Disko Fan. In order to have the moonpool free of ice for ROV operations, the hot water system was turned on in early evening.

Upon arrival in the Disko Fan area early in the night of 19 July, a rosette was performed for the different groups and a series of 4 box cores were collected at two different locations. Despite the measures implemented the prior evening, the moonpool was filled with ice as the hot water system was only dispensing a useless trickle. It took 3 hours to empty the moonpool with the basket frame. A first attempt was made to deploy the ROV, but as soon as the cage was out of the moonpool the ROV headlights failed. The cage was pulled back in and it took two more hours to fix the problem. Meanwhile, a series of 2 boxcores was completed. Procedures for the second dive began at 13h15 and it took nearly an hour to bring the cage down to the ROV deployment point. Once the ROV was out of the cage, a small delay occurred before a search pattern could be implemented at the bottom. It took an hour to locate the experimental frame thanks to Vincent's skillful piloting. The buoy was gone but the looped rope was conveniently floating above the assembly. The recovered experimental frame turned out to be substantially degraded by corrosion even though it was made of stainless steel. Since the next experimental frame to be installed was supposed to stay there for 5 years, Evan decided not to deploy it given the high probability that nothing would be left of it after such a long period.

On 20 July, the ship arrived at Float station #2 early in the night and made a first rosette, during which time the ice closed in on the position. Much to everyone surprise the cast was cut short at ca. 1655 m because we were nearing the end of the wire on the winch drum. The ship then repositioned to the west to be able to launch the 4 floats, after which another rosette cast was made. The Amundsen left the float deployment site in the morning and sailed for piston coring station 8.1, which was completed the same day.

On 21 July, nutrient station BB3 was reached. The site was in a compacted area of pack ice, so the ship had to open a hole. After verifying the stability of the ship and hole, the Rosette cast was performed. During the rest of the night the ship headed east to full station BB2. During the transit, the helicopter was launched to drop a beacon on a nearby iceberg. The ship reached BB2 on 22 July and the station was completed before night along with the deployment of the three remaining floats.

The next day, 23 July, a mooring was successfully recovered with all its equipment intact. The ship then moved west to begin the North Water transect with station 101. The following two days, stations of the transect kept being performed at a steady pace (station 102, 103, 104, 105, 106 and 107). Two moorings were also deployed and triangulated without any problem, after which we sailed to the MVP start position and surveyed the planned transect at 8 knots.

After finishing the MVP transect, on 26 July, the ship moved to full station 115, which was completed during the day while performing a helicopter sortie to deploy beacons on nearby icebergs. We then resumed the line with stations 114, 113 and 112 and 111.

Stations 111, 110, 109 and 108, were completed on 27 July after which the ship left for the northern end of Smith Sound. Most of the night was spent transiting. Work started at nutrient stations 126 and 127. The ship then moved to the McEwan coring station (129) and resumed the transect with nutrient stations 130 and 131. Ice conditions in Kane Basin prevented diligent access to the basic station there and the decision to keep our contingency time to favor ROV operations was made.

Since the Bay was still covered with fast ice at the time of arrival, the sites designated for coring and the full station were not accessible so the ship moved close to previous station TS233 just east of the fast ice margin. Operations began at 5h30 on 28 July and the helicopter departed at 9h30 for glacier operations. The Amundsen then sailed for station 114 at the eastern end of the NOW transect.

Starting work early in the night of 29 July, all stations of the transect got completed, including the beginning of Station 108, which was converted into a basic station to provide enough time to complete ROV, mapping and coring operations in Jones Sound. The ship reached the beginning of the mapping line toward Manson Glacier at 5h45 on 30 July. The winds and the swell were much higher and rising at the dive area. Conditions were judged to be borderline by Vincent and Captain Lafrance, who opted to cancel the operation considering there was little to no chance that the ship would be able to hold position. Nonetheless, a rosette was performed to characterize the water column habitat for a future dive.

On 31 July, after a night of transit, scientist and crew started a full station (323) at 8h00. The station was completed around 19h00, at which time the ship started its transit toward the alternate ROV site slightly to the northeast of Pond Inlet. Once in station, on 1 August, a large ice floe was present and we started fragmenting it with the ship to make sure that no large obstacle stood in the way of maneuvering during ROV operations. The dive was successful. A rosette and a short bottom mapping line followed. The ship then started to transit towards a second alternate ROV site at the entrance of Navy Board Inlet at which we arrived in the early morning of 2 August. A dive was attempted but the winds had risen to 20 knots and above. After several attempts it became clear that the ship could not hold position sufficiently to allow the dive to continue. We aborted and the cage was lifted back to the ship, after which we proceeded towards nutrient station 325 to resume the Lancaster Sound transect. Meanwhile, a team of 3 (Shawn, Thomas and Jonathan) was deployed by helicopter to nearby Wollaston Island in order to calibrate current meters. After that another flight was organized for Abby to drop beacons on icebergs and ice island fragments. As the ship proceeded north along nutrient stations 324, 300 and 322, it eventually got within safe distance of Devon Island and additional flights were completed to allow Cara to sample river water and Allison to work on glaciers at the southeastern tip of the Island. Station 322 was completed late in the evening, after which we began transiting west towards station 301. Morale continued to be very high on the ship, despite all the accommodations and changes we had to do for ice and weather.

On 3 August, the ship arrived at station 301 early in the night and performed most of the water column operations of this full station. The bottom mapping preparatory for the ROV dive was performed during breakfast, after which the ROV was deployed. Weather conditions were ideal, with very low winds and virtually no swell. The dive was a success, despite some telemetry issues early on. Full station 301 was completed with a series of 4 box cores precisely positioned by using a beacon on the box frame. The next day, nutrient station 303 was completed during mid-morning while the helicopter was on land with Cara. The ship then sailed to short basic station 304 and began the series of stations on the 305 line (A, B, C and D). The transit towards Resolute began around 8h30 after completion of station 305D and a short bottom mapping near Resolute was done. With the news of a good lead of open waters and old rotten ice along the way we took the decision to pursue our route towards 5.10 and we arrived on station at 21h30 on 5 August. Upon arrival in the area of interest, a 30-minute bottom mapping survey conducted by Trottier allowed the team to locate an area propitious for coring. The piston core was deployed successfully. A box core followed, then a rosette for nutrients. The station was completed at 01h00 am of 6 August amidst the cheers of the crew and scientist on deck and in the wheelhouse. The ship then set sail Southeast towards coring station 3.9. Weather conditions were assessed at 06h00am for helicopter operations and river sampling and determined to be favorable for a flight after breakfast. Coring station 3.9 was moved slightly to avoid ice floes and was completed at 9h30.

7 August was a transit day towards Queen Maud Gulf (QMG) stations. The ship arrived on station QMG-M at 02h00 on 8 August and operations started immediately. Activities progressed very well and rapidly mainly due to shallow waters. Upon completion of all the “basic-station” activities planned, the ship proceeded towards QMG mooring WF1 and conducted multibeam lines, CTD rosette, zodiac deployment, and successful recovery of the mooring was done by 9h45. Complex refueling operation followed this station; science operations started again at 20h15

with a suite of basic-type activities (rosettes, nets, cores, etc.). The next day, the ship sailed to QMG-3 where the entire suite of operations (basic + extra box core and gravity core) was successfully completed by 04h30. We then transited back to the QMG mooring WF1 site where a mooring deployment started at 06h30, followed by triangulation and a CTD rosette. The ship started its transit towards QMG-1 at 09h00 and arrived at 13h00 and all basic activities planned were completed successfully by 15h45. The Amundsen then sailed southwest to QMG-2 arriving at 17h45. All activities were completed successfully at 20h30 and we transited towards basic station 312 at which we arrived on 10 August at 01h30. All the activities there were conducted with success until 06h30 at which time we sailed Northwest. Basic stations 311 and 310 were cancelled due to ice conditions.

On 11 August, the ship started its Northwest course towards coring station 3.7 through the old ice. We arrived on station at 06h00 and operations for piston coring began around 06h30. Upon completion of the activities, the ship transited towards the entrance of Bellot Strait and slowly entered the Strait around 12h00. We conducted a short opportunistic rosette. The morale on board seems very good: most people are cheery and rested after the intensity of QMG. We arrived on station at 20h45 and operations there began with a Vertical Net Tow, one box core and two gravity cores. The operations at coring site 3.4 were completed successfully at midnight and the ship sailed towards coring site 3.5.

The ship arrived on coring site at 7h45 on 12 August and operations began at 8h00 with a box core followed by a piston core. The operations were completed by 09h45 and we started sailing southeast towards coring site 5.11. we arrived there at 18h15. The ice conditions there did not permit a piston core but by swerving around with the ship we created an area relatively clear of ice and did a gravity core followed by a box core. The activities at coring site 5.11 were completed by 00h30 and the ship set sail towards Fury and Hecla Strait.

By the morning of 13 August, the ship had reached station A15. A nutrient rosette was conducted before the Amundsen continued its way towards basic station 333, where a whole suite of operations took place between 15h00 and 19h30. We started sailing northeast at 19h30 towards coring site 3.10-2.

On 14 August, once in station, a box core was deployed with success. The ship then sailed towards coring site 3.10 and arrived at 11h25. The Box core and seismic survey revealed the presence of a top layer of heavy gravel not conducive for piston coring. The decision was taken by Montero-Serrano to cancel the piston at this station. Following the abrupt ending of operations, the ship started its transit towards nutrient station A8 which was reached by 03h30 on 15 August. A short rosette cast for nutrients was done. The ship then continued its transit towards coring site 1.1 which was reached at 09h45. Seismic survey over the region revealed two areas of interest for each team. Operations at this final piston coring site were successful. A long transit towards nutrient station A1 began immediately after and the target was reached at 22h00. A 45-minute nutrient rosette was done and the ship sailed to Nutrient station A2. Many people participated in a “Disney-themed” costume party during this last bar night of the cruise.

After completion of the sampling at nutrient station A1 on 16 August, the ship continued on the line towards nutrient station A2, sampled successfully by 01h30, moving on to the last station of the cruise. We reached nutrient station A3 at 03h00 in the morning and the sampling there was completed at 03h40. This last station officially completes the science plan for the 2017 Leg 2b. A group photo was taken and a last meeting was held at 18h00 with the science personnel and a few coast guard including the Captain. Labs were cleaned and boxes secured.

On 17 August, the ship anchored near Puvirnituq at 05h30. Helicopter operations began at 08h00. The charter plane arrived at 12h39 and the full crew and scientists boarded at 16h30.

5 Leg 3 and 4a – 17 August to 6 October 2017 – Health Survey

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5.1 Introduction and Objectives

The responsibilities of the Nunavik Regional Board of Health and Social Services (NRBHSS) in the areas of information on, and monitoring of, Nunavimmiut's health are defined according to two contexts: the NRBHSS's mission itself and the legal mandate of the regional public health director (Act Respecting Health and Social Services, sections 371-375).

Within this framework, only two regional health surveys undertaken in Nunavik were conducted: the 1992 Inuit Health Survey and Qanuippitaa 2004. Since then, no other survey allowing for an update of the information on the health of this population has been conducted. Further, it is extremely difficult and expensive, indeed impossible, to extend existing Quebec surveys to this region to obtain this information, for multiple reasons: language and cultural barriers, methodological considerations, the need to adapt tools, administrative and transportation costs, the need to carry out the related work on site (since the data-gathering methods used in Quebec are not applicable), and so forth.

One of the lasting benefits of the Qanuippitaa 2004 survey has been the working relationship between the Population Health Unit at the CHU de Quebec Research Centre, the Institut national de santé publique du Québec (INSPQ) and the NRBHSS. This relationship provides a solid base for the development of a follow-up to the 2004 health survey.

Several reasons and preoccupations justify this initiative:

- Recognition of new priorities: youth health, tuberculosis, food insecurity, mental health, suicide, addictions, violence and others;
- Upcoming development of the Plan Nord, which will have major repercussions on the region. It is of utmost importance to accurately document the population's overall state of health for subsequent comparison purposes;
- Current clinical projects whose objectives are to implement preventive strategies and services in close partnership with the communities and with concern for strengthening community capacities and fostering empowerment;
- The need to obtain data required to support the next Strategic Regional Plan for health and social services (starting in 2016).

Thus, in February 2014, the NRBHSS board of directors (composed of representatives of the region's 14 communities and the two health centres) unanimously adopted a resolution to conduct a new health survey in Nunavik.

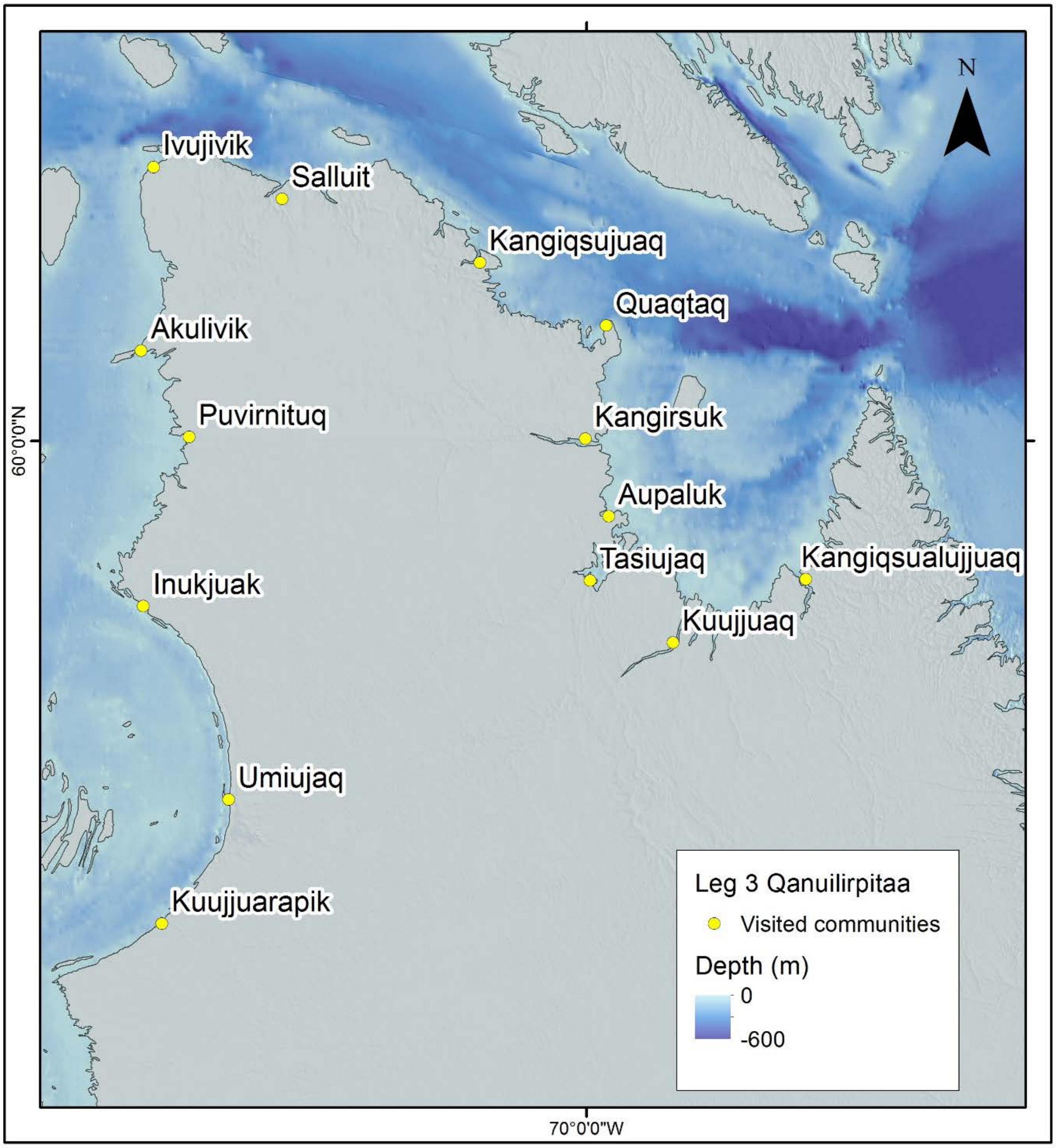

Figure 5.1 Visited communities

In 2013 and 2014, Nunavik regional organizations conducted a vast consultation in all communities, Parnasimautik, to identify preoccupations and issues among Nunavimmiut. Their report provides further impetus for conducting a new health survey to better document health and social issues with a view to supporting actions that target health and its social and environmental determinants in Nunavik. While continuity between the new survey and the previous ones is necessary in order to assess the evolution of certain trends, the new survey must also move beyond traditional survey approaches and comply with contemporary paradigms for developing knowledge in Nunavik, in order to properly reflect the characteristics of the population and its communities.

For Nunavimmiut, health depends on the balance and harmony of economic, cultural, environmental and biological factors. It is thus reflected through individual level attributes (e.g., diseases, limitations, lifestyles) and broader societal and cultural factors (e.g., social supports, community wellness, social policies and programs, traditions). The involvement of key regional partners is thus important in order to provide the necessary links to factors that can influence the health of Nunavimmiut and their community.

5.1.1 *Key messages*

- The Nunavik population is undergoing a rapid transition and there is a strong need to document emerging issues.
- The upcoming development of the Plan Nord will have major repercussions on the region. It is of utmost importance to accurately document the population's overall state of health for subsequent comparison purposes.
- The survey - now entitled Qanuilirpitaa? 2017- is intended to provide stakeholders and authorities with solid ground on which to update policies and health programs in Nunavik, in particular to obtain the data required to support the next Strategic Regional Plan for health and social services.
- Additional funding for Qanuilirpitaa? was obtained from the Northern Contaminants Program (Indigenous and Northern Affairs Canada).

5.1.2 *Objectives*

The health survey Qanuilirpitaa? 2017 includes three components, each with its specific sets of objectives:

<u>Adult component</u>

To assess adult health status in 2017 and follow-up on the adult participants enrolled in 2004 (N=700) in order to assess and compare trends, and recruit 300 additional participants aged 31 and older to ensure the representativeness of the adult cohort.

<u>Youth component</u>

Nesting a new youth cohort in Qanuilirpitaa? 2017 will allow us:

1) To complement the adult follow-up by recruiting a new group of 1000 Nunavimmiut aged 16-30 year-old;
2) To study the evolution of the prevalence of risk factors and diseases in the 18-30 year-old population between 2004 and 2017;
3) To document new emerging threats to health and new indicators of health and well-being pertaining to the younger generation.

<u>Community component</u>

To identify, define and assess culturally appropriate community indicators of health and well-being. Specific objectives are:

- To define community health and well-being from the perspective of Nunavimmiut;
- To identify and describe elements that foster community health and well-being;

- To develop indicators to assess, and ways to describe, community health and well-being.

5.2 Synopsys of Activities and Analysis

From August 19 to October 5 2017, a total of 1326 Nunavimmiut were recruited and visited the Amundsen for a 2 ½ hour period that involved anthropometric measurements, collection of various biological samples, questionnaires and clinical tests (spirometry, dental examination). The number of participants recruited are listed in Table 5.1 according to age, sex and community of residence. The number of participants who were part of the 2004 Survey is also indicated.

Table 5.1 Participants recruited in the Qanuilirpitaa? Survey by community of residence, age categories and sex.

Community		16-30			31 +						Total		
					Female		Male		Total				
		Female	Male	Total	All	Cohort 2004	All	Cohort 2004	All	Cohort 2004	Female	Male	Total
Hudson	Akulivik	21	17	38	16	10	11	6	27	16	37	28	65
	Inukjuak	54	28	82	64	29	31	12	95	41	118	59	177
	Ivujivik	9	0	9	12	6	6	5	18	11	21	6	27
	Kuujjuarapik	10	10	20	24	8	17	3	41	11	34	27	61
	Puvirnituq	45	20	65	34	17	23	12	57	29	79	43	122
	Salluit	48	22	70	53	26	28	9	81	35	101	50	151
	Umiujaq	13	4	17	17	2	17	5	34	7	30	21	51
	Total	**200**	**101**	**301**	**220**	**98**	**133**	**52**	**353**	**150**	**420**	**234**	**654**
Ungava	Aupaluk	14	5	19	18	6	7	2	25	8	32	12	44
	Kangiqsualujjuaq	40	19	59	66	25	35	15	101	40	106	54	160
	Kangiqsujuaq	24	7	31	28	13	21	10	49	23	52	28	80
	Kangirsuk	11	13	24	19	10	21	8	40	18	30	34	64
	Kuujjuaq	65	17	82	93	38	39	14	132	52	158	56	214
	Quaqtaq	18	5	23	15	3	8	3	23	6	34	13	47
	Tasiujaq	22	13	35	20	3	9	5	29	8	42	22	64
	Total	**194**	**79**	**273**	**259**	**98**	**140**	**57**	**399**	**155**	**454**	**219**	**673**
Nunavik		**394**	**180**	**574**	**479**	**196**	**273**	**109**	**752**	**305**	**873**	**453**	**1326**

Activities conducted in 2017-2018 include:

- Finalisation of all questionnaires
- Finalisation of the translation of the questionnaires
- Finalisation of the Medical review component for the adult cohort (ongoing)
- Finalize the Research design
- Presentation of the last documents to the Ethic Board – CHU (Letters of support-questionnaires- consent forms)
- Translation of the consent forms in all languages
- Preparation of the required documents and forms for the clinical follow-up after the survey (ongoing)
- Finalize the recruitment of the field work personnel
- Videos of all consent forms
- Finalisation of the questionnaires on tablets
- Finalization of the participants lists
- Establish links with the communities (Daycare-school- Coop-Transportation-etc)
- Design the various documents needed to collect data
- Finalize the training manuals (both for the interviewers and the recruiters)
- Preparation of the contracts by the Human resources

- Contact the Health Centres to get authorizations for Medical files review
- Buy the clinical and laboratory material
- Identification of the people on the ship (schedule)
- Promotion of the 2016 Inuit Health Survey among the communities
- Preparation of the trainings for all personnel (logistic for the respiratory team, oral health team, nurses team, interviewers team and recruitment team on the field)
- Shipping and mobilization of the material for the Amundsen and for the Airplane cargo
- Training of the field work personnel (60 persons)
- Start of Qanuilirpitaa 2017 (August 19th – October 5th, 2017)
- Data entry of all data collected
- Treatment and analysis of data (and biological and clinical measures)

Table 5.2 Themes Identified for Quanuilirpitaa 2017

Themes included in Qanuilirpitaa? 2017	Targeted cohort
Sociodemographic information (including education, income, employment)	Youths and Adults
Subjective rating of overall mental and physical health (quality of life, self-rated health, satisfaction in life)	Youths and Adults
Mental health and well being (psychological distress, stress, suicide, traumas, historical loss, community attitudes toward mental health)	Youths and Adults
Resilience self-esteem	Youths and Adults
Social support	Youths and Adults
Victimization - Crime against property - Physical and sexual abuse - Childhood trauma - Elder's victimization - Bullying	- Youths and Adults - Youths aged 18 and older and Adults - Youths aged 18 and older and Adults - Adults aged 55 and older - Youths
Sexual health (sexual orientation, indicators of sexual health, perceived benefits of childbearing, risky sexual behaviors for STIs and pregnancies, pregnancy history)	Youths
Teenage pregnancy (socio-cultural factors influencing teenage pregnancy)	16-20 year old
Justice	Youths and Adults
Substance use and dependence, gambling	Youths and Adults
Media	Youths and Adults
Family (family relations and support, cohesion, family traumas (stressors, residential school, foster care))	Youths and Adults

Themes included in Qanuilirpitaa? 2017	Targeted cohort
Socio-cultural determinants of health (incl cultural identity, community involvement, equity and discrimination, social integration and exclusion, spirituality)	Youths and Adults
Housing and homelessness	Youths and Adults
Cardiometabolic health	Youths and Adults
Acute gastroenteritis infection and *Cryptosporidium* spp.	Youths and Adults
Zoonosis (rabies infection and risk of bites)	Youths and Adults
Zoonosis: *Toxoplasma gondii* and *Trichinella* spp.	Youths and Adults
Helicobacter pylori	Youths and Adults
Oral Health	Youths and Adults
Respiratory health	Youths and Adults
Men's health	Men from both cohorts
Women's health	Women from both cohorts
Nutrition/Food frequency questionnaire (FFQ)	Youths and Adults
Food security	Youths and Adults
Hunting and fishing	Youths and Adults

Table 5.3 Contaminants

Toxic metals	Mercury
	Lead
	Cadmium
Legacy POPs	Organochlorines
	Polychlorinated biphenyls (PCBs) and halogenated phenolic compounds
New POPs	Halogenated flame retardants
	Perfluorinated compounds
	Polychlorinated naphthalenes
Contaminants of Emerging Concern (CECs)	Short-chain chlorinated paraffins
	Other halogenated flame retardants
	Organophosphate triester (OPs)

Table 5.4 Clinical test

Theme	Test/measurement	Targeted cohort	Rationale for inclusion in Q2017
Anthropometric measurements	Height, weight, waist size and BMI Body composition (bioelectrical impedance analysis)	Youth and Adults	Risk factor for diabetes, cardiovascular diseases, metabolic syndrome
Cardiovascular health	Blood pressure (BP) Heart rate	Youth and Adults	Cardiovascular health, metabolic syndrome
Diabetes	Glucose and insulin	Youth and Adults	Diabetes screening
Oral health	Oral exam	Youth and Adults	Dentate status and utilization of removable prostheses; dental trauma; gingival status; debris and calculus assessment; dental caries and associated conditions (ICDAS II); clinical consequences of untreated dental caries; screening of the oral mucosa (see section 4.6 of oral health protocol)
Lung health	Spirometry (pre- and post-bronchodilator*) Post- bronchodilator only for participants aged 40 and older with abnormal spirometry results	Youth and Adults	Asthma/COPD

Table 5.5 Biological samples and laboratory analysis

Biological sample	Laboratory analysis	Targeted cohort	Rationale for inclusion in Q2017
Blood	Complete blood count Clinical chemistry Vitamins, micronutrients, etc. Contaminants Specific IgEs, antibody titers	Youths and Adults	Anemia, allergies, diabetes screening, liver diseases, nutritional deficiencies, exposure to contaminants, zoonoses. *Cryptosporidium, H. pylori*
Urine	Clinical chemistry Contaminants	Youths and Adults	Kidney diseases, nutritional deficiencies, exposure to contaminants
	STI testing	Youths–men	Syphilis, chlamydia and gonorrhea infection
Vaginal swab collection	STI testing	Youths–women	Syphilis, chlamydia and gonorrhea infection

Oro-pharyngeal swabs	Microbiological analyses	Youths and Adults	Possible risk factor of respiratory diseases (see section 11.3.1)
Stool sample collection	*H. pylori* (antigen) Occult blood presence	Youths and Adults	*H. pylori* (active infection) Colorectal cancer screening (50 y +)

5.3 Conclusion

We had initially envisioned recruiting approximately 2000 participants. After the first few days of the survey, in order to obtain quality data, we had to reduce our targeted number of participants to 1674. We ended up recruiting 1326 participants, corresponding to 79.2% of our revised target number. Bad weather and a rescue mission in Iqaluit resulted in several clinic days being lost.

Biological samples were sent to laboratories for analyses. Most results were received and letters to participants and local CLSC are being prepared and will be sent in June 2018.

Eight databases are being prepared to produce the different outputs of the project:

1) Questionnaires;
2) Laboratory tests;
3) Lung function (spirometry);
4) Dental examination;
5) Clinical measurements;
6) Auxiliary data;
7) Body composition data;
8) Medical file review data.

Data analyses will follow to produce the different reports requested by the region and then scientific articles.

Thanks to the close collaboration with Inuit organisations and adoption of a strong participatory approach, the data collection phase of the Qanuilirpittaa? Survey was completed with success. Data analysis and interpretation are underway.

5.3.1 *Integration of Network Partners*

The governance structure that has been established calls for the participation of several representatives from Nunavik's communities, reflecting the participatory approach that characterizes this survey. Governance is overseen by a steering committee composed of the main regional leaders and key representatives of the Nunavik community: Kativik Regional Government, Makivik, Kativik School Board and two mayors representing the communities. Representatives of two major organizations, the Institut national de santé publique du Québec (INSPQ) and the CHU de Québec Research Centre/Université Laval, are also key members of the Steering Committee. The NRBHSSS chairs the steering committee and is responsible for the overall survey.

Three partners are working together toward the realization of this survey: the Nunavik Regional Board of Health and Social Services (NRBHSS), the Institut national de santé publique du Québec (INSPQ) and the CHU de Québec Research Centre/Université Laval. The INSPQ has been mandated to ensure the project's overall coordination and administrative management.

This decision-making body and the active involvement of communities, which is at the core of this project, are intended to allow Nunavimmiut to appropriate all phases of this health survey and its results, thus strengthening Nunavimmiut autonomy and their ability to manage their health.

Inuit and northern communities and organization:

- Makivik Corporation
- Kativik Regional Government (KRG)
- Kativik School Board (KSB)
- Qarjuit Youth Council (QYC)
- Kativik Municipal Housing Bureau (KMHB)
- Inuulitsivik Health Centre (IHC)
- Ungava Tulattavik Health Centre (UTHC)
- Avataq Cultural Institute
- Mayors of the Nunavik communities

Government agencies and industry:

- Nunavik Regional Board of Health and Social Services (NRBHSS)
- Quebec Ministry of Health and Social Services
- Institut national de santé publique du Québec

6 Leg 4b – 6 October to 12 October 2017- Labrador Sea

Chief Scientist: Alexandre Forest[1] (Alexandre.Forest@as.ulaval.ca)
[1] *Amundsen Science, Université Laval, Québec, QC, Canada*

6.1 Introduction and Objectives

Starting on 6 October in Kuujjuaq and ending on 12 October in Quebec City, Leg 4b was dedicated to the ArcticNet program and its collaboration with the Departement of Fisheries and Oceans Canada. This one-week leg took the ship return to Quebec CIty as an oceanographic sampling opportunity (Figure 6.1).

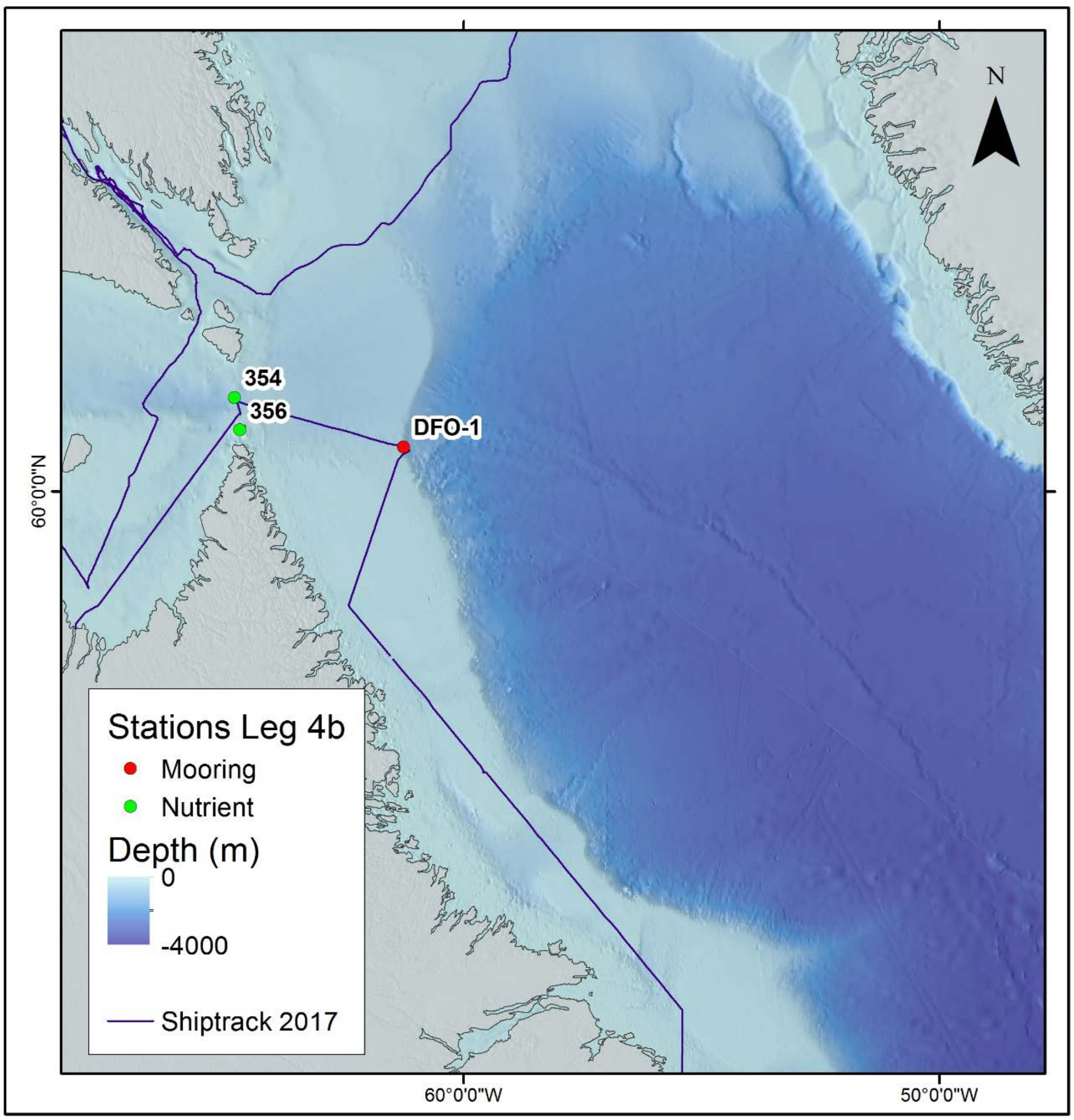

Figure 6.1 Cruise track and stations – Leg 4b

The project targets the following objectives:

- Two mooring deployments at HiBio-A and HiBio-B;
- Surface sampling at Saglek;
- Oceanographic sampling.

6.2 Synopsis of operations

This section provides a general synopsis and timeline of operations during Leg 4b. Detailed cruise reports provided by onboard participants and including specific objectives, methodology and preliminary results for projects conducted during this leg are available in Part II of this report. During this leg, the Amundsen traveled from Kuujjuaq (6 October) to Quebec City (12 October) and 3 stations were visited with an overall tally of operations and activities as follows:

- 3 CTD-rosette casts
- 1 box core
- 1 beam trawl deployment
- 1 mooring deployment
- 1 5NVS deployment

A detailed scientific log for all sampling operations conducted during Leg 4b with the positions and depths of the visited stations is available in Appendices 1 and 2.

6.2.1 *Timeline of Operations*

After a science rotation in Kuujjuaq on 6 October, the ship started its course towards its final destination: Quebec City. Onboard, 28 scientists took this journey as the opportunity to collect more oceanographic data.

On 7 October, 3 stations were completed (356, 354, DFO-1). Operations that day consisted in rosette deployments, mooring recovery, net deployment as well as box core and beam trawl operations.

For the remaining time of Leg 4b, the ship was busy making its way back to its homeport while an observer from the Canadian Wildlife Service (CWS) conducted a pelagic seabird and mammal survey of the Labrador Shelf from the bridge of the ship.

Leg 4 ended with the 2017 Amundsen Expedition on 12 October as the *Amundsen* reached Quebec City.

Part II – Project reports

1 Carbon Exchange Dynamics, Air-Surface Fluxes and Surface Climate – Leg 2b

Project leaders: Tim Papakyriakou[1] (Tim.Papakyriakou@umanitoba.ca), Brent Else[2], Ming-Xi Yang[3]
Cruise participants – Leg 2b: Tonya Burgers[1], Brian Butterworth and Charel Wohl[3]
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1.1 Introduction

The biogeochemical cycling of carbon is continually changing within the Arctic Ocean as a consequence of climate change. The Arctic Ocean itself has undergone significant change in recent years, with large reductions in sea ice cover, increasing sea surface temperatures, and increased freshwater inputs. One objective of our research is to investigate such changes and their influence on air-sea CO_2 exchange rates. Comparatively, little is known about in-situ concentrations and/or air-sea exchange of oxygenated volatile organic compounds (OVOC's) such as acetone, acetaldehyde, etc.

Specific objectives of this research include:

1. Develop a process-level understanding of the exchange of CO_2, heat and momentum between the sea surface and atmosphere
2. Forecast how the ocean's response to climate change and variability will affect the atmosphere-ocean cycling of CO_2

1.2 Methodology

Multiple observation platforms have been utilized throughout the cruise to collect data pertaining to the atmosphere and surface ocean, such as a meteorological tower on the ship's foredeck, an underway pCO_2 system in the engine room, and radiation sensors above the wheelhouse of the ship. Table 1.1 lists the variables that are monitored, the location where the sensor is installed, the purpose for each variable, along with the sampling and averaging frequency (if applicable).

Table 1.1 Summary of variable inventory and application

Variable	Instrumentation	Location	Purpose	Sample/Average Frequency (s)
Air temperature (T_a)	HMP155A	foredeck tower	meteorological parameter	1 / 60
relative humidity (RH)	HMP155A	foredeck tower	meteorological parameter	1 / 60

wind speed (ws-2D)	RM Young 05106-10	foredeck tower	meteorological parameter	1 / 60
wind direction (wd-polar)	RM Young 05106-10	foredeck tower	meteorological parameter	1 / 60
barometric pressure (P_{atm})	RM Young 61302V	foredeck tower	meteorological parameter	1 / 60
incident solar radiation	Eppley Pyranometer	wheel-house platform	heat budget and microclimate	2 / 60
incident long-wave radiation	Eppley Pyrgeometer	wheel-house platform	heat budget and microclimate	2 / 60
photosynthetically active radiation (PAR)	Kipp & Zonen PARLite	wheel-house platform	heat budget and microclimate	2 / 60
wind speed 3D (u, v, w) and sonic temperature	Gill Wind Master Pro	foredeck tower	air-sea flux	0.1 (10 Hz)
Wind speed 3D (u, v, w) and sonic temperature	CSAT3	foredeck tower	air-sea flux	0.1 (10 Hz)
atm. water vapour concentration (ρ_v)	LICOR LI7500A & LI7000	foredeck tower	air-sea flux	0.1 (10 Hz)
atm. concentration of CO_2 (ρ_c)	LGR CO_2 Analyzer	foredeck tower	air-sea flux	0.1 (10 Hz)
rotational motion (acc_x, acc_y, acc_z, r_x, r_y, r_z)	Systron Donner MotionPak	foredeck tower	air-sea flux	0.1 (10 Hz)
upper sea water temperature (T_{sw})	General Oceanics 8050 pCO_2	under-way system, foreward engine room	air-sea flux and ancillary information	3 / 60
sea water salinity (S)	General Oceanics 8050 pCO_2	under-way system, foreward engine room	air-sea flux and ancillary information	3 / 60
dissolved CO_2 in seawater	General Oceanics 8050 pCO_2	under-way system, foreward engine room	air-sea flux and ancillary information	3 / 60
pH	General Oceanics 8050 pCO_2	under-way system, foreward engine room	air-sea flux and ancillary information	3 / 60
dissolved O_2 in seawater	General Oceanics 8050 pCO_2	under-way system, foreward engine room	air-sea flux and ancillary information	3 / 60

1.2.1 *Micrometeorology and Eddy Covariance Flux Tower*

The micrometeorological tower located on the front deck of the Amundsen provides continuous monitoring of meteorological variables and eddy covariance parameters. The tower consists of slow response sensors that record bulk meteorological conditions (air temperature, humidity, wind speed/direction, surface temperature) and fast response sensors that record the eddy covariance parameters (CO_2/H_2O concentration, 3D wind velocity, 3D ship motion, air temperature). All data was logged to Campbell Scientific dataloggers; a model CR3000 logger was used for the eddy covariance data, a CR1000 logger for the slow response met data. All loggers were synchronized to UTC time using the ship's GPS system as a reference.

1.2.2 *Underway pCO_2 System*

A General Oceanics 8050 pCO_2 system has been installed on the ship to measure dissolved CO_2 within the upper 5 m of the sea surface in near real time. The system is located in the engine room of the Amundsen, and draws sample water from the ship's clean water intake. The water is passed into a sealed container through a shower head, maintaining a constant headspace. This set up allows the air in the headspace to come into equilibrium with the CO_2 concentration of the seawater, and the air is then cycled from the container into an LI-7000 gas analyzer in a closed loop. A temperature probe is located in the equilibrator to provide the equilibration temperature. The system also passes subsample of the water stream through an Idronaut Ocean Seven CTD, which measures temperature, conductivity, pressure, dissolved oxygen, pH and redox. All data is sent directly to a computer using software customized to the instrument. The LI-7000 gas analyzer is calibrated daily using ultra-high purity N_2 as a zero gas, and three gases of known CO_2 concentration as span gas. Spanning of the H_2O sensor is not necessary because a condenser removes H_2O from the air stream before passing into the sample cell.

1.3 Comments and Recommendations

A kind reminder that when we are at station that the ship be pointed into the wind (when possible) so that the ship's smoke is not blown towards the met tower.

2 Are the Polar Seas a Net Source or Sink of Oxygenated Volatile Organic Compounds? – Leg 2b

Project leaders: Mingxi Yang[1] (miya@pml.ac.uk) and Brent Else[2]
Cruise participant – Leg 2b: Charel Wohl[1]
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[2] University of Calgary, Calgary, AB, Canada

2.1 Introduction

Acetone, acetaldehyde and methanol consume 80% of the OH radicals in the maritime atmosphere and affect ozone concentrations, a major air pollutant. Owing to the high solubility and in situ production of Oxygenated Volatile Organic Compounds (OVOCs), the oceans have an enormous potential to act as a source or a sink. The reactivity, ubiquity, high solubility and low concentrations make detection of OVOCs challenging. Previous atmospheric measurements of these compounds in the high Arctic show that observed concentrations could not be explained by air mass transport alone, pointing towards local sources.

In addition to OVOCs, a variety of climate active gases are measured on Leg 2b e.g. DMS, Isoprene, Trimethyl amine. These gases could act as cloud condensation nuclei especially in the marine atmosphere and hence influence the radiation balance of our planet.

The aim of this field campaign is to measure these gases in the air, in the continuous seawater supply and from CTD Rosette and evaluate these data in conjunction with the particle size distribution measurements and ozone measurements. This will give us a holistic view of the impacts of the ocean on the Arctic atmosphere and climate.

2.2 Methodology

We have developed a segmented flow coil equilibrator (Figure 2.1, left) for this cruise, which allows for continuous extraction of these compounds from the seawater. The segmented flow coil equilibrator was coupled to Proton-Transfer-Reaction Mass Spectrometer (PTR-MS) and deployed on board (Figure 2.1, right). The PTR-MS switches between underway water and air measurement of these compounds, enabling estimations of the gas fluxes between the atmosphere and the ocean. Air is sampled through an airline from the forward tower of the ship to lab 610 and underway seawater is analysed from the seawater tap in lab 610.

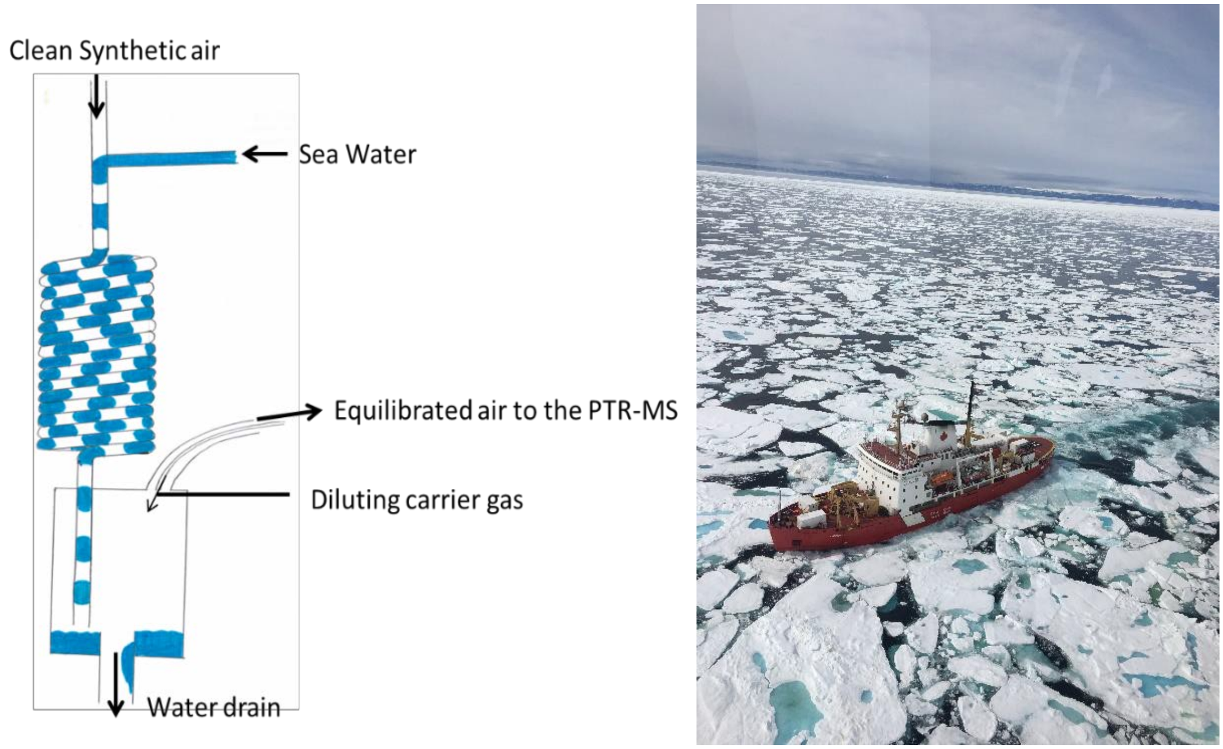

Figure 2.1 *Left*: Segmented flow coil equilibrator; Sea water and clean synthetic air mix in a 10m long coil submerged in a water bath. While travelling through the coil, the water and the carrier gas equilibrate with the neighbouring section of air. The equilibrated carrier gas is analysed by PTR-MS. *Right*: Deployment on board the ice breaker NGCC Amundsen and alteration between waterside and airside measurements of OVOCs.

At stations, a Niskin bottle was deployed from the foredeck to sample the minimally-disturbed surface. Seawater was collected from the rosette in the following stations to produce a 6 point depth profile;

Table 2.1 Operations conducted

Cast	Station	Lat-deg	Lat-sec	Long-deg	Long-sec
13	A16	63	38.36	68	37.574
17	BB1	66	51.6636	59	3.474
19	180	67	25.5636	61	23.3076
20	ROV Discofan	67	58.0524	59	30.1992
23	176	69	36.781	65	23.49
25	BB3	71	24.8928	68	36.7848
26	BB2	72	46.1076	67	0.2712
31	101	76	22.98	77	24.2796
34	103	76	20.778	76	35.6796
37	105	76	19.0488	75	45.6252
38	105	76	19.098	75	45.8784
45	126	78	19.4268	74	53.604
48	129	78	19.56	74	7.6176
51	131	78	19.7004	73	5.2824

53	TS233	77	45.294	76	36.3552
57	111	76	18.5436	73	13.1868
59	110	76	18.1704	73	37.0344
61	108	76	15.84	74	36.1416
63	ROV Jones	76	5.0832	81	56.4852
65	326	74	9.5628	80	27.8808
66	ROV Pond	72	49.6596	77	36.2196
67	ROV NBI	73	43.6464	81	6.0336
68	325	73	49.1016	80	29.7732
72	301	74	16.6596	83	21.8844
Zodiac	301	74	16.6596	83	21.8844
77	304	74	14.8752	91	31.986
82	Coring 5.10	74	29.3952	99	5.4372

Additionally a Zodiac was deployed to verify that surface water concentrations were not an artefact of the sampling method. Opportunistically, river water was analysed on the Rivers by Cara Manning.

3 Pelagic Seabird Surveys – Leg 4b

Project leader: Carina Gjerdrum[1] (carina.gjerdrum@canada.ca)
Cruise participant – Leg 4b: Carina Gjerdrum[1]
[1] *Canadian Wildlife Service, Environment and Climate Change Canada, Dartmouth, NS, Canada*

3.1 Introduction

The East Coast of Canada supports millions of breeding marine birds as well as migrants from the southern hemisphere and eastern North Atlantic. In 1969, PIROP (Programme intégré de recherches sur les oiseaux pélagiques) was initiated to document the abundance and distribution of marine birds in Atlantic Canada and eastern Arctic. The program was operated by the Canadian Wildlife Service (CWS) and supported by the large DFO oceanographic fleet based in eastern Canada. Much of the data collected under PIROP are limited beyond the mid-1980s, therefore, CWS reinvigorated the pelagic seabird monitoring program in 2005 with the goal of identifying and minimizing the impacts of human activities on birds at sea. Since 2005, a protocol for collecting data at sea and a sophisticated geodatabase have been developed, relationships with industry and others to support offshore seabird observers have been established, and over 250,000 km of ocean track have been surveyed by CWS-trained observers. These data are now being used to identify and address threats to birds in their marine environment.

The Labrador Shelf is known to be very important for seabirds in the fall, but we lack sufficient data to quantify abundance in the area. The objective of our seabird survey on board the Amundsen was to collect data on the abundance of seabirds from Kuujjuaq to Quebec City, data that will contribute to our understanding of this important migration corridor.

3.2 Methodology

Seabird surveys were conducted from the bridge of the Amundsen from 6-12 October 2017 travelling from Kuujjuaq to Quebec City. Surveys were conducted during the day while the ship was moving, looking forward and scanning a 90° arc to one side of the ship. All birds observed on the water within a 300 m-wide transect were recorded, and we used the snapshot approach for flying birds (intermittent sampling based on the speed of the ship) to avoid overestimating abundance of birds flying in and out of transect. Distance sampling methods were incorporated to address the variation in bird detectability. Marine mammal observations were also recorded, although surveys were not specifically designed to detect marine mammals. Details of the methods used can be found in the CWS standardized protocol for pelagic seabird surveys from moving platforms.

3.2.1 *Data Storage*

All data collected on marine bird and mammal sightings from the Amudsen will be imported into our main pelagic seabird survey database (MS Access), which is managed by Canadian Wildlife

Service in Dartmouth, Nova Scotia. The data are made publically available on OBIS (Ocean Biogeographic Information System), which is updated on a semi-annual basin.

3.3 Preliminary Results

We surveyed a total of 805 km of ocean from 6-12 October, 2017 through Ungava Bay, along the length of the Labrador shelf, and into the Gulf of St. Lawrence. A total of 2306 birds were observed from 10 families (Table 3.1). Seabird densities averaged 6.5 birds/km2 (ranging from 0 – 59.3 birds/km2). Dovekies accounted for 36% of the sightings (Table 3.1), the bulk of which were observed on the northern Labrador shelf. Dovekies are planktivorous and breed in the millions at colonies in western Greenland. After the breeding season, they travel across Baffin Bay and then eventually south to their wintering grounds on the Grand Banks and Scotian Shelf.

Northern Fulmars and Black-legged Kittiwakes were observed throughout the survey route, and accounted for 18% and 13% of the observations, respectively. Both species breed in Arctic and sub-Arctic colonies of eastern Canada, as well as Greenland, Iceland and the United Kingdom, but winter off eastern Canada.

Thick-billed Murres were also abundant on the shelf, and accounted for 10% of the sightings. Many of the adults observed were accompanying their young, which cannot yet fly. Murres breed in large numbers in significant colonies in the eastern Arctic and eastern Newfoundland and Labrador, and winter on the Grand Banks and Scotian Shelf.

Although the survey protocol used for the seabird surveys was not designed for marine mammals, all marine mammals observed were also recorded. Just 36 marine mammals were recorded, most of which were observed in the Gulf of St. Lawrence. These included Atlantic white-sided dolphins, minke whales, and a single humpback whale.

Table 3.1 List of bird species observed during surveys from the Amundsen, 6-12 October 2017

Family	Common name	Latin	number observed
Gaviidae	Common Loon	*Gavia immer*	1
	Unidentified Loon	Gaviidae	7
Procellariidae	Northern Fulmar	*Fulmarus glacialis*	423
	Sooty Shearwater	*Ardenna griseus*	45
	Great Shearwater	*Ardenna gravis*	2
Sulidae	Northern Gannet	*Morus bassanus*	2
Anatidae	Long-tailed Duck	*Clangula hyemalis*	15
	White-winged Scoter	*Melanitta fusca*	5
	Unidentified Ducks	Anatidae	7
Scolopacidae	Red-necked Phalarope	*Phalaropus lobatus*	11
	Unidentified Phalaropes	*Phalaropus*	150
Laridae	Pomarine Jaeger	*Stercorarius pomarinus*	5
	Unidentified Jaegers	*Stercorarius* Jaegers	1
	Unidentified Skuas	*Stercorarius* Skuas	1
	Black-legged Kittiwake	*Rissa tridactyla*	292
	Herring Gull	*Larus argentatus*	30
	Glaucous Gull	*Larus hyperboreus*	30
	Great Black-backed Gull	*Larus marinus*	11
	Unidentified Gulls	*Larus*	2
Alcidae	Dovekie	*Alle alle*	825
	Thick-billed Murre	*Uria lomvia*	228
	Common Murre	*Uria aalge*	77
	Atlantic Puffin	*Fratercula arctica*	50
	Razorbill	*Alca torda*	12
	Unidentified Murres	*Uria*	17
	Black Guillemot	*Cepphus grylle*	1
	Unidentified Auks	Alcidae	24
	Unknown Bird	Aves	2
Falconidae	Peregrine Falcon	*Falco peregrinus*	1
Strigidae	Snowy Owl	*Bubo scandiaca*	1
Fringillidae	Common Redpoll	*Carduelis flammea*	20
	House Finch	*Carpodacus mexicanus*	8
TOTAL			2306

Acknowledgement

The CWS monitoring program for seabirds at sea relies on the generous support of ships' crew and personnel; the surveys conducted from the Amundsen would not have been possible without the kind support of Alexandre Forest, and I thank him, the science staff, and ship's crew for giving me this valuable opportunity to accompany their mission.

4 Glaciers, Icebergs and Photogrammetry – Leg 2b

Project leaders: Luke Copland[1] (luke.copland@uottawa.ca), Anna Crawford[2] and Alison Cook[3]
Cruise participants – Leg 2b: Alison Cook[3], Abby Dalton[1] and Jill Rajewicz[2]
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4.1 Introduction

Tidewater glaciers drain glaciers, ice caps and ice sheets and terminate into the ocean where they discharge through the calving of icebergs and ice islands (large tabular icebergs). The Canadian Ice Service (CIS) produces charts to identify the presence of icebergs but has little knowledge about the sources and sinks of icebergs in Canadian waters. It is important to understand where these icebergs and ice islands originate, where they drift, how they deteriorate and the time scale of these processes. Trinity and Wykeham Glaciers on SE Ellesmere Island have increased iceberg production from 22% of total discharge from the CAA (Canadian Arctic Archipelago) in 2000 to 62% in 2016. They are the only two glaciers in the Queen Elizabeth Islands (QEI) to have shown consistent acceleration between 1999 and 2015 making it an area of significance for the study of ice discharge into Canadian Waters (Van Wychen et al., 2016). Operations during this leg will address the following gaps in knowledge surrounding the production and movement of icebergs and ice islands in Canadian waters:

- Which tidewater glaciers are the sources of icebergs and ice islands in Canadian waters and where do they drift?
- Are there changes in the size, shape or timing of iceberg production in the recent past and is this linked to glacier dynamics?
- Do sea ice conditions impact the production of icebergs at the termini of tidewater glaciers?
- How is the velocity of Trinity Glacier changing over time?
- What is the volume change of glacier ice over the past few decades?

4.2 Methodology

4.2.1 *Ice Island Measurements*

Ice island PII-2012-A_1-f grounded near Qikiqtarjuaq was unable to be visited due to poor weather conditions. The ice island was previously visited on July 27, 2016 by Luke Copland and Abby Dalton on behalf of Anna Crawford to make measurements of surface melt and changes in ice depth. Nine ice depth measurements were made along a transect previously marked by Anna using a ground penetrating radar (GPR) which will be compared with past measurements made at the same locations. Continuous measurements were unable to be made along the entire transect because of issues with the GPR receiver so spot measurements were made instead. Ablation stakes at each transect waypoint were measured to determine levels of surface melt. Five additional ablation stakes located near the weather station in the view of camera were measured. A new 5m hole was drilled for the sonic ranger at the weather station. If possible, the ice island will be visited later during the cruise or independently in Spring 2018.

4.2.2 *Iceberg Beacon Deployment*

Between July 16, 2017 and August 2, 2017 a total of 14 beacons were deployed on icebergs and ice islands in Baffin Bay and Lancaster Sound. Through a contract with Environment and Climate Change Canada (ECCC), 5 beacons were deployed onto icebergs and ice islands within Baffin Bay and Jones Sound (Table 4.1). The targets were chosen based on size, location and whether they were likely to drift (Figure 4.1). All 5 beacons have since successfully transmitted data remotely.

Figure 4.1 Examples of iceberg chosen for beacon deployment based on size, shape and stability. This iceberg was tagged August 2, 2017 in Lancaster Sound. Photo: Abby Dalton.

Table 4.1 CIS beacon deployment summary.

IMEI #	Date	Time (local)	Latitude	Longitude	Deployment Location
3002340-3516450	July 16 2017	10:31	62° 20.250 N	65°02.748 W	E of Resolution Island
3002340-62324750	July 21 2017	13:27	70°29.508 N	66°38.519 W	E of Scott Inlet
3002340-62325760	July 21 2017	13:46	70°19.976 N	67°01.636 W	E of Scott Inlet
3002340-62328750	July 25 2017	09:30	76.31615 N	75.14414 W	E of Manson
3002340-62327750	July 30 2017	14:22	76.12078 N	80.97548 W	Jones Sound

Figure 4.2 Example of placement of CIS beacon. Deployed on iceberg near Jones Sound (July 30, 2017). Photo: Abby Dalton.

Nine additional beacons were deployed containing iridium GPS receivers (RockStar), batteries and solar panels (Figure 4.3). Four of these beacons were deployed onto icebergs/ice islands within Baffin Bay, three were deployed within Trinity Fiord to track movement of icebergs produced by Trinity Glacier within and out of the fiord and two were deployed in Lancaster Sound. Positions of these seven beacons will be viewed on www.core.rock7.com to monitor movement and identify drift patterns of icebergs around Baffin Bay. Additionally, three beacons deployed in Trinity Fiord in 2016 were retrieved and redeployed onto icebergs in Trinity Fiord. Settings had to be changed on these devices to allow them to turn back on after losing power over the winter.

Figure 4.3 Example of placement of beacon on iceberg. Deployed E of Manson icefield July 25, 2017. Photo: Abby Dalton.

Table 4.2 RockStar beacon deployment summary

Unit	Deployment Date	Deployment Time (local)	Latitude N (as of 00:00 UTC first full day deployed)	Longitude W (as of 00:00 UTC first full day deployed)	Deployment Location
3642	July 25 2017	10:50	76° 13.865' N	075° 32.961' W	E of Manson
3520	July 26 2017	11:10	76° 20.323' N	070° 05.973' W	W of Thule
5973	July 26 2017	11:25	76° 25.578' N	070° 32.510' W	W of Thule
3636	July 30 2017	14:41	76° 10.603' N	081° 37.738' W	Jones Sound
3650	August 2 2017	13:57	74° 01.697' N	078° 31.716' W	Lancaster Sound
3656	August 2 2017	14:06	73° 54.856' N	078° 45.478' W	Lancaster Sound
3505	July 28 2017	11:55	77° 56.051' N	077° 34.233' W	Trinity
3610	July 28 2017	13:44	77° 57.251' N	078° 10.398' W	Trinity
3646	July 28 2017	13:18	77° 53.950' N	077° 29.749' W	Trinity

4.2.3 *Differential GPS System Maintenance*

Two differential GPS systems (dGPS) were installed on Trinity Glacier on August 10, 2016 to monitor changes in glacier velocity (Figure 4.4).The first station is located down-glacier (78º01' 54.94''N, 78º50'56.40''W) and contains a battery and solar powered dGPS system (Trimble NetR9 & XI-100). Since installation, this station has moved ~0.5 mi from its original position. The station is now (as of July 28, 2017) located between two large crevasses and is no longer safely accessible. The Trimble NetR9, antenna and timelapse camera were recovered. The second station was installed up-glacier at 78º01'51.75''N, 79º12'14.62''W and has since moved to 78° 01.968' N 079° 11.660' W as of July 21, 2017 and contains a battery and solar powered dGPS (Trimble R7). Both stations transmit data remotely through Iridium connection and include south-looking solar-powered timelapse cameras (SpyPoint) facing ablation stakes marked with 5cm increments to monitor surface melt rates. Timelapse cameras are programmed to take photos hourly. Timelapse data was downloaded from the camera/ablation stake. While attempting to drill in new ablation stakes the flights became frozen in the ice and was therefore not completed.

Figure 4.4 Inaccessible lower dGPS station on Trinity Glacier July 28, 2017. Photos courtesy of Abby Dalton.

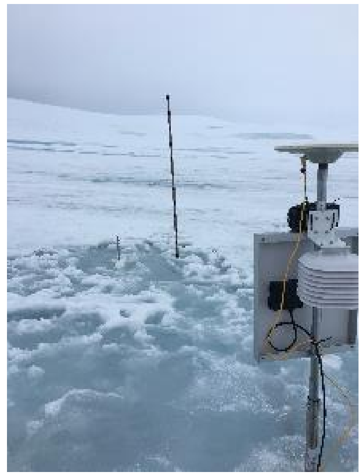

Figure 4.5 Upper dGPS station on Trinity Glacier July 28, 2017. Photos courtesy of Abby Dalton.

4.2.4 *Timelapse Camera Maintenance*

A DSLR camera (Canon EOS Rebel T6i with EF-S 24mm f/2.8 STM lens) was installed on a nunatak between Trinity and Wykeham Glaciers on August 10, 2016. The camera is housed within a Harbortronics unit mounted on a tripod. The camera is connected to a battery for power through the winter with a solar panel mounted on the tripod for power during the summer months. The camera faces the terminus of Trinity Glacier and is set to take photos every hour to monitor iceberg. This site was visited on 28 July 2017 to download imagery. Approximately 7600 images were taken since deployment and continued being taken until June 2017 when the memory card was full. A new 64GB memory card was put in the camera and reformatted. Due to weather conditions, the intervalometer was not reprogrammed with updated settings. The intervalometer and the camera were placed back in the pod to continue taking hourly photos for another year.

Figure 4.6 DSLR timelapse camera facing Trinity Glacier, July 28, 2017. Photo courtesy of Abby Dalton

Three additional SpyPoint cameras were installed around Trinity Fiord on 10 August 2016 to monitor iceberg production and sea ice/iceberg movement within the fiord (Figure 3.6). Two cameras (adjacent to the DSLR camera location) were installed between Trinity and Wykeham Glaciers, one facing the terminus of Wykeham Glacier and one facing outward towards the mouth of the fiord. A third camera was installed on an island directly in front of Trinity Glacier (77º57'21.23''N, 78º07'54.25''W) to monitor movement of sea ice and ice melange at the terminus. Images from these cameras were downloaded. The camera facing Wykeham Glacier successfully took photos until the date of retrieval. The camera facing Trinity Glacier stopped working in September 2016. After clearing the memory cards and reprogramming the time lapse settings, both cameras were left to continue data collection. The camera located on the island facing Trinity Glacier only worked for ~4 days before being blown over by wind. Batteries in the back of the camera leaked and it was unable to be reinstalled. This camera was taken off the island.

Figure 4.7 SpyPoint timelapse on an island facing the terminus of Trinity Glacier. Camera was damaged and as a result was taken off the island, July 28, 2017.Photo: Abby Dalton.

4.2.5 *Photogrammetry of Devon Island Glacier*

On 2 August 2017, conditions were suitable for undertaking an aerial survey of 'Cunningham East' glacier on SE Devon Island. This glacier extended to the ocean in 1959, as shown in aerial photographs from an early survey. The front of the glacier has retreated by over 2 km since then and now terminates inland. The aim of the new aerial survey is to produce a model of the ice surface, and from this calculate the change from the elevation of the ice surface in 1959. This is using the technique 'Structure from Motion', whereby photographs taken from the helicopter can be mosaicked and a surface model constructed using photogrammetric software. This method requires ground position measurements to be taken for georeferencing the imagery and to increase accuracy of the elevation model.

Fieldwork began with setting up GPS units on suitable ground control points surrounding the glacier (Figure 4.8); however it was not possible to set out more than three units (from an intended six) due to ship schedule and increasing cloud.

The aerial photography sortie was successfully completed in 1 hour 10 minutes, with a total of 1045 digital photographs (using Canon EOS 6D camera) taken from the open rear door of the helicopter. The helicopter flight track was at a suitable flying height (6000 ft) and with repeat lines in order to produce overlapping photographs, as required for the photogrammetry. The processed images and GPS positions will be used for analysis following the cruise.

The original intention was to complete surveys for up to 10 glaciers. Unfortunately poor weather and other constraints (such as timings) meant that we did not achieve any of the 10 glaciers on our original list. Although not on our list, Cunningham East glacier was a suitable glacier. Overall the mission was successful, although with issues such as few GPS location points and poor light for photography.

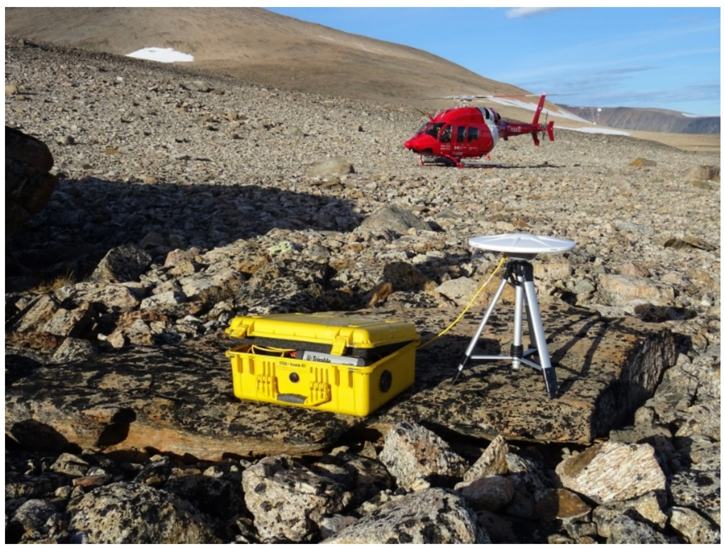

Figure 4.8 One GPS unit set up on rock feature on the west side of 'Cunningham East' glacier (photo: Alison Cook)

Figure 4.9 'Cunningham East' glacier. Photograph taken from the helicopter during GPS ground position location search (photo: Alison Cook)

4.3 Preliminary Results

Shown below (Figure 4.10) is a track of an iceberg tagged off Manson Icefield on SE Ellesmere Island. Results show that is has drifted in a looping pattern since being deployed. Most results will only be known at a later time once the newly deployed iceberg trackers have been followed for several months and the dGPS instruments and time lapse cameras at Trinity Glacier are downloaded and analyzed.

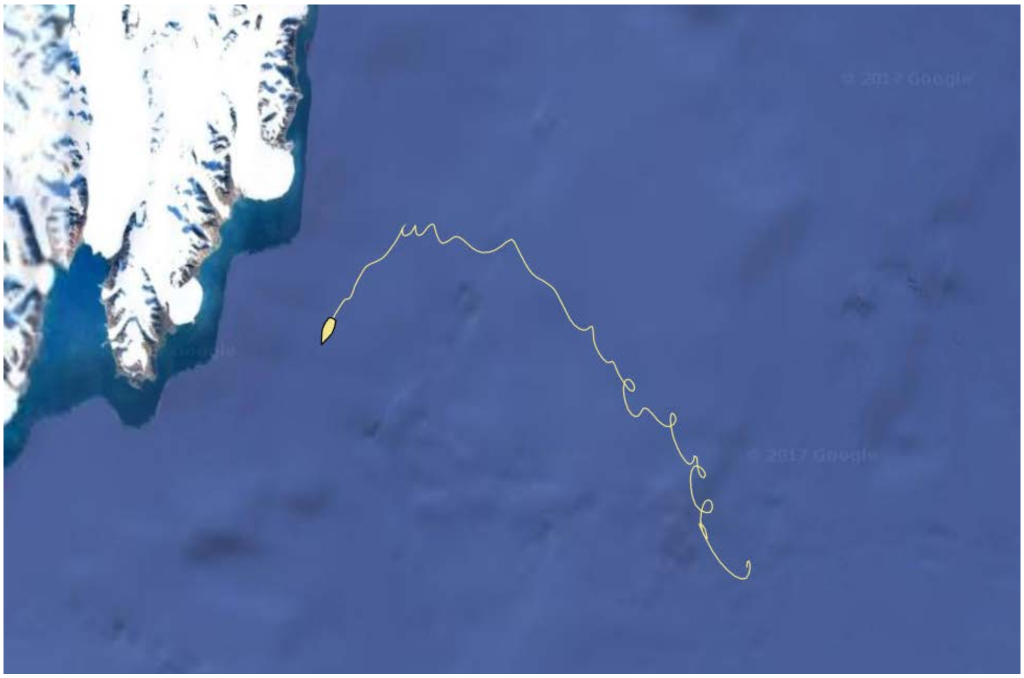

Figure 4.10 Drift track of iceberg tagged off the SE coast of Ellesmere Island from July 26 to August 4, 2017.

Reference

Van Wychen, W., Davis, J., Burgess, D.O., Copland, L., Gray, L., Sharp, M. and Mortimer, C. (2016) Characterizing interannual variability of glacier dynamics and dynamic discharge (1999-2015) for the ice masses of Ellesmere and Axel Heiberg Islands, Nunavut, Canada. Journal of Geophysical Research – Earth Surface, 121, doi: 10.1002/2015JF003708

5 Deployment of BGC Argo Floats – Leg 2b

Project leader: Marcel Babin[1] (marcel.babin@takuvik.ulval.ca)
Cruise participants – Leg 2b: Claudie Marec[1] and José Lagunas[1]
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5.1 Introduction

During the Amundsen AN7 leg2B cruise, we deployed 7 BGC (biogeochemical) Argo floats, following the deployment performed in 2016 (GreenEdge cruise) where different instruments were used to track the "ice edge spring bloom". PRO-ICE floats are autonomous platforms, equipped with numerous sensors dedicated to characterize the water column. During its life (at least 3 years depending on the frequency of profiles) a float drifts (Lagrangian ARGO float) and profiles between the surface and down to the bottom (or a programmed depth: 1000m in our case) then back to the surface. When in the surface, the float is geo-localized and transmits its data using the Iridium communication system.

Basically, two ice detection systems are implemented on the PRO-ICE floats to ensure a safer navigation in icy waters (avoid surfacing when ice is present). An upward-looking altimeter will detect thick ice and icebergs. Additionally, an algorithm based on sea-water temperature (ISA Ice Sensing Algorithm) will be an indicator of the presence of sea-ice.

5.2 Methodology

7 PRO-ICE floats were deployed using the A-frame. The areas for deployment were previously chosen after a study of the global Baffin Bay circulation (thanks to E.Rehm's simulations-Takuvik).

Four theoretical positions were chosen according to those discussions and bibliography about the currents in the area (Tang et al, 2003). A daily study of geo-referenced Radarsat ice maps received onboard helped (when available) to deploy in the center East of Baffin Bay and ensure an ice-free area. Besides composite maps from remote-sensing (AMSR2 for sea-ice concentration and MODIS for chla concentration) were daily generated by Takuvik (thanks to M. Benoit-Gagné).

During operations, it was decided to reduce to 2 zones and deploy 2 batches of floats (4 in the first area (GreenEdge cruise) and 3 in the central Baffin Bay).

4 Argo floats were deployed in the same area as during the Greenedge cruise in 2016. Hereafter is the description of their parameters.

The area for the initial launching was still covered by ice. It was decided to steam a little more East than the theoretical position to reach a safe ice-free area.

5.2.1 *Description of the Floats and their Scientific Payload*

Each float is equipped with the following sensors:

- CTD,
- Radiometer: OCR wavelengths:380, 412, 490nM, PAR,
- fluorescence chla,
- fluorescence CDOM,
- Backscattering,
- Suna (nitrates),
- Optode (Oxygen)
-

takapm006C
(WMO 4901804) deployed on 20th, July 2017,
lat: 69°38.136'N / Long 60°43.961'W
bathymetry 1674m

takapm012B
(WMO 4901805) deployed on 20th, July 2017,
lat: 69°38.742'N / Long 60°44.949'W
bathymetry 1674m

takapm015B
(WMO 6902670) deployed on 20th, July 2017,
lat: 69°38.525'N / Long 60°43.237'W
bathymetry 1666m

takapm008B
(WMO 6902669) deployed on 20th, July 2017,
lat: 69°38.948'N / Long 60°42.329'W
bathymetry 1659m

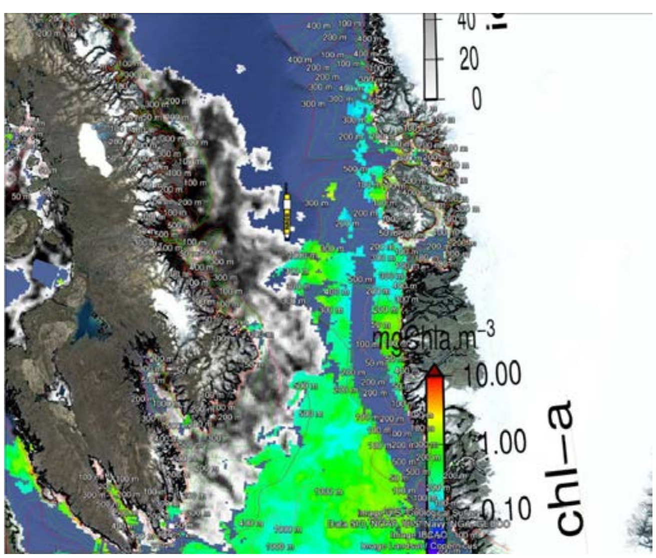

Figure 5.1 1st area for 4 deployments: ice cover (AMSR2) and chla concentration (MODIS)

3 more PRO-Ice floats were deployed N-NW of the previous batch of floats (BB2 ArcticNet historical station). This site is located in the very center of the cyclonic gyre in Baffin Bay and the simulations foretell that the floats would stay navigating in the Central Baffin Bay throughout their lifetime.

takapm007B
(WMO 6902666) deployed on 23rd, July 2017,
lat: 72°46.295'N / Long 67°01.885'W
bathymetry 2373m

takapm016B
(WMO 6902671) deployed on 23rd, July 2017,
lat: 72°46.127'N / Long 67°00.485'W
bathymetry 2323m

takapm017B (WMO 6902829) deployed on 23rd, July 2017,
lat: 72°46.180'N / Long 67°00.400'W
bathymetry 2372m

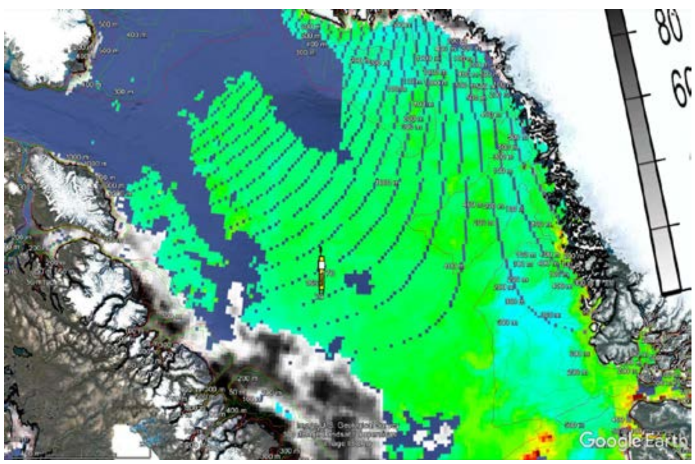

Figure 5.2 Second area for 3 deployments in Central Baffin Bay: ice cover (AMSR2) and chla concentration (MODIS)

CTD casts were performed at both site of deployment; sampling for HPLC, chl a, Ultrapath (CDOM) and nutriments analysis were performed on the casts. This will be used for in situ calibrations. Oxygen samples are analysed to check the response of the CTD (helpful to cross-check the optode response of the float) BB2 is a full station were different operations and CTD casts were performed.

5.3 Preliminary Results

Since their deployment, the sampling and navigation functionalities of all 7 floats have worked as expected and continue to do so and navigate (see figure underneath). Data are daily collected on a server. We had to adapt the diving pattern because of a drifting foe arriving on their zone.

The floats are programmed on a seasonal pattern and profile the water column daily down to 1000m until fall (ice covering). Then the pattern will change to a profile every 3days. During wintertime, they will park with a profile per month only (no surfacing because of ice-cover). Thanks to a bi-directional Iridium communication system, it is possible to modify the pattern of the float and the resolution of sensors.

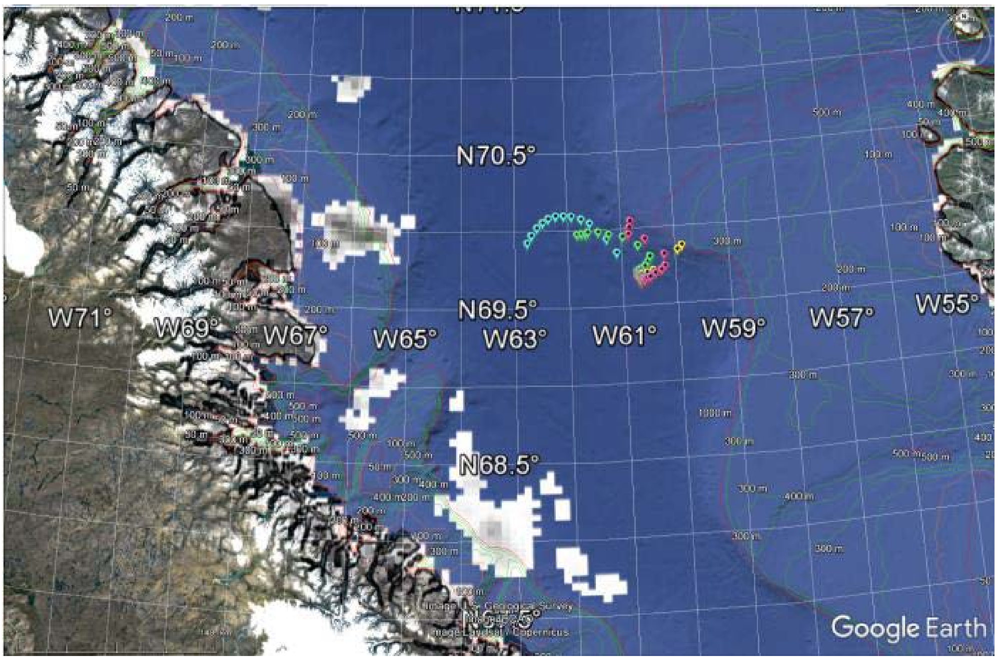

Figure 5.3 Routes of the 4 & 3 PRO-ICE since deployment till Aug,14th2017(1st batch)

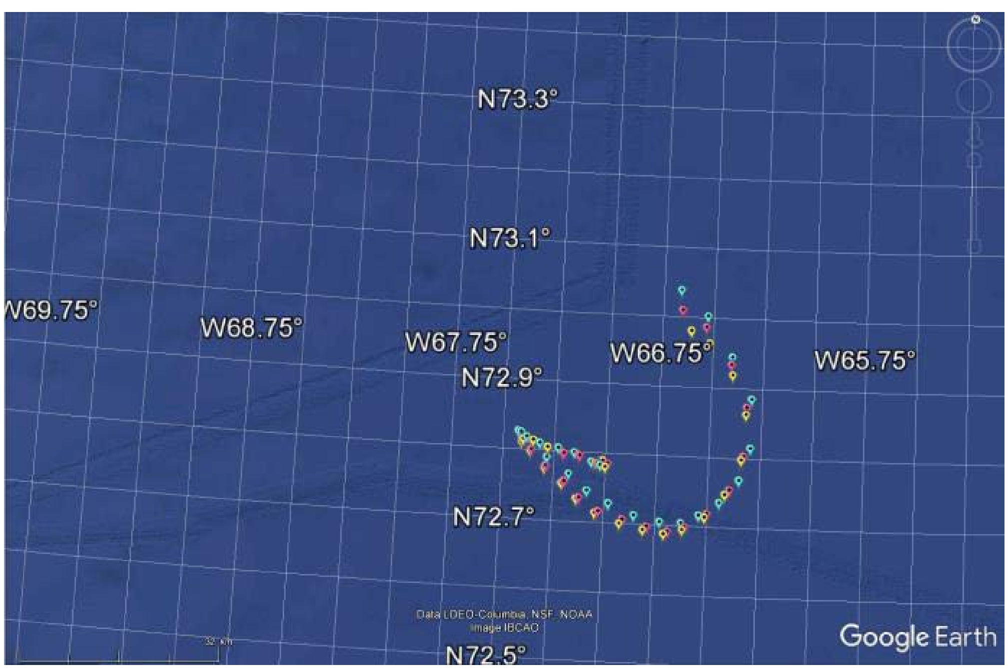

Figure 5.4 Routes of the 4 & 3 PRO-ICE since deployment till Aug,14th2017(2nd batch)

5.3.1 *Amount and Type of Data Collected*

Geo-localized data from the floats are presently collected once a day. The frequency of the profiles will vary accordingly to the month, as described in Table 5.1. The criteria to produce this schedule was the ice cover conditions in Baffin Bay throughout the year and the phytoplankton bloom period. This drift and profiling plan accounts for a yearly total of 207 profiles per float.

Table 5.1 Profiling schedule for the deployed Pro-Ice floats, given in number of profiles per month

Month	No. of Profiles/month	Month	No. of Profiles/month
January	3	July	31
February	3	August	31
March	3	September	30
April	3	October	30
May 1 – May 16	8	November 1-15	15*
May 16 – May 31	15	November 16-30	2*
June	30	December	3

*ice cover dependant

These profiles will provide data from the different sensors measuring the water column between 1000m and surface. The resolution of each sensor is set accordingly to specific depths, for instance high resolution in the euphotic zone, compared to the depth layer between 1000m and 350m. This is best described in Table 5.2, where the sampling rate of the sensors previously described are modified while ascending through the water column. The last depth zone is activated whenever a 2000m bathymetry is available

Table 5.2 Scientific payload sampling rate for the month of September, the last zone is activated whenever a 2000m bathymetry is available

	CTD / m	OCR / m	ECO / m	Optode / m	Suna / m
0-10m	0,2	0,2	0,2	1	2
0-50m	0,2	0,2	0,2	1	2
10-350m	1	1	1	1	10
350-1000m	1	-	10	10	30
1000-2000m	10	-		50	50

Data from the floats have been readily available since their deployment. Figure 5.5 show an example of preliminary of data sent back by the takapm012b (July, 26th 2017).

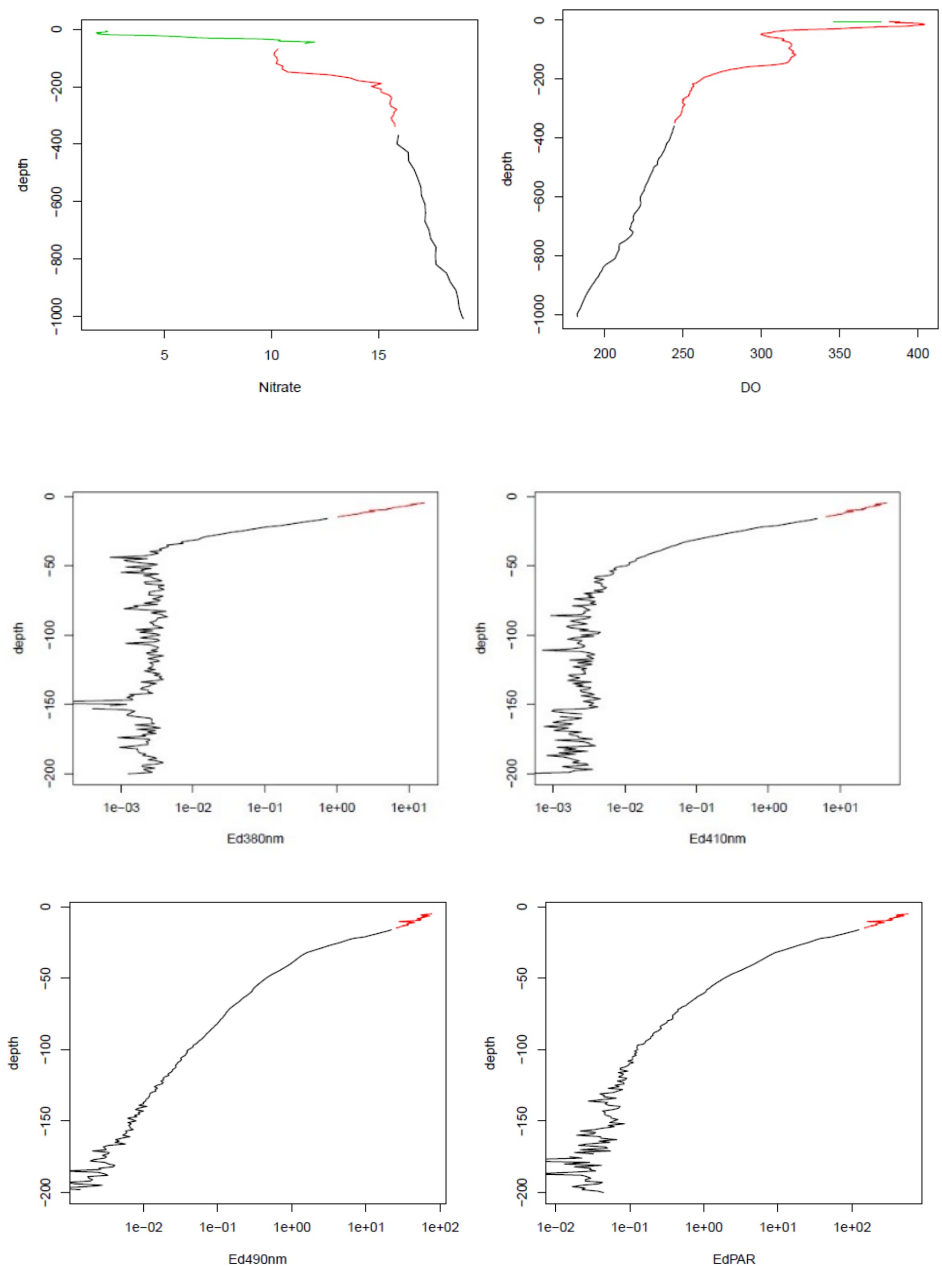

Figure 5.5 Top left: temperature, salinity and potential density anomaly, Top right: CDOM (Colored dissolved organic matter), Middle left: proxy of Chlorophyll-a concentration Middle right: back-scattering, Bottom left: Nitrate Bottom right: Dissolved Oxygen Data from the 3 radiometers and the PAR sensor (Photo-synthetically Available Radiation).

5.4 Comments and Recommendations

The operations on board of the Amundsen have been satisfying -the help and support of the crew timely and precise. The advice of officers for the ice-maps reading was essential.

The point to be signaled is the erratic access to internet which makes things difficult to access to the server and therefore communicate with the floats. This was a real issue for the deployments and the follow up of the floats. Fortunately, we were given an exceptional access to internet through Iridium, in order to recover files from the 4 first floats and transmit new instructions to them.

Acknowledgement

J.E Tremblay, Jonathan Gagnon, Martine Lizotte, Joannie St Onge, Joannie Charette, and Aude Boivin-Rioux for their help with sampling, filtering and other activities regarding this operation.

6 Mooring Program

Project leader: Louis Fortier[1]
Cruise participants: Shawn Meredyk[1](Amundsen Lead), Jeurgen 'Baly' Zier (Laurier Lead)[1], Luc Michaud[1], Thomas Linkowski[1] , Greg Curtiss[2], Mark Downey[3]
[1] *Amundsen Science, Université Laval, Québec, QC, Canada*
[2]*Golder Associates Ltd., Seattle, WA, USA*
[3]*Memorial University of Newfoundland, St. John's, NL, Canada*

6.1 Introduction

Sampling year 2017 was part of a summer-fall campaign involving three legs and two support vessels, studying the air-sea interactions, underwater sound ecology, ocean circulation variability and basin-shelf sediment interactions in the southern Beaufort Sea, Amundsen Gulf, Queen Maud Gulf and northeastern Baffin Bay.

Mooring operations during Leg 2b (July 13 – August 17) included two continuing mooring programs (Weston and LTOO). The ArcticNet – Parks Canada – Weston Foundation mooring (WF1), investigating the oceanographic conditions affecting the shipwreck Erebus in the Queen Maud Gulf. The Baffin Bay LTOO moorings (BA06, BA05) were redeployed to continue studying the bottom current rounding southern Greenland and its interactions with the Nares Strait and Lancaster Sound water masses. Leg 4b (Oct.6 – Oct. 13) onboard the *Amundsen* deployed a new mooring (HiBioA) for the HiBIO program, which is studying the oceanographic conditions of the Hudson Strait outflow and their possible control on benthic ecology around Hatton Basin.

Mooring operations during between September 18 – October 4, onboard the *Laurier*, were part of the ArcticNet Long-Term Ocean Observatory (LTOO) project / and Integrated Beaufort Observatory (iBO; partly supported by the Environmental Study Research Fund (ESRF)). The LTOO moorings in Cape Bathurst Polynya are a continuation of the LTOO dataset studying these nutritive waters. The iBO mooring sites are based on key locations identified by the Southern and Northeastern Beaufort Sea Marine Observatories project funded under the former Beaufort Regional Environmental Assessment (BREA) (2011 to 2014). Mooring operations onboard the *Laurier* concerned the re-deployment of iBO-LTOO associated moorings maintained by the Institute of Ocean Sciences (IOS, Fisheries and Oceans Canada) and ArcticNet / Amundsen Science. The details of which can be found in the 2017 IOS cruise report (DFO, 2017).

The total ArcticNet / Amundsen Science managed mooring operations, during leg 2 and 4 onboard the *Amundsen*, included five moorings deployed and three moorings that were redeployed in the northeastern NE Baffin Bay and in the Queen Maud Gulf. A benthic lander / mooring was deployed for Dr. P. Archambault in conjunction with the OceanLab in Edinburgh, Scotland. Simultaneously, mooring operations onboard the *Laurier*, on Leg 3, included five mooring recoveries and four mooring re-deployments with two deployments for LTOO (CA05, CA08) in the Beaufort Sea and Amundsen Gulf.

6.2 Methodology

6.2.1 *Areas of Focus*

Eastern Arctic

In the NE region of Baffin Bay, moorings BA05 and BA06, were redeployed to continue to examine the interaction of the bottom water currents (up to 50m off-bottom) and the potential mixing with the water mass leaving Nares Strait and Lancaster Sound water masses.

Small passive water samplers (SPMD) that clamp directly to the mooring line or instrument cage were redeployed to continue to monitor concentrations of persistent organic pollutants (POPs) in the benthic layer (deep Atlantic waters) by Gary Stern at CEOS in Winnipeg, Manitoba (for further reference to SPMD analysis and results contact Gary Stern).

A benthic lander / mooring was deployed for Dr. K. Jackson from the OceanLab in Edinburgh, Scotland in conjunction with ULaval researcher Dr. P. Archambault. This lander was designed to take photos of the benthic environment every hour. The original deployment site was at Qikitarjuak, however, ice conditions this year prevented all operations along the East coast of Baffin Island this year.

Labrador Sea

A new mooring was developed to examine the water properties at the shelf break on the eastern edge of the Hatton Basin and Labrador Sea was deployed this year, for the HiBIO program (Memorial University Lead). The mooring was equipped with profiling current meters examining the upper 10m off-bottom, sediment traps and hydrophones. Hydrophone recordings on the shelf-slope area will monitor bioacoustics vocalizations throughout the year to better understand the soundscape that current and future fishing operations have in this potential marine protected area.

Central Arctic

Moorings WF1 and WF2 are part of a combined effort by the Weston Science Foundation, ArcticNet and Parks Canada, to study the oceanographic conditions effecting the shipwrecks the Erebus and Terror, in the Queen Maud Gulf. The Weston Foundation provided sufficient funding for oceanographic equipment and ArcticNet and Parks Canada provided technical and operations support with the vessel support from the CCGS Amundsen. Mooring WF1 was deployed in 100m of water in the Queen Maud Gulf and WF2 was a benthic tripod (located at the Erebus at 12m depth) with an upward looking ADCP (RDI Sentinel V) combined with an RBR CTD-Tu sensor (Appendix 2). These moorings provide a baseline dataset of water column current profiles, turbidity and sedimentation rates and organic carbon fluxes, and fluorescence.

Western Arctic

The Amundsen Gulf is an area where the air-sea interactions occurring in the ice-free sections of the southern Beaufort Sea and Amundsen Gulf were investigated. This productivity hotspot is of interest, to monitor the intermittent upwelling of cold-saline water on the eastern shelf, despite the fact that the origin of the upwelling is much closer to Cape Bathurst (e.g. CA05). Ocean circulation is highly variable here, but the along-shelf flow of Pacific-derived water entering the Amundsen Gulf can be potentially monitored at depth. Mooring CA08 is the center of the 'Cape Bathurst polynya' as defined in Barber and Hanesiak (2004). This location continues to be a good site for the long-term monitoring of particle flux, as it has all the advantages of adequately recording both the seasonal signal and the inter-annual variability of marine productivity in the Amundsen Gulf, with minimal terrigenous input.

Capturing the Beaufort gyre's anti-cyclonic (west) movement relative to a long-shore counter-current (east) plays an important role in understanding deep and shallow water movements relative to nutrient and particle fluxes.

Ice cover, examined by moored ice profilers and satellite imagery, plays a significant role in terms of affecting momentum transfer from wind to water, constrained (in the case of landfast ice) and enhanced (in the case of drift ice) by wind.

Hydrophone recordings on the shelf-slope area will monitor bioacoustics vocalizations throughout the year to better understand the potential impact that future operations in the Beaufort Sea could have on the marine mammals.

The Mackenzie Trough, a cross-shelf canyon in the Beaufort Sea shelf, has been observed to be a site of enhanced shelf-break exchange via upwelling (caused by wind- and ice-driven ocean surface stresses). The canyon provides a conduit for bringing deeper, nutrient rich water to the shelf. Shelf waters in the area are seasonally influenced by freshwater output from the Mackenzie River, both in terms of temperature-salinity properties and suspended sediments / turbidity.

The SPMDs on the deeper-water moorings were redeployed in an effort to continue to monitor concentrations of persistent organic pollutants (POPs) in the mixed surface layer (Pacific water mass and the deep Atlantic waters) by Gary Stern at CEOS in Winnipeg, Manitoba (for further reference to SPMD analysis and results contact Gary Stern).

6.2.2 *Mooring Arrays*

<u>Baffin Bay</u>

Moorings BA05 and BA06 form a small array near the Northern Open-water Polynya in the upper NE region of Baffin Bay. These mooring were deployed in 2016 and were re-deployed in 2017 to continue collecting data on the NSW Greenland benthic current. The data will also be used in current model validation by Dr. Danny Dumont (UQAR).

Beaufort Sea

The iBO moorings (BRG, BR1, BRK, BR3) helped form three shelf –slope arrays that examined the spatial variability in shelf-slope processes in the southeastern Beaufort Sea. These moorings continued a long-term integrated observation of ice, water circulation and particle fluxes established in the southern Beaufort Sea since 2002. Moorings BR1, BRG, BR3 and BRK were as part of the iBO program. Additionally, moorings DFO-1, DFO-2 and DFO-9 (included in the iBO program) were redeployed from the CCGS Laurier in September 2017, along with MARES and other DFO moorings.

<u>Amundsen Gulf</u>

LTOO moorings CA08 and CA05 deployed in the Amundsen Gulf to extend the annual time-series collected in the area from 2002 to 2016. This region, also known as the “Cape Bathurst Polynya”, was previously identified as an area of increased biological activity due to an earlier retreat of sea ice in spring and frequent upwelling of nutrient-rich waters that develops along Cape Bathurst and near the eastern edge of the Mackenzie Shelf.

<u>Queen Maud Gulf</u>

Moorings WF1 and WF2 are moorings that are part of a combined effort by the Weston-Garfield Foundation, ArcticNet and Parks Canada deployed to study the oceanographic conditions near the Erebus and in the Queen Maud Gulf near the location of the wreck site. The Weston Foundation provided sufficient funding, with in-kind support from ArcticNet. ArcticNet and Parks Canada provided technical and operations support with the vessel support from the CCGS Amundsen / Sir Wilfred Laurier. Mooring WF1 was redeployed in 112m of water in the Queen Maud Gulf. WF2 was a benthic tripod (near the Erebus at 12m depth) with an upward looking ADCP (RDI Sentinel V) combined with an RBR CTD-Tu sensor was not serviced in 2017, due to complications with vessel logistics between Parcs Canada and the Canadian Coast Guard.

<u>Labrador Sea</u>

The new mooring HiBIOA is a shelf – slope break mooring array installed in 2017 to examine the effects on invertebrate megafaunal settlement, marine mammal presence and shelf-slope carbon fluxes. The moorings were also equipped with hydrophones and near bottom current profilers which will help answer questions about near-bottom sedimentation (benthic currents) and to listen for marine mammal activity. The HiBIO project was created to collect baseline studies of the area and processes needed to help DFO make an informed decision as to where to place the Marine Protected Area (MPA) in this part of the Labrador Sea. Emphasis on benthic marine life and the processes governing them is the over-arching objective of this mooring.

6.2.3 *Individual Mooring Objectives – 2017*

i. Continued LTOO Moorings CA08-17 (400m) and CA05-17 (200m) were deployed, in an effort to collect data in the center and NW extent of the Amundsen Gulf.

ii. LTOO moorings BA05-17 (531m) and BA06-17 (535m) were redeployed in the NE Baffin Bay (Figure 6.1).

iii. The Weston-Garfield Science Foundation mooring WF1 (100m) was redeployed, in a continued effort to collect baseline data within the Queen Maud Gulf (QMG) to better understand the oceanographic conditions affecting the shipwrecks Erebus and Terror and Biogeochemical fluxes in QMG (Figure 6.1).

iv. Moorings BRK-17 (170 m), BRG-17 (700 m), BR3-17 (714m), BR1-17 (699m) were re-deployed as part of the ongoing effort to assess ocean circulation (the southern extent of the Beaufort gyre current near the Mackenzie Shelf), biogeochemical fluxes and sea ice motion and thickness distribution in key areas of the Mackenzie shelf-slope system (Figure 6.1).

v. Mooring HiBIOA-17 (508m) was deployed as part of the new HiBIO program investigating the effects on invertebrate megafaunal settlement, marine mammal presence and shelf-slope carbon fluxes for the eastern edge of Hatton Basin – Labrador Sea (Figure 6.1).

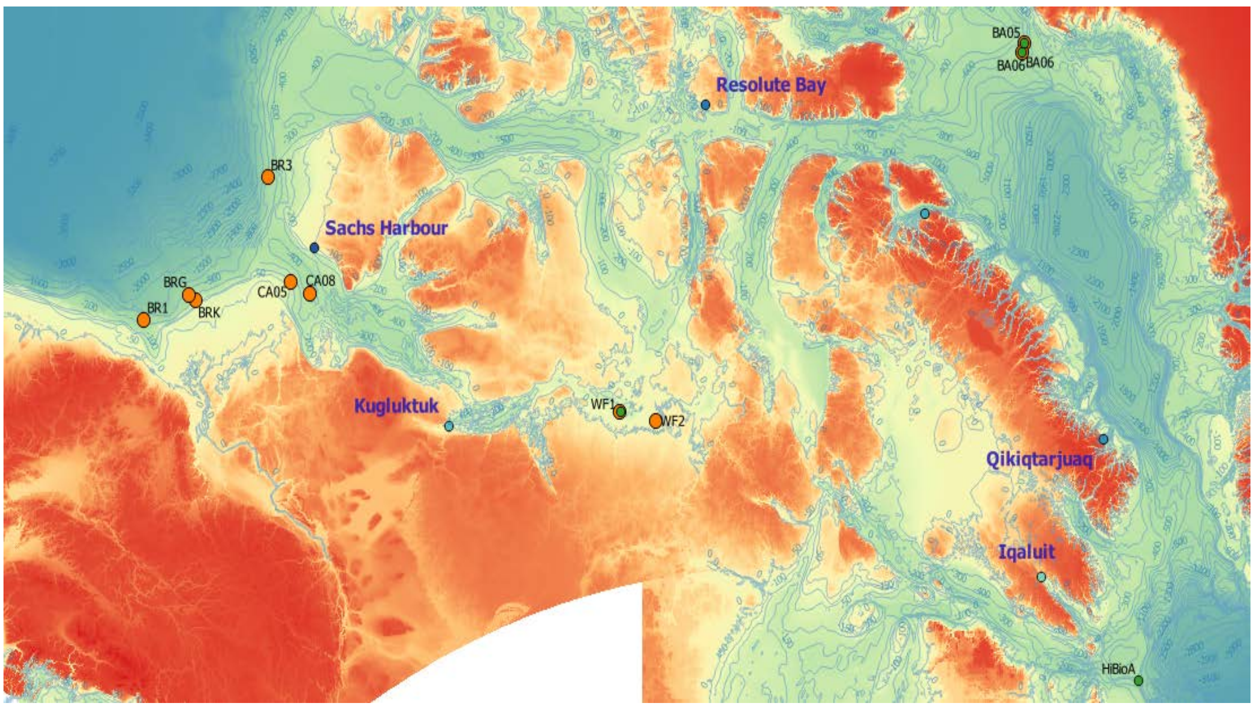

Figure 6.1 Mooring Locations 2016 (orange) & 2017 (green): iBO, LTOO and Weston Moorings. iBO moorings DFO-1, DFO-2, and DFO-9 can be found in the IOS Sciences Cruise report 2017-97 (DFO, 2017).

6.2.4 *iBO & ArcticNet Mooring Designs*

<u>Recoveries</u>

BA05-16	Northeast Baffin Bay	
Target Instrument Depth (m)		Instrument
		
418		Nortek 470kHz ADCP (DL)#6064
		Contineta frame
		Continetal frame panther buoys (6)
		Benthos Pinger
		SPMD (attached on cage)
		2 x 1/2" galv. shackle, swivel, 2 x 7/16" Galv. Shackles
		5/16" Amsteel 2 rope; 100m
		2x 1/2" SS shackle
		2 x Double Panther Floats
		5/16" Amsteel 2 rope; 2m
		1 x 5/8" SS shackle, 1 x 1/2" SS Shackle
521		Seaguard # 30
		- Single point with CTD , DO, Tu
		1 x 5/8" SS Shackle, 1 x 1/2" SS shackle, Swivel,Rope Link
		17" Vitrovex Glass Floats (4x with Eddy Grip) - Orange
		2x 3/8 " SS shackle , swivel
526		1 x 5/8" SS shackle and Rope Link
		865A Tandem#1: 41452 , #2 - 41438
		Tandem assembly (2x chain SS)
		1 x 7/8" galv shackle, pear link
		5m 3/4" polysteel drop line w/ large Ring
		1.5 m chain
535		2 train wheels

Figure 6.2 BA05-16 Design

BA06-16	Northeast Baffin Bay	
Target Instrument Depth (m)		Instrument

Target Instrument Depth (m)	Instrument
342	Nortek 190kHz ADCP (DL)#6116
	Continetal frame
	Continetal frame panther buoys (6)
	Benthos / RJE Pinger # 1002
	SPMD (attached on cage)
	2 x 1/2" galv. shackle, swivel, 2 x 7/16" Galv. Shackles
	5/16" Amsteel 2 rope; 190m
	2x 1/2" SS shackle
	2 x Double Panther Floats
	5/16" Amsteel 2 rope; 2m
	1 x 5/8" SS shackle, 1 x 1/2" SS Shackle
535	Seaguard # 292
	- Single point with CTD , DO, Tu
	Link
	17" Vitrovex Glass Floats (4x with Eddy Grip) - orange
	2x 3/8 " SS shackle , swivel
540	1 x 5/8" SS shackle and Rope Loop
	865A Tandem#1: - 41441 , #2 - 41449
	Tandem assembly (2x chain SS)
	1 x 7/8" galv shackle, pear link
	5m 3/4" polysteel drop line w/ large Ring
	1.5 m chain
549	2 train wheels

Figure 6.3 BA06-16 Design

WF1-16	Near Victoria Island	
Target Instrument Depth (m)		Instrument
		RDI Sentinel V 300 kHz ADCP #24314
80		Sentinel V Ext. Batt Case #82706
		ASL Dual Frame
		RBR CTD-Tu #65774 (clamped to cage)
		XEOS beacon# 300234062790570
		Swivel, galv shackles
		5/16" Amsteel 2 rope; 10m
		2 x 1/2" galv shackle and Rope Link
		Technicap PPS 3/3 24 S sediment trap #56
94		disc# 136 , motor# 12-25
		2 x 1/2" galv shackle
		5/16" Amsteel 2 rope; 10m
		2 x 1/2" galv shackle and Pear Link
		SF-30-300m elliptical MSI buoy
		galv shackles, swivel
		2 x 1/2" galv shackle
106		dual CART releases #55660 & #33748
		Tandem assembly
		D-ring 3/4-inch shackle
		5m 3/4" polysteel drop line
		~2 m chain + 7/8" shackle + Pear Link
115		1 train wheels

Figure 6.4 WF 1-16 Design

Deployment

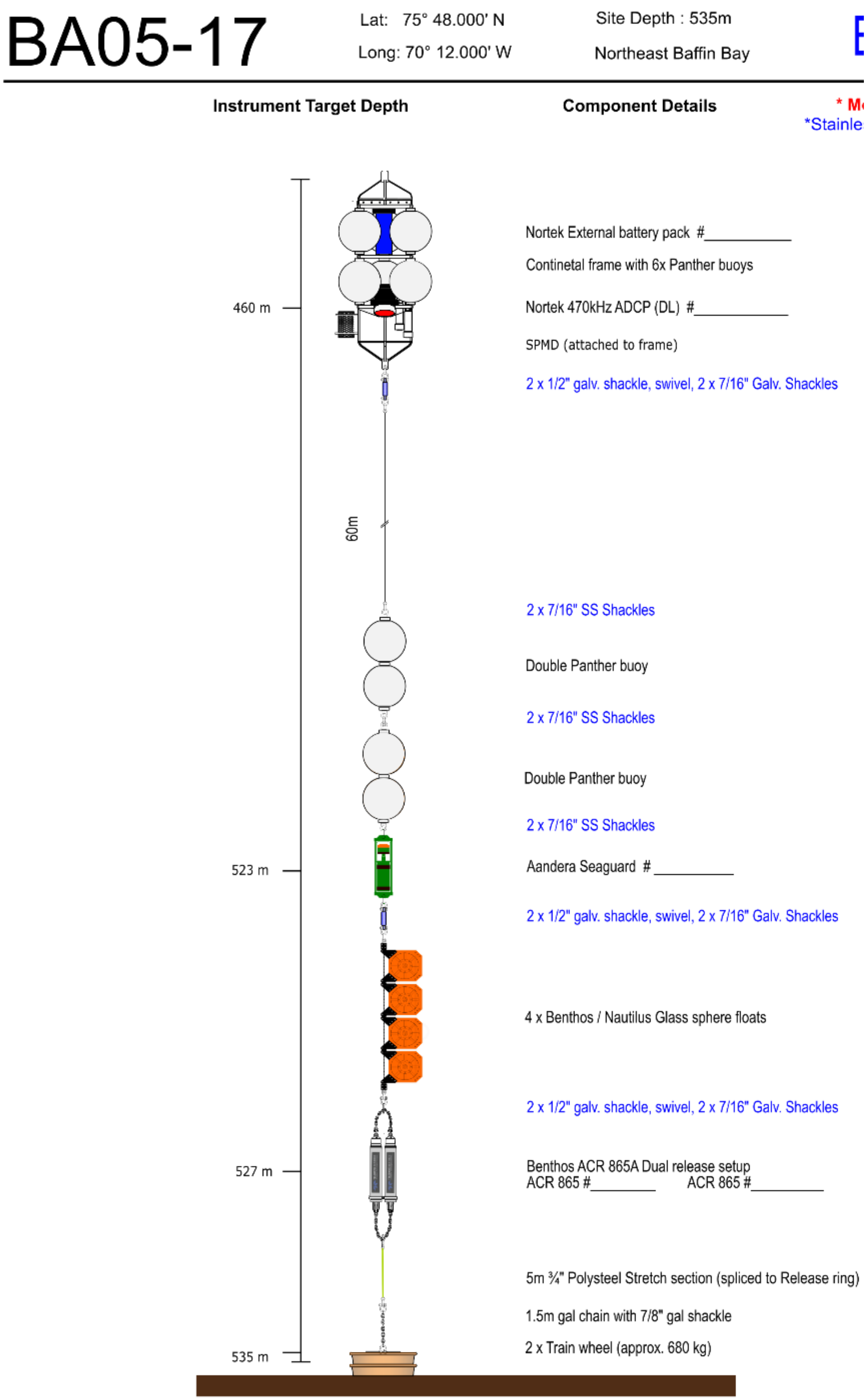

Figure 6.5 BA05-17 Design

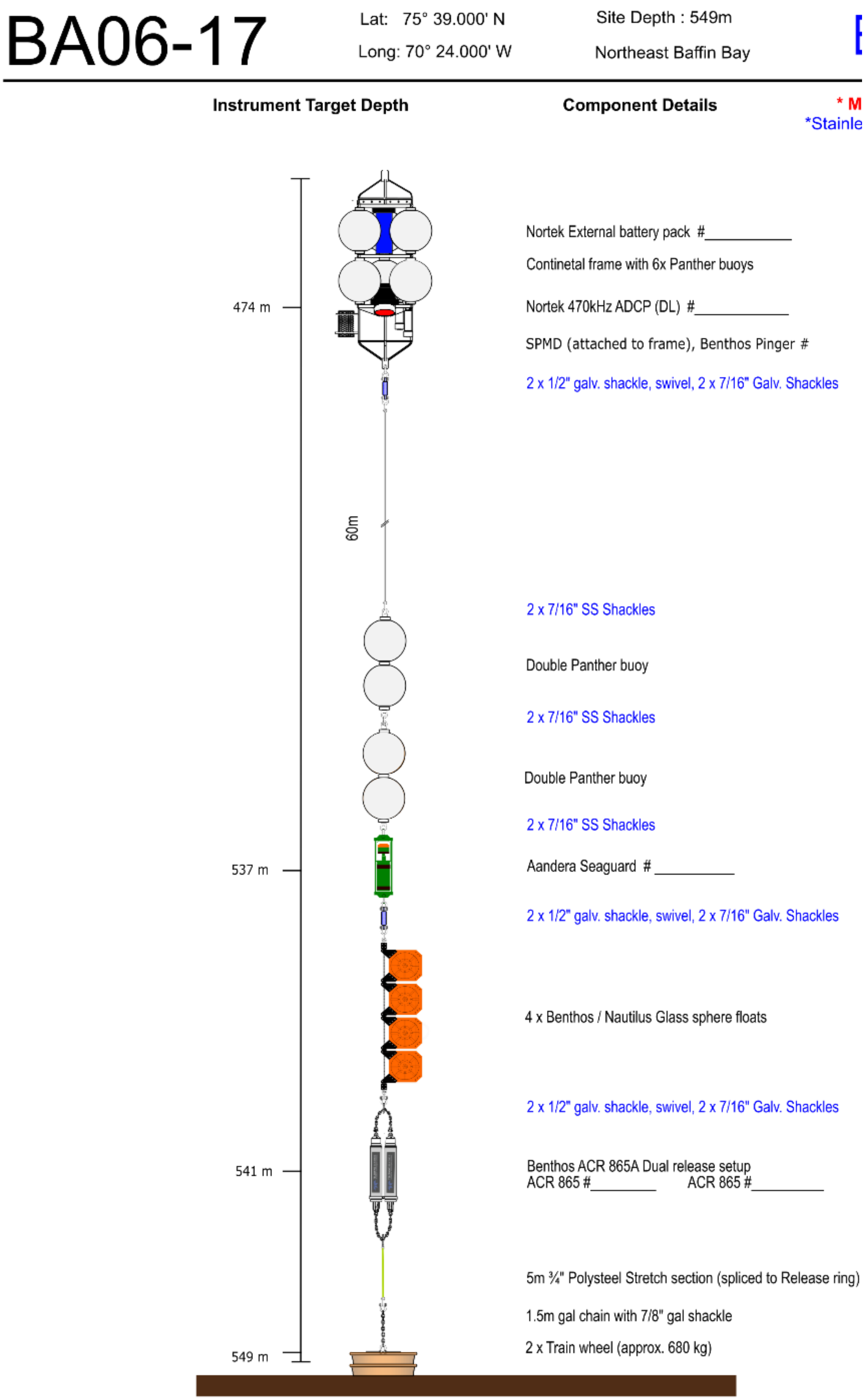

Figure 6.6 BA06-17 Design

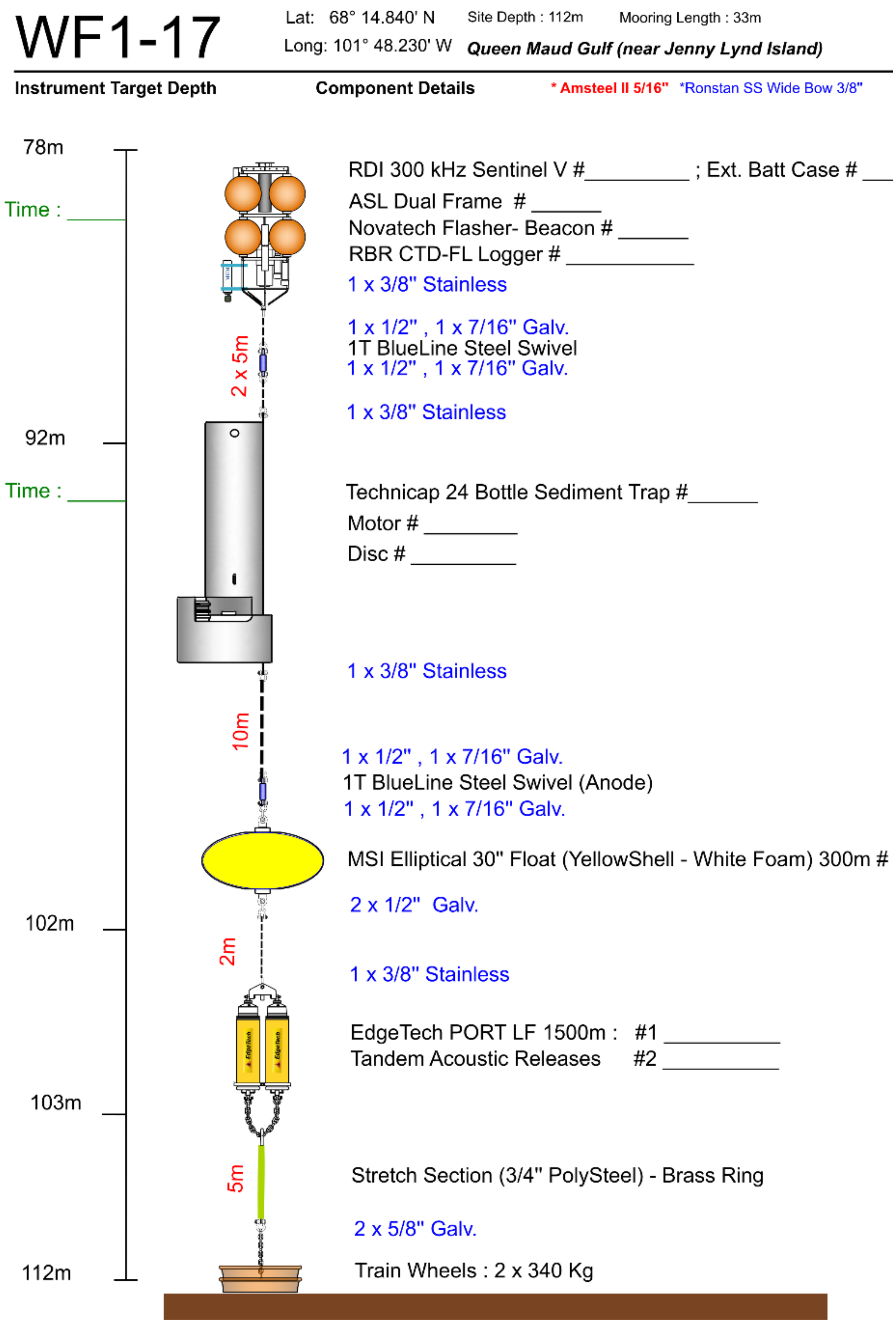

Figure 6.7 WF1-17 Design

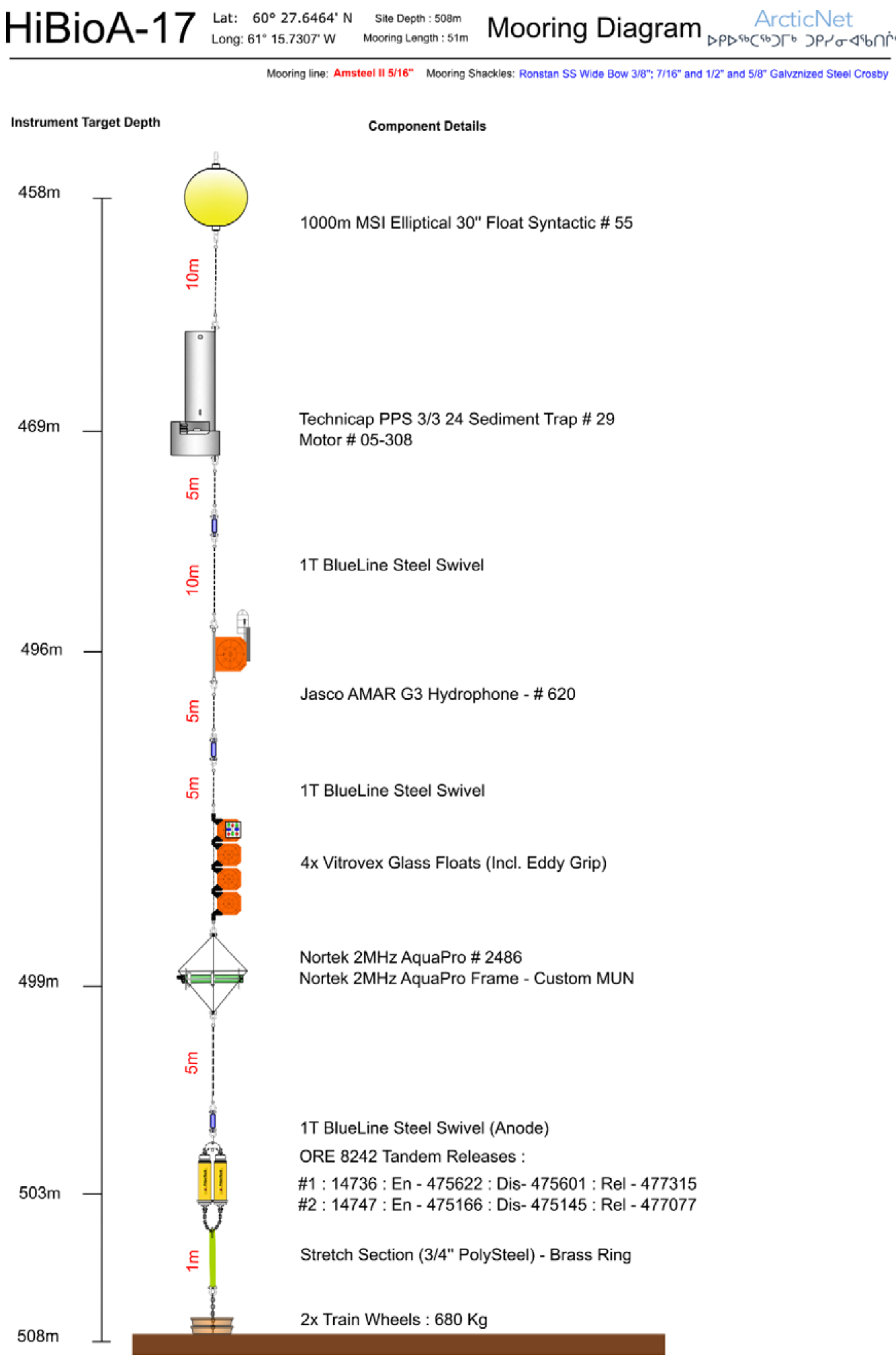

Figure 6.8 HiBioA-17 Design

6.3 Preliminary Results

6.3.1 *2016-2017 Mooring Recovery Summary*

Five of seven moorings from the Beaufort Sea (CA05, CA08, BR1, BR3, BR3b, BRK and BRG) were successfully recovered using the CCGS Laurier. Moorings CA05 and CA08 were lost during the at an unknown time due to probable corrosion of the Teledyne-Benthos tandem release kits. The acoustic releases (Teledyne-Benthos) were successfully communicated to by the deckbox onboard the Laurier, identifying that the releases were there and still functional. However, when the releases 'released' the mooring, nothing came to the surface. The Laurier`s multibeam system though limited to 200m depth, was able to look for the top sections of the moorings, however, nothing was seen in the multibeam passes, which confirms the mooring loss.

All three moorings from the Eastern and Central Arctic (BA05, BA06, WF1) were recovered using the CCGS Amundsen. For a full record of the recovered moorings see Appendix 2 . Benthic Mooring (Tripod) WF2 was not serviced due to logistical complications between Parks Canada and the Canadian Coast Guard. This mooring will hopefully be serviced next year or potentially during the winter diving operations (2018).

6.3.2 *2016-2017 Mooring Data Recovery Summary*

The seven moorings planned for recovery aboard the CCGS Laurier between September-October 2017 and the three moorings in the Eastern and Central Arctic (BA05, BA06, WF1) were 96% successfully recovered from their original deployment locations as CA05 and CA08 were lost. The data recoveries were 94% (Amundsen) and 99% (Laurier).

Table 6.1 Data Recovery from Moorings 2016-2017, Whole Mooring QC Comments

Mooring_ID	Level 1 QC Comments
BA05-16	
BA06-16	
BR1-16	Mooring was deployed 8m shallower than planned.
BR3-16	Mooring slid 30m down a submarine slump, thus 30m depth offset was applied.
BR3b-16	Mooring was deployed 1.2 Km south of BR3 since the triangulation at deployment identified the mooring slide. The slide of BR3 put the range of the ice profiler out of range of the surface, therefore BR3b was deployed.
BRG-16	Mooring was deployed 8m shallower than planned.
BRK-16	
WF1-16	

Table 6.2 2016-2017 Recovered Instrument Data Details

Site	InstrumentID	TimeFirstGoodData	TimeLastGoodData	Nominal Depth (m)	Raw Data Recovery
BA05-16	Nortek_Continental_6064	06-Aug-2016 03:00:00	24-Jul-2017 02:15:00	420	100%
BA05-16	Aanderaa_Seaguard_30	06-Aug-2016 03:00:00	24-Jul-2017 02:00:00	528	100%
BA06-16	Nortek_Continental_6116	06-Aug-2016 00:30:00	23-Jul-2017 23:45:00	325	100%
BA06-16	Aanderaa_Seaguard_292	06-Aug-2016 01:00:00	23-Jul-2017 23:00:00	520	100%
BR1-16	ASL_IPS5_51109	03-Sep-2016 02:54:00	27-Sep-2017 15:50:00	60	100%
BR1-16	RBR_XR-420-CT_15263	03-Sep-2016 03:00:00	27-Sep-2017 15:50:00	61	100%
BR1-16	Technicap_PPS_3-3_motor_12-22	04-Sep-2016 00:00:00	01-Sep-2017 00:00:00	120	93%
BR1-16	Seabird_SBE37-SM_12235	03-Sep-2016 03:30:01	27-Sep-2017 15:50:01	122	100%
BR1-16	RBR_XR-420-CT_15274	03-Sep-2016 04:00:00	27-Sep-2017 15:50:00	182	100%
BR1-16	RDI_QM_12823	03-Sep-2016 03:00:00	27-Sep-2017 15:29:59	182	100%
BR1-16	Technicap_PPS_3-3_motor_12-28	04-Sep-2016 00:00:00	01-Sep-2017 00:00:00	310	93%
BR1-16	RDI_LR_12943	03-Sep-2016 03:00:00	27-Sep-2017 15:30:00	462	100%
BR1-16	RBR_XR-420-CTD_17352	03-Sep-2016 03:00:00	27-Sep-2017 15:50:00	462	100%
BR1-16	Nortek_Aquadopp_8543	03-Sep-2016 03:30:00	20-May-2017 00:55:00	591	67%
BR1-16	Nortek_Aquadopp_8448	03-Sep-2016 03:30:00	27-Sep-2017 15:30:00	743	100%
BR1-16	Seabird_SBE37-SM_10850	03-Sep-2016 03:40:01	27-Sep-2017 15:50:01	744	100%
BR3-16	ASL_IPS5_51108	09-Sep-2016 00:44:00	23-Sep-2017 17:15:00	92	100%
BR3-16	RBR_XR-420-CT_61550	09-Sep-2016 01:30:00	24-Sep-2017 17:20:00	93	100%
BR3-16	Technicap_PPS_3-3_motor_09-345	09-Sep-2016 00:30:00	24-Sep-2017 18:00:00	156	100%
BR3-16	Seabird_SBE37-SM_10851	09-Sep-2016 01:30:01	24-Sep-2017 17:20:01	157	100%
BR3-16	RDI_QM_8784	09-Sep-2016 01:00:00	24-Sep-2017 16:30:00	209	100%
BR3-16	RBR_XR-420-CT_61551	09-Sep-2016 00:50:00	24-Sep-2017 17:20:00	219	100%
BR3-16	Technicap_PPS_3-3_motor_12-23	09-Sep-2016 00:30:00	24-Sep-2017 18:00:00	336	100%
BR3-16	RDI_LR_18785	09-Sep-2016 01:00:00	24-Sep-2017 16:00:00	489	100%
BR3-16	RBR_XR-420-CT_15281	09-Sep-2016 02:30:00	24-Sep-2017 17:00:00	490	100%
BR3-16	Nortek_Aquadopp_8447	09-Sep-2016 03:00:00	24-Sep-2017 17:00:00	606	100%
BR3-16	Nortek_Aquadopp_9473	09-Sep-2016 03:00:00	24-Sep-2017 17:00:00	708	100%

BR3-16	Seabird_SBE37-SM_10849	09-Sep-2016 01:10:01	24-Sep-2017 17:20:01	709	100%
BR3b-16	ASL_IPS5_51104	13-Sep-2016 21:45:00	23-Sep-2017 14:51:00	60	100%
BR3b-16	Seabird_SBE37-SM_10196	13-Sep-2016 21:50:01	23-Sep-2017 15:00:01	61	100%
BRG-16	ASL_IPS5_51106	04-Sep-2016 00:00:00	01-Oct-2017 00:00:00	54	100%
BRG-16	RBR_XR-420-CT_15271	04-Sep-2016 18:10:00	01-Oct-2017 14:50:00	54	100%
BRG-16	Technicap_PPS_3-3_motor_11-16	15-Sep-2016 00:00:00	01-Oct-2017 00:00:00	119	97%
BRG-16	Seabird_SBE37-SM_12236	04-Sep-2016 18:10:01	01-Oct-2017 14:50:01	122	100%
BRG-16	RBR_XR-420-CT_15264	04-Sep-2016 18:10:00	01-Oct-2017 14:50:00	172	100%
BRG-16	RDI_QM_12699	04-Sep-2016 18:45:00	01-Oct-2017 14:29:59	172	100%
BRG-16	Technicap_PPS_3-3_motor_12-27	15-Sep-2016 00:00:00	01-Oct-2017 00:00:00	299	97%
BRG-16	RDI_LR_13079	04-Sep-2016 18:30:00	01-Oct-2017 14:30:00	453	100%
BRG-16	RBR_XR-420-CT_15275	04-Sep-2016 18:10:00	01-Oct-2017 14:50:00	453	100%
BRG-16	Nortek_Aquadopp_8419	04-Sep-2016 18:30:00	01-Oct-2017 14:30:00	579	100%
BRG-16	Nortek_Aquadopp_8442	04-Sep-2016 18:30:00	01-Oct-2017 14:30:00	681	100%
BRG-16	Seabird_SBE37-SM_10852	04-Sep-2016 18:10:01	01-Oct-2017 14:50:01	681	100%
BRK-16	RDI_WHS_7844	05-Sep-2016 00:30:00	11-Aug-2017 04:30:00	145	88%
BRK-16	Sequoia_LISST100x_1445			152	100%
BRK-16	RBR_Concerto-CT-Tu-DO-FL_17112	05-Sep-2016 02:00:00	26-Sep-2017 22:00:00	152	100%
BRK-16	Nortek_AquaPro_11147	05-Sep-2016 02:00:00	26-Sep-2017 21:00:00	154	100%
WF1-16	RDI_SV100_24314	21-Aug-2016 17:40:00	08-Aug-2017 13:00:00	79	100%
WF1-16	RBR_Concerto-CTD-Tu_65774	21-Aug-2016 17:40:00	30-Jan-2017 23:10:00	79	46%
WF1-16	Technicap_PPS_3-3_motor_12-25	01-Sep-2016 00:00:00	08-Aug-2017 00:00:00	92	97%

6.3.3 *2017 Mooring Deployment Summary*

<u>Re-Deployment Summary</u>

Five moorings (BR3, BRK, BRG, BR1, BA05, BA06, WF1) were successfully re-deployed very near their targeted locations and very near their target depths (Table 5). Moorings CA05 and CA08 were deployed but not re-deployed as they were lost in 2017.

Leg	Mooring ID	Latitude	Longitude	Latitude (DD)	Longitude (DD)	Depth (m)
2b	BA05-17	75 48.2322 N	70 12.1774 W	75.8039	-70.2030	538

2b	BA06-17	75 39.377 N	70 24.5402 W	75.6563	-70.4090	531
2b	WF1-17	68 14.5498 N	101 47.9152 W	68.2424	-101.7986	98
3	BRK-17	70 51.7923 N	135 01.4506 W	70.8632	-135.024	165
3	BRG-17	71 00.0918 N	135 29.5331 W	71.0015	-135.492	699
3	BR1-17	70 25.9911 N	139 01.5892 W	70.4332	-139.027	759
3	BR3-17	73 24.0855 N	129 21.0377 W	73.4094	-129.354	690

Deployment Operations Summary

Three moorings were deployed during Leg 2b and two more moorings were deployed during Leg 4b, onboard the Amundsen. A benthic lander was deployed in Nares Straight (middle) as an alternative to the Qikitarjuak deployment site. A Weston Foundation – ArcticNet – Parks Canada moorings (WF1-17) was redeployed during Leg 2b, however the Benthic Tripod / Mooring WF2-16 was not serviced this year due to logistical complications between Parcs Canada and the Canadian Coast Guard (vessel availability).

The LTOO moorings BA06 and BA05 were deployed in almost the same position as recovery. However, the QMG mooring WF1-17 was not redeployed exactly where it had been recovered, but rather 500m SE of its recovered position. This 2017 position is near to the original 2015 position. The mooring professional had asked the chief officer if the vessel was in-position before releasing the anchor and the bridge had confirmed that they were in the correct position, however, this was not the case. The 500m SE offset is not problematic, though it wasn't the desired spot (within the flow channel)(Figure 28). The Multibeam system after mooring deployment had also malfunctioned and was having a problem re-establishing communications with its software. After an hour of trying to get the multibeam system to visualize the mooring orientation, the decision to abandon the multibeam visualization operation was made.

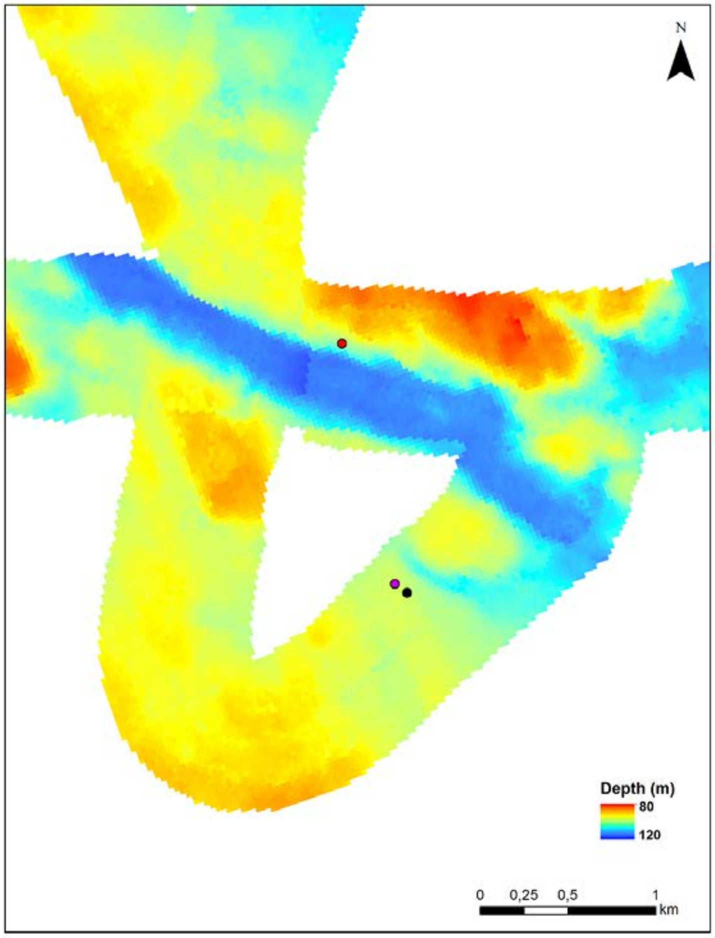

Figure 6.9 WF1-17 Deployment Positions. (Red dot: Recovered and Redeployment Position; Purple Dot: Anchor Drop; Black dot: Triangulated Anchor Position) (Annie-Pierre Map credit, 2017)

During Leb 4b, two moorings were planned to be deployed (HiBioA and HiBioB), however, due to very unfavourable weather and sea state, transiting between sites took longer than expected and thus HiBioB was cut from the deployment plan. HiBioA was planned to be deployed at 400m though the boat's drift was not calculated with the proper factor, the wind. It was thought by the ship's crew that the currents were pushing the boat more than the wind, however, this was not the case. The mooring was eventually deployed 2 Km SE from the planned site at a depth of 508m. This depth and position was approved by the Chief Scientist (on the foredeck during operations helping when needed).

The mooring was difficult to deploy as the rough sea state and short rope sections made operations potentially hazardous. The crew performed well and following the mooring lead, operations were successfully and safely executed.

During deployment, the newly installed (last minute addition) settlement plates, became caught on the rope section between the Aquadopp profiler and the string of four glass spheres. This made for a hazardous deployment situation but the entanglement was dealt with and the deployment continued well.

Due to the rough weather, it was a constant battle to manage the swing and heave of the equipment in the air and in the water. Variable high-low tensions caused by swell and wave state pushed and pulled the equipment. Through experience and proper technique of using the deck horn and setting up the next lifting point with the secondary winch (2.5T), a hazardous situation was made manageable. The Aquadopp Profiler and glass spheres were lifted with the 500 HP winch and simultaneously the releases were lifted with the 2.5T winch. Thereby, providing accidental release from the next unit in-line and to facilitate the deployment of short rope lengths. Due to wave and swell of the vessel the out-going Aquadopp Profiler and glass sphere string were accidentally released by the release level catching the edge of the vessel. Luckily the units were over the rail and in the air and under-tension. Thus when the seacatch released accidentally, the units only fell a few centimeters. But, the tension was held by the 2.5T seatch and releases, which we safely in the air and no damage was observed during this accidental release. Again, this was not a ‘near-miss’ as procedure and experience kept the operation and deployment crew safe.

Benthic Lander

The benthic lander was deployed in ice-free conditions at station 106 on the North Water transect. Coordinates at the moment of surface release were 76□18.494’N, 75□21.831’W (depth 377m). The ship-based estimate of current drift was ~0.5 knot to the southwest. The lander was visible on the multi-beam during downward transit and estimated drop speed to be ca. 50 m/min (Figure 29). It took roughly 7.5 minutes for the Lander to reach bottom with a southwestward drift of ~0.07 nautical miles. Estimated coordinates are 76□18.441’N, 75□22.155’W. We made a multibeam pass over the position, but the Lander could no longer be seen clearly once at the bottom, so for the recovery, it is not expected to be visible in the multibeam pass. The lander was deployed without complications, though it should be noted that the weight attachment was the most difficult task to perform due to the design of the small spaces and suspended weight. Possibly a better design would help this in the future. As for the deployment, the float package above the lander was held away from the main frame with a single rope while the lander itself was lifted by the SeaCatch® and before releasing the lander, the single rope / tag line for the above float package was released, followed by the release of the lander. The unit was deployed as a free-fall and gently descended to the ocean floor.

Table 6.3 Mooring Deployment Summary 2017

Leg	Mooring ID	Latitude	Longitude	Latitude (DD)	Longitude (DD)	Depth (m)
2b	BA05-17	75 48.2322 N	70 12.1774 W	75.8039	-70.2030	538
2b	BA06-17	75 39.377 N	70 24.5402 W	75.6563	-70.4090	531
2b	WF1-17	68 14.5498 N	101 47.9152 W	68.242484	-101.798604	98
4b	HiBioA-17	60 27.6464 N	61 15.7307 W	60.460773	-61.2621783	508
4b	HiBioB-17	Cancelled	Cancelled	Cancelled	Cancelled	Cancelled
3	CA05-17	71 18.675 N	127 35.5466 W	71.3113	-127.592	201
3	CA08-17	70 59.2635 N	126 1.7583 W	70.9877	-126.029	390

6.3.4 *Annual Lessons Learned Summary*

Table 6.4 Summary table of Lessons Learned throughout the Amundsen and Laurier 2017 missions

Problem	Solution	Operation
Stainless Shackle Corrosion on Benthic Tandem Kit	Source 5/8" SS Wichard shackles instead of the ones supplied by Benthos	Deployment / Recovery
Stainless Shackle Corrosion with plastic isolation (bushings)	Don't trust plastic isolators. Don't mate dissimilar metal types. Or, get more robust bushings	Deployment
SeaCatch Safety pin snagging	Place the safety pin in an area where it won't get a chance to touch the deck edge. Rough Sea-State can accidentally trigger the SeaCatch and extra safety was needed / used (second SeaCatch with equipment in air near guard rail).	Deployment
Attaching weight to Benthic Lander is difficult under A-frame	Use a mooring rope length to lift weight to avoid having to cut wire sling.	Deployment
Sentinel V units can't get a good calibration in the arctic	Use Default calibration and perform post-verification checks, just like the Nortek units. Additionally, use BEAM coordinates and not ENU.	Deployment
Galvanized Steel Corrosion on the CART chain separator junctions	Use stainless chain on the CART units, with stainless shackles, to mate a stainless housing.	Deployment
Drop Location not in desired position	Cruise planning document needs to have the up-to-date coordinates and also mention the range / depth tolerance in the Toolbox meeting. Ship's crew need to use the proper weather influences in their vessel drift calculations, in-order to not be kilometers out of position (wind can be a bigger factor than current).	Deployment
Pin Corrosion on Nortek Bulkhead connectors.	Inspection and Bulkhead connector replacements could be needed	Deployment / Recovery
Tilt not enabled on Benthos releases can confuse the recovery process	Enable tilt function on all Benthos releases	Recovery
Hard to track battery performance or fault diagnostics if thrown-out	Keep the dead batteries from faulty units to later inspection	Recovery
A lack of photos at deployment and recovery reduce trouble shooting capacity	Take many photos at deployment and recovery of every connection	Deployment / Recovery
Minimal workspace and time on Laurier missions	Cooperation with other teams and utilization of upper lab spaces and starboard mid-level workspaces could help.	Deployment / Recovery
ADCP buoys moving around in transport truck.	Double Strap the M40 buoys to a pallet and / or leave the integrated frame in-tact as this help the Laurier deckhands handle the bouys better.	Deployment / Recovery
Cables ties (Zip Ties) breaking in colder weather	Use Arctic rated cable ties	Deployment / Recovery

Acknowledgements

I would like to acknowledge the teamwork and co-operation between the Coast Guard crew of the CCGS *Amundsen* and CCGS *Laurier* and the Mooring Team (Shawn Meredyk, Juergen 'Baly' Zier, Luc Michaud, Thomas Linkowski, Alexander Forest, Mark Downey (MUN) and Greg Curtiss (Golder)). Working together as a team and performing admirably under extreme weather conditions, the moorings were successfully deployed, recovered and re-deployed efficiently and safely as possible.

I would also like to acknowledge the teamwork and co-operation of Dr. Humfrey Melling (IOS) and the CCGS *Sir-Wilfred Laurier* for their hard work and cooperation with the ArcticNet / Amundsen Science Mooring Team.

7 CTD-Rosette – Legs 2 and 4b

Project leader: Alexandre Forest[1]
Cruise participants – leg 2: Colline Combault[1], Christopher Beasley[1] and Claudie Marec[1]
Cruise participants – leg 4b: Simon Morisset[1]
[1] *Amundsen Science, Université Laval, Québec, QC, Canada*

7.1 Introduction

The objective of our shipboard fieldwork is to characterize the water column physical and chemical properties: temperature, salinity, fluorescence, CDOM, dissolved oxygen concentration, nitrate concentration, light penetration and turbidity. We use a SBE 911 CTD (with dual sensor system conductivity and temperature) with various other sensors (see Table 6.1) mounted on a cylindrical frame known as a rosette. A 300 kHz Lowered Acoustic Doppler Current Profiler (LADCP) is attached to the frame to provide us with vertical profiles of the velocities on station. The rosette also supplies water samples for biologists and chemists.

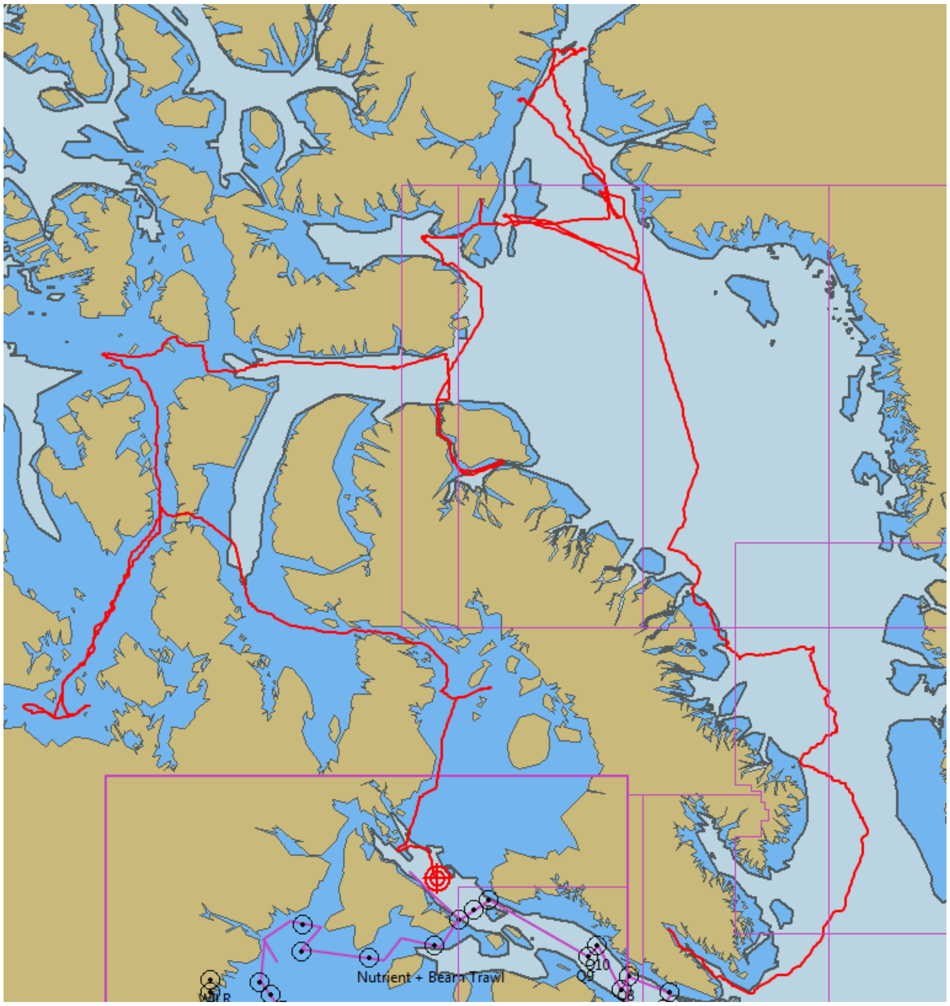

Figure 7.1 Leg 2 ship's course

7.2 Methodology

7.2.1 *CTD-Rosette*

The rosette frame is equipped with twenty-four (24) twelve (12) liter bottles and the sensors described in Table 6.1 and Table 6.2

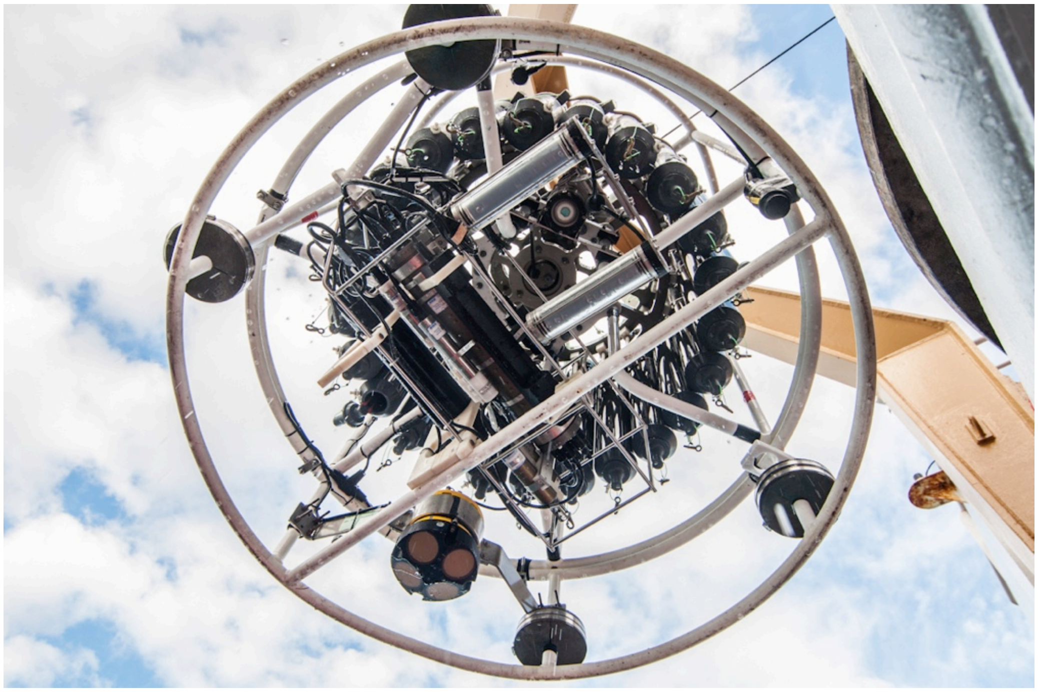

Figure 7.2 the CTD-Rosette

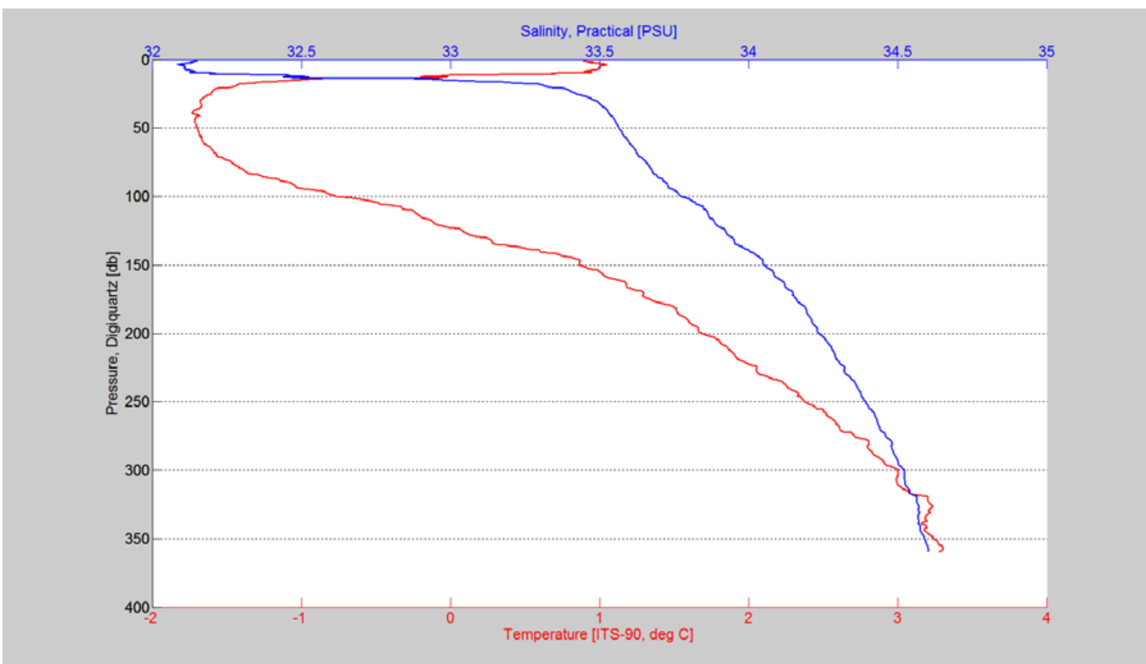

Figure 7.3 Example of data provided by the CTD-Rosette

Table 7.1 Rosette Sensors

Instrument	Parameter	Properties	Serial Number	Calibration date
Sea-Bird SBE 911plus	CTP	Sampling rate : 24 Hz	09P24760-0679	
SBE 3plus	Temperature	Range: -5ºC to + 35ºC Accuracy: 0.001	03P4318 03P4204	25-Oct-2016 25-Oct-2016
ParoscientificDigiquartz®	Pressure	Accuracy: 0.015% of full range	0679	12-Nov-2016
SBE 4C	Conductivity	Range: 0 to 7 S/m Accuracy: 0.0003	042696 042876	26-Oct-2016 26-Oct-2016
SBE 43	Dissolved Oxygen	Range: 120% of saturation Accuracy: 2% of saturation	430240	28-Oct-2016
MBARI-ISUS Satlantic	Nitrates	Range: 0.5 to 200 µM Accuracy: ± 2 µM	132 (137)	08-May-2017 18-May-2016
QCP-2300 Biosherical	PAR	PAR Dynamic Range: 1.4×10^{-5} to 0.5 µE/(cm^2 sec)	7270	02-Fev-2017
QCR-2200 Biosherical	Surface PAR	PAR Spectral Response: Equal (better than ±10%) quantum response from 400 to 700nm	20147	02-Fev-2017
Seapoint	Fluorometer	Minimum Detectable Level 0.02 µg/l Gain Sens, V/(µg/l) Range/(µg/l), 10x 0.33 15	SCT-3119 Nr 1 (bottom) SCT-3120 Nr 2 (top)	1-Jan-2016 15-May-2017
WetLabs C-Star	Transmissometer	Path length: 25 cm Sensitivity: 1.25 mV	CST-671DR	08-Jun-2017
Teledyne PSA-916	Altimeter	Range: 50 m from bottom	1044	Feb 2014
WetLabs ECO	fluorometer (CDOM)	FL(RT)D Digital output resolution : 14 bit Analog output signal: 0-5V Range: 0.09-500ppb Ex/Em: 370/460nm	FLCDRTD-2344	02-Apr-2017

Table 7.2 Sensor Specifications

Parameter	Sensor		Range	Accuracy	Resolution
	Compagny	Instrument Type			
Attached to the Rosette					
Data Logger	SeaBird	SBE-9plus [1]			
Temperature	SeaBird	SBE-03 [1]	-5°C à +35°C	0.001°C	0.0002°C
Conductivity	SeaBird	SBE-4C [1]	0-7 S/m (0-70mmho/cm)	0.0003 S/m (0.003mmho/cm)	0.00004 S/m (0.0004 mmho/cm)
Pressure	Paroscientific	410K-105	up to 10 500m (15 000psia)[2]	0.015% of full scale	0.001% of full scale
Dissolved oxygen	SeaBird	SBE-43 [3]	120% of surface saturation[4]	2% of saturation	unknown
Nitrates concentration	Satlantic	MBARI-ISUS 5T [6]	0.5 to 2000 µM	2 µM	0.5 µM
Light intensity (PAR)	Biospherical	QCP-2300			
sPAR	Biospherical	QCR-2200			
Fluorescence	Seapoint	Chlorophyll-fluorometer	0.02-150 □g/l	unknown	30
Transmissiometer	Wetlabs	C-Star	0-5 V	unknown	1.25 mV
Altimeter	Benthos	PSA-916 [7]	0 - 100 m	unknown	0.01 m
CDOM fluorescence	Wet Labs	FL(RT)D [7]	0.09-500ppb	unknown	14 bit

Notes: [1] Maximum depth of 6800m

[2] Depending on the configuration

[3] Maximum depth of 7,000m

[4] In all natural waters, fresh and marine

[5] Maximum depth of 1,200m

[6] Maximum depth of 1,000m

[7] Maximum depth of 6,000m

Problems Encountered with the CTD-Rosette

Intermittent telemetry with the rosette was noted during leg 2a. Re-splicing of the deployment end of the sea cable was required due to a failure within the original splice. A 50m section was removed due to the possibility of water ingress within the cable itself. This action has subsequently left the rosette with a maximum deployment depth of 1700m (allowing approximately 100m on the drum for safety factor).

7.2.2 *Probes Calibration*

Salinity

Seabird CTD

Water samples were taken on several casts with 200 ml bottles. They were analyzed with a GuildLine, Autosal model 8400B. Its range goes from 0.005 to 42 PSU with an accuracy better than 0.002. 96 salinity samples were analysed onboard.

Seabird TSG.

Water samples were taken at different times during the transit from the surface thermosalinograph to measure salinity and fluorescence. The probe is located in the engine room. The samples were also analyzed with the GuildLine. As far as the fluorescence is concerned, the samples were analysed with a fluorometer by Aude Boivin-Rioux. 17 salinity samples were analysed onboard as well as 12 fluorescence samples for chl_a.

Oxygen

Oxygen sensor calibration was performed based on dissolved oxygen concentration measured in water samples using Winkler's method and a Mettler Toledo titration machine. 5 casts were sampled for Oxygen titration.

Problem encountered

There were difficulties in obtaining stable measurements from the titration machine during the beginning of leg 2. During leg 2a a series of blanks were performed delivering results outside our specifications (+/- 0.005).

7.2.3 *Water Sampling*

Water was sampled with the rosette according to each team's requests. To identify each water sample, we used the term "rosette cast" to describe one CTD-rosette operation. A different cast number is associated with each cast. The cast number is incremented every time the rosette is lowered in the water. The cast number is a seven-digit number: xxyyzzz, with

xx : the last two digits of the current year;
yy : a sequential cruise number;
zzz : the sequential cast number.

For this cruise, the first cast number is: 1702001. To identify the twenty-four rosette bottles on this cast we simply append the bottle number: 1702001nn, where “nn” is the bottle number (01 to 24).

All the information concerning the Rosette casts is summarized in the CTD Logbook (one row per cast). The information includes the cast and event number and station id, date and time of sampling in UTC, latitude and longitude, bottom and cast depths, and minimalist comments concerning the casts (Appendix 3).

An Excel® Rosette Sheet is also created for every single cast. It includes the same information as the CTD Logbook plus a table of what was actually sampled and at what depth. Weather information and ice conditions at the sampling time is included in each Rosette. For every cast, data from three seconds after a bottle is closed to seven seconds later is averaged and recorded in the ascii ‘bottle files’ (files with a btl extension). The information includes the bottle number, time and date, trip pressure, temperature, salinity, light transmission, fluorescence, dissolved oxygen, irradiance and CDOM measurements.

All those files are available in the directory “Data\Rosette” on the ‘Data’ folder on the Amundsen server. There are six sub-directories in the rosette folder.

- \Rosette\log\: Rosette sheets and CTD logbooks.
- \Rosette\plots\: plots of every cast including salinity, temperature, oxygen, light transmission, nitrate, fluorescence and irradiance data.
- \Rosette\odv\: Ocean Data Viewer file that include ctd cast files.
- \Rosette\svp\: bin average files to help multibeam team to create a salinity velocity profile.
- \Rosette\avg\: bin average files of every cast.
- \Rosette\LADCP\: LADCP post-process data results.

7.2.4 *Lowered Acoustic Doppler Current Profiler (LADCP)*

A 300 kHz LADCP (RD-Instrument Workhorse®) was mounted on the rosette frame in upward and downward looking position. The LADCPs get their power through a battery installed on the rosette frame and the data is uploaded on the rosette acquisition computer connected to the instrument through a RS-232 interface after each cast. The LADCP are programmed in individual ping mode (one every second). The horizontal velocities are averaged over thirty-two, 8 m bins for a total (theoretical) range of 100 to 120 m. The settings are 57600 bauds, with no parity and one stop bit. Since the LADCP are lowered with the rosette, there will be several measurements for each depth interval. The processing is done in Matlab® according to Visbek (2002; J. Atmos. Ocean. Tech., 19, 794-807)

Figure 7.4 Lowered Acoustic Doppler Current Profiler (LADCP)

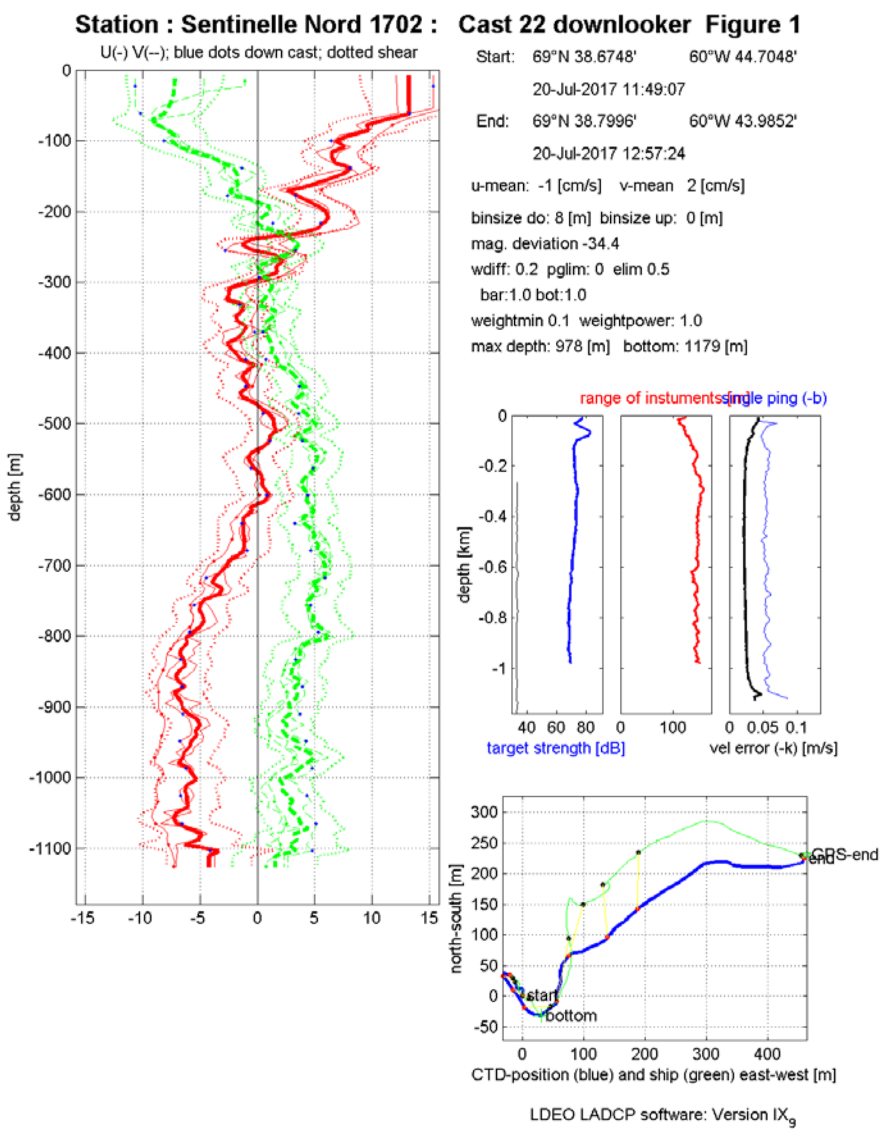

Figure 7.5 Example of profile velocities provided by the LADCP

Problems Encountered with the LADCPs

LADCP Transformer required rework due to water breaching the o-ring surfaces. The breach was more than likely due to one of the two endcap fasteners having come loose. Approximately 10ml of standing water was noted once the instrument was opened for repair. This failure occurred circa cast #028 to 031 (data for 028 is missing). All electronics were cleaned, desiccant was replaced and a bulkhead connector of a different type was used during the repair with an accompanying 1m patch cable for the re-integration. Furthermore, casts (<90m) performed in shallow waters does not provide correct LADCP results due to the range of the instruments (100m).

8 Zooplankton, Fish Ecology and Acoustic – Leg 2

Project leader: Louis Fortier[1] (louis.fortier@bio.ulval.ca)
Cruise participants – Leg 2: Gérald Darnis[1], Thibaud Dezutter[1] and Mathieu LeBlanc[1]
[1] *Département de biologie, Université Laval, Québec, QC, Canada*

8.1 Introduction

The main objective of our team during this leg was the monitoring of zooplankton and fish key parameters (abundance, diversity, biomass and distribution) using various sampling devices and the echosounder EK60.

Before going further into this report, we would like to express our sincere gratitude to the commanding officer, the officers and crew of the CCGS *Amundsen*, whose precious help was essential for making this mission a success.

8.2 Methodology

8.2.1 *5 Nets Vertical Sampler (5NVS) (3 × 200µm, 1 × 500µm, 2 × 50µm)*

Zooplankton sampler. Four 1-m^2 metal frames attached together and rigged with three 6-m long, conical-square plankton nets and two external 10-cm diameter, 50-µm mesh net. Deployed vertically from 10 meters off the bottom to the surface. The 5NVS was equipped with five KC Denmark® flowmeters. After removal of fish larvae/juveniles (kept separately in 95% ethanol + 1% glycerol), zooplankton samples from one 200-µm and one 500-µm mesh nets were preserved in 4% formaldehyde solution for taxonomy and abundance measurements and one 200-µm mesh net was used for biomass and genetics analyses. During leg 2a, the other 200-µm mesh net was provided to Jean-Eric Tremblay's team while in leg 2b, the other 200-µm mesh net was provided to Victoria Peck for pteropod analyses.

8.2.2 *Double Square Net (DSN) (1 × 500µm, 1 × 750µm, 1 × 50µm)*

Ichtyoplankton Net. Rectangular frame carrying two 6-m long, 1-m^2 mouth aperture, square-conical nets and an external 10-cm diameter, 50-µm mesh net (to collect microzooplanktonic prey of the fish larvae). The sampler was towed obliquely from the side of the ship at a speed of ca. 2-3 knots to a maximum depth of 90 m (depth estimated during deployment from cable length and angle; real depth obtained afterward from a Star-Oddi® mini-CTD attached to the frame). The DSN was equipped with three KC Denmark® flowmeters. Fish larvae collected with the DSN were measured and preserved individually in 95% ethanol +1% glycerol. Zooplankton samples from the 500-µm mesh net were preserved in 4% formaldehyde solution for further taxonomic identification. During leg 2a, 2 casts were done per station. The first cast was split between Gary Stern and Jean-Éric Tremblay's team while the second cast was entirely for the zooplankton team. During leg 2b, only one cast was done per station and samples from the 750-µm mesh net were provided to Sarah Bernstein for microplastics analyses.

8.2.3 *Ringnet (500 µm)*

Zooplankton net. Circular frame (0.65 m diameter) carrying one net of 500 µm. The net was deployed from the Zodiak at a speed between 1.2 and 2 knots. Surface and vertical tows were done.

8.2.4 *Hydrobios (9x200 µm)*

Multi-nets plankton sampler. Square device carrying nine nets opened sequentially with 0.5-m^2 mouth aperture and mesh size of 200 µm. The sampler was deployed vertically from 20 meters off the bottom to the surface and the nets were opened at different depths that were set before the deployment. After removal of fish larvae/juveniles (kept separately in 95% ethanol + 1% glycerol), zooplankton samples from the nine nets were preserved in 4% formaldehyde solution for abundance measurements.

8.2.5 *Isaac-Kidd Midwater Trawl (IKMT)*

Pelagic juvenile and adult fish sampler. Rectangular net with a 9-m^2 mouth aperture and mesh size of 11 mm in the first section, 5 mm in the last section. The net was lowered to a depth where a fish aggregation has been detected with the echosounder and towed at that depth for 20 minutes at a speed of 2-3 knots (depth estimated during deployment from cable length and angle; real depth obtained afterward from a Star-Oddi® mini-CTD attached to the frame).

8.2.6 *Benthic Beam Trawl*

Demersal fish sampler. Rectangular net with a 3-m^2 mouth aperture, 32-mm mesh size in the first section, 16 mm in the last section and a 10-mm mesh liner. The net was lowered to the bottom when a fish aggregation has been detected by the echosounder and towed for approximately 20 minutes at a speed of 3 knots. Fish collected with this sampler were measured and stored at -20°C.

8.2.7 *Acoustic Monitoring*

The Simrad® EK60 echosounder of the Amundsen allows our group to continuously monitor the spatial and vertical distribution of zooplankton and fish, the latter mostly represented by Arctic cod (Boreogadus saida). The hull-mounted transducers are in operation 24h a day thus providing an extensive mapping of where the fishes are along the ship track.

8.3 Preliminary Results

86 net deployments were done during leg 2 (Table 7.1), in which a total of 3403 fish were caught. 3357 individuals were young-of-the-year (61% of Polar cod) and 46 were adults (41% of Polar cod). 11 regions were sampled during leg 2. Relative abundance and mean standard length (SL) of species are presented by region in Table 7.2. Polar cod (Bosa) dominated (>92 %) the relative abundance in 4 regions: Davis Strait, Baffin Bay, Lancaster Sound and Barrow Strait. Liparis sp. dominated in Hudson Strait and Ungava Bay while Cottidae dominated in Queen Maud Gulf.

Hudson Bay was the most diverse region with Polar cod, Liparis sp. and Stichaeidae all dominating the region.

Table 8.1 Summary of operations conducted and samples collected during leg 2

Station	Date	5NVS	DSN	Ringnet	Hydrobios	IKMT	Beam trawl	Fish larvae samples		Adult fish samples	
								Inc	Bosa	Inc	Bosa
732	2017-07-08	x	x x								
736	2017-07-08	x	x x					8	7		
736Z	2017-07-08			x							
720	2017-07-09	x	x x					5	2		
694	2017-07-10	x	x x					13	4		
688	2017-07-10	x	x x					28	2		
688Z	2017-07-10			x							
684	2017-07-11	x	x x					189	2		
682	2017-07-11	x	x x					653	2		
682Z	2017-07-11			x							
676	2017-07-12	x	x x					48	6		
670	2017-07-12	x	x x					73	2		
670Z	2017-07-12			x							
A16	2017-07-15	x	x					3			
180	2017-07-18	x	x					1	72		
176	2017-07-21	x							20		
BB2	2017-07-22	x	x					4	268		1
101	2017-07-24	x	x		x			6	640	25	11
105	2017-07-25	x	x					3	146		
115	2017-07-26	x	x			x		10	83		
129	2017-07-27	x									
Trinity TS233	2017-07-28	x	x		x		x (pelagic)		33		
111	2017-07-29	x	x					2	226		
108	2017-07-30	x	x					7	50		
323	2017-07-31	x	x		x		x (pelagic)	5	123		
301	2017-08-03	x	x		x		x (pelagic)	5	69		
304	2017-08-04	x	x					8	17		
305	2017-08-05	x	x					16	246		
QMG-M	2017-08-08	x	x				x	61	14		
QMG-4	2017-08-08	x	x				x	5	5	2	5
QMG-3	2017-08-09	x	x					8	2		1
QMG-1	2017-08-09	x	x				x	56	3		
QMG-2	2017-08-09	x	x					71	12		
312	2017-08-10	x	x					7	3		
3.4	2017-08-12	x									
333	2017-08-13	x	x				x	3			1

Table 8.2 Number of fish larvae and mean standard length by species for each sampled region

Region	Species	Individuals	mean SL (mm)
Hudson Bay (98.17m)	Bosa	13	12.58
	Stichaeidae	12	14.63
	Liparis sp.	12	10.87
	Cottidae	1	12.27
	Sand lance	1	18.28
Hudson Strait (101.83m)	Bosa	6	12
	Stichaeidae	233	11.82
	Liparis sp.	503	11.02
	Cottidae	112	15.32
	Sand lance	2	16.33
	Ulcina olriki	2	11.09
Ungava Bay (113.5m)	Bosa	12	11.12
	Stichaeidae	17	12.55
	Liparis sp.	96	12.64
	Cottidae	8	10.88
Frobisher Bay (125m)	Stichaeidae	3	14.48
Davis Strait (578m)	Bosa	72	10.23
	Liparis sp.	1	13.13
Baffin Bay (678.61m)	Bosa	1474	11.79
	Stichaeidae	6	16.27
	Liparis sp.	23	15.11
	Cottidae	3	52
Lancaster Sound (635m)	Bosa	211	16.48
	Liparis sp.	16	12.35
	Cottidae	1	16.41
	Ulcina olriki	1	14.84
Barrow Strait (164.67m)	Bosa	246	14.19
	Stichaeidae	1	11.25
	Liparis sp.	14	11.18
	Cottidae	1	17.66
Queen Maud Gulf (79.65m)	Bosa	38	16.15
	Stichaeidae	75	18.67
	Liparis sp.	8	19.45
	Cottidae	87	17.9
	Sand lance	22	13.67
	Ulcina olriki	7	16.47
Victoria Strait (65m)	Bosa	3	13.39
	Cottidae	3	24.5
	Liparis sp.	1	22.03
	Ulcina olriki	3	15.01
Foxe Basin (26m)	Cottidae	3	30.67

Acknowledgement

Once again we would like to express our sincere gratitude to the commanding officer, the officers and crew of the CCGS *Amundsen*, whose precious help was essential for making this mission a success. We would like to express an extra thanks to the night shift who were “Sur la coche”.

9 Initial Investigations of Plankton, Epifauna, Infauna and Sea Water Profiles for Proposed Labrador Sea Marine Protected Area – Leg 4b

Project leader: Dave Côté[1] (connie.lovejoy@bio.ulval.ca)
Cruise participants – Leg 4b: Erin Herder[1,2], Jennica Seiden[1] and Cyril Aubry[3]
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9.1 Introduction

In 2016 the Government of Canada announced its commitment and plan to protect 5 percent of Canada's marine and coastal areas by 2017 and 10 percent by 2020. An area of focus for this plan is to designate a large, offshore Marine Protected Area (MPA) under the Oceans Act. A candidate area identified is an off-shelf area of the Labrador Sea (NAFO Zones 2G and 2H) within the Canadian Exclusive Economic Zone (EEZ). This frontier area is under limited resource development, particularly beyond the continental slope. The scientific knowledge of this area's ecosystem is extremely limited, as the depths (<3,500m) extend well beyond the range typically monitored by DFO (e.g. the deepest RV survey sets only reach 1,500) and NAFO.

This research program was established to characterize the ecosystem of this area to support MPA designation decisions and subsequent management. The program goal of this cruise is exploratory research, upon which more extensive sampling program will be developed for cruises in 2018 and 2019. The goal was to collect CTD profiles, pelagic-zone plankton collections, eDNA collections (demersal fish community and surface plankton), and benthic community sampling at 2 DFO sampling stations.

9.2 Methodology

Sampling was conducted to document preliminary findings of the water column and seabed at two DFO full stations and 2 boxcore only stations along a transect from 500 m to 2000 m in the Labrador Sea to support a proposed MPA in the region. Due to weather restrictions, only DFO-1 was sampled at a depth of approximately 500 m (Figure 6.1).

Figure 9.1 Planned sample stations for Leg 4b of CCGS *Amundsen* research cruise, Oct. 6-12, 2017.

A CTD profile was collected to characterize water column parameters, while the rosette collected water samples for eDNA analysis. Plankton samples were collected to characterize zooplankton and fish larvae in the water column, and epifaunal and infaunal samples were collected to characterize the benthic fish and invertebrate communities living on and in the sediment. Acoustic monitoring was also conducted 24 hours/day to identify spatial and vertical distribution of plankton and fish. Table 8.1 summarizes the locations where samples were collected during Leg 4b.

Table 9.1 GPS coordinates of samples collected at station DFO-1 on October 7, 2017

Sample Type	Depth (m)	GPS Position	Notes
CTD and Water (eDNA)	5, 200, 541	60 26.278 N 61 14.467 E	• Water collected at 3 different depths. • GPS position taken at time of ascent.
Vertical Plankton Tow (plankton/fish larvae)	491	60 26.658 N 61 15.664 E	• Samples collected using 5 different mesh size nets. • GPS position taken at time of ascent.
Box Core (epifauna/infauna)	507	60 27.219 N 61 15.726 E	• Box core collected at 1 station. • GPS position taken when box core touched bottom.
Beam Trawl (fish/epifauna)	Start: 661	60 26.205 N 61 15.381 E	• Start and stop depth and GPS position recorded. • GPS position taken when trawl touched bottom. Heading 112° for 10 min. Ship speed 2 knots.

A rosette with twenty-four 12-L Niskin bottles designed to collect water samples at various depths was deployed on a winch system. Niskin bottles were closed at three depths to collect water samples for eDNA: bottom (541 m), mid-water (200 m), and surface (5 m) (Figure 8.10).

Water samples were then transferred to the lab and filtered using a pump. Longmires preservation buffer was added to the water samples for preservation of eDNA to be analyzed in a laboratory.

A 5 net vertical sampler (5NVS) (3 × 200µm, 1 × 500µm, 1 × 50µm) was deployed to collect zooplankton and fish larvae. Four 1-m^2 metal frames attached together and rigged with four 5-m long, conical-square plankton nets and one external 10-cm diameter, 50-µm mesh net. Deployed vertically from 10 meters off the bottom to the surface. The 5NVS was equipped with five KC Denmark® flowmeters. After removal of fish larvae/juveniles (kept separately in 95% ethanol + 1% glycerol), zooplankton samples from one 200-µm and one 500-µm mesh nets were preserved in 4% formaldehyde solution for subsequent taxonomy and abundance measurements and one 200-µm mesh net was used for integrated biomass and genetics analyses. During leg 4b, the other 200-µm mesh net was provided to Jean-Eric Tremblay's team, for lipids analysis.

A box core (24 inch x 24 inch) was deployed using a winch system to collect epifauna and infauna at station depth of 500 m (Figure 8.10). The box core was lowered to the sea bottom at a rate of 50 m/min. When it reached 50 m above the bottom, the rate of lowering was reduced to 25 m/min to reduce any displacement of sediment by the force of the box core. The box core was then brought to the surface at a rate of 50 m/min and contents of the core were removed. Sediment and biological samples obtained from the box core were frozen at -20°C for later analysis.

A benthic beam trawl was deployed to collect demersal fish and macro-benthic organisms. The beam trawl is a rectangular net with a 3 m^2 mouth aperture, 32 mm mesh size in the first section, 16 mm in the last section and has a 10 mm mesh liner (Figure 8.10). The beam trawl was lowered to the sea bottom and the line was led out approximately 3 times the water depth. Once the trawl reached bottom, it was towed at a rate of 2-3 knots for 10 minutes along the sea bottom. Fish that were collected were measured and stored at -20°C. Corals, sponges, bryozoans, and hydroids collected in the beam trawl were frozen at -20°C for later analysis. All other benthic invertebrates were counted and fixed in 4% formalin for 24 hours then transferred to 70% ethanol for long term preservation of the samples. Rocks collected in the trawl net photographed and organisms that could not be removed were documented.

The Simrad® EK60 echosounder of the Amundsen allowed for continuous monitoring of the spatial and vertical distribution of zooplankton and fish. The hull-mounted transducers are in operation 24h a day thus providing an extensive mapping of where the fishes are along the ship track.

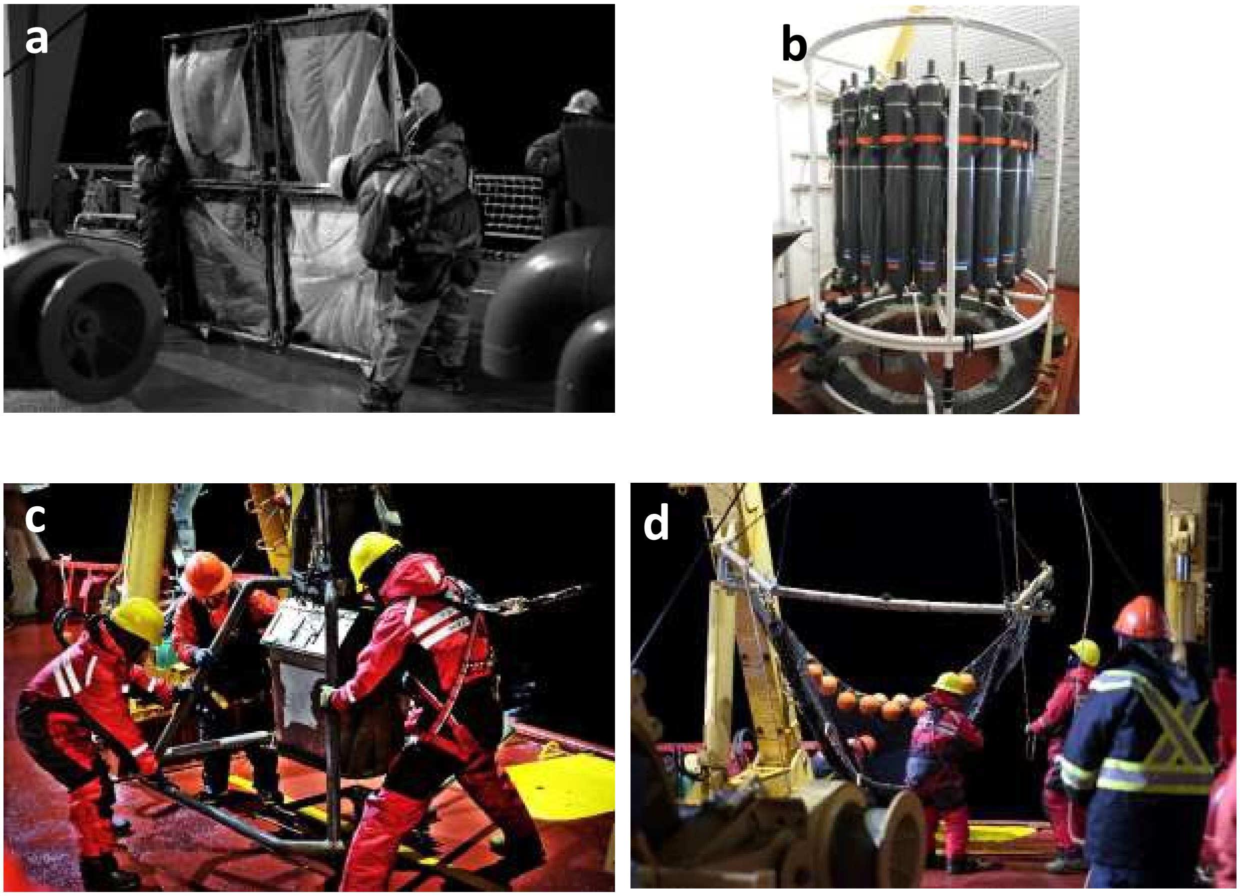

Figure 9.2 Sampling equipment used during CCGS *Amundsen* cruise 4b: a) Plankton Sampler, b) CTD Rosette, c) Box Core, d) Beam Trawl. Photo Credit: a,c,d: Sam Davin. b: Jennica Seiden.

9.3 Preliminary Results

9.3.1 *Box Core*

Multibeam bathymetry suggested that the bottom type at this station was sand and rock. The single box core suggested this to be accurate as only very fine gravel was returned to the surface. Two colonies of coral attached to a cobble and 2 species of bryozoan were collected in the sample. The coarse sediment was sieved and discarded. Figure 8.3 depicts the coral and bryozoan specimens retained.

Figure 9.3 Box core contents from station DFO-1 containing coarse sand and cobbles

Figure 9.4 Box core contents from station DFO-1 containing three bryozoan species

Figure 9.5 Box core contents from station DFO-1 containing and soft coral specimen

9.3.2 *Beam Trawl*

Over 60 invertebrate species and nine fish (5 families) were documented in the beam trawl. This number will likely increase after identifications are made for all individuals collected (Table 8.2). Many invertebrates appeared to be juveniles or small individuals. One large coral skeleton was collected (*Primnoa* sp. c.f.Figure 8.6); as well as large and small live specimens. One large rock collected was covered with encrusting organisms as well as one very large sponge (description below).

Figure 9.6 Skeleton base of large coral sp. (possibly Primnoa sp.) found at station DFO-1 in beam trawl. Photo credit: Sam Davin

Table 9.2 List of species observed (excluding fish species) in beam trawl collected at 661 m on October 7, 2017.

Specie		Comment
Anthozoa		
Duva sp.	3	Basket stars attached to coral polyps
Primnoa sp.	1 (+?)	Many fragments
Duva florida	2	
Gersemia sp.	2	
Anthomastus sp.	2	
Coral skeleton	1	Large base of coral skeleton (*Primnoa* sp. c.f.)
Porifera		
Sponge #1	?	Many pieces, long spicules, sheet like
Sponge #2	7	Ball-like
Sponge #3	3	Yellow, smooth, globulose
Sponge #4	1	Large and yellow
Sponge #5	1	Yellow, vase-like
Sponge #6	2	Round, brown, oval protrusions (var. 1)
Sponge #7	11	Flattened, brown, oval protrusions (var. 2)
Assorted Sponges	24	Small sponges, some could be similar species or could all be different species.
Bryozoa		
Bryozoan species	Many	Up to 5 different species
Hydrozoa		
Hydrozoan #1	N/A	Many fragments
Hydrozoan #2	N/A	Many fragments
Hydrozoan #3	N/A	Many fragments
Chordata		
Unid. Tunicate	1	Small, brown, rounded
Echinodermata		
Gorgonocephalus sp.	3	Additional individuals observed in *Duva* sp.
Ophiuroidea	60	Potentially up to 7 different species observed.
Crinoidea	2	
Asteroidea	2	5 arms, very pale
Arthropoda		
Squat Lobster	1	
Porcupine crab	1	Juvenile, spikes on carapace
Isopod	8	Flat, pale colour
Isopod (other)	1	
Pycnogonid	2	Small, brown
Crustaceanea (Subphylum)		
Unid. Shrimp #1	1	Dark red colour
Eualus gaimardii sp. 1	7	Candy cane striped
Eualus gaimardii sp. 2	19	Pale pink
Mysidae	9	
Amphipoda (Order)		
Black amphipod	27	Black and transparent
Stegocephalus sp.	6	
Paramphitoe sp.	19	
Pink eyed amphipod	19	Could be at least 3 different species
Red amphipod	24	Small, red and transparent

Mollusca		
Buccinum sp.	1	
Margarites sp.?	1	
Unid. Gastropod	1	Long, thin, cone shape
Scallop	2	Small, juvenile
Annelida		
Polychaetes	9	Could all be different species
Annelid #1	1	Smooth body, green
Annelid #2	1	Smooth body, red/orange
Flatworm?	1	Flat body, transparent
Sipuncula		
Sipunculid #1	1	Smooth, brown, peanut shaped
Algae		
Green leafy algae	3	Fragments
Red leafy algae	1	Fragment
Fiberous stalk of algae	3	
Cnidarians (other)		
Unid. Jelly mass	1	
Chordata		
Sebastidae	1	Adult
Lotidae	1	Adult
Zoarcidae	1	Adult
Liparidae	1	Juvenile
Myctophidae	4	Juvenile
Unknown fish sp.	1	Juvenile, very damaged.
Other		
Plastic?	1	One fragment of pink plastic collected

Characterization of large rock in trawl

Size: 40 cm x 26 cm x 35 cm

Encrusting species/species not removed: *hydrozoans*, calcified polychaete tubes, encrusting bryozoans, base of deep sea coral spp. (*Primnoa* sp. c.f.), lattice bryozoans, branching bryozoans, polychaete worms with soft tubes (in rock crevices), encrusting sponges, tunicate (other) (Figure 6.7).

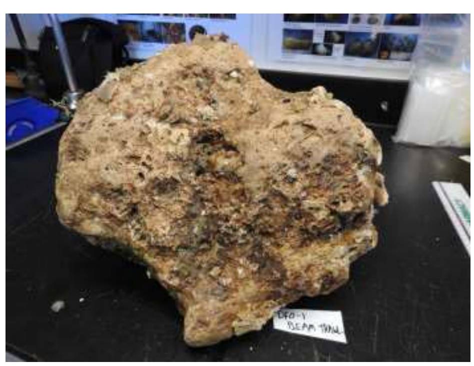

Figure 9.7 Large rock collected in beam trawl on October 7, 2017. Photo credit: Erin Herder.

Characterization of large yellow sponge attached to large rocks

Size: 40 cm x 35 cm x 23 cm

Encrusting species/species not removed: many hydroids growing on sponge, second yellow sponge attached to main sponge, encrusting bryozoans attached to rocks, hydroids attached to rocks (Figure 8.8).

Figure 9.8 Large sponge with rocks attached, collected in beam trawl on October 7, 2017. Photo Credit: Erin Herder.

9.4 Comments and Recommendations

The crew again, has been so helpful with all sampling activities and any other needs on-board the Amundsen making our experience on-board as enjoyable and productive as possible. As we were a small group of scientists onboard during leg 4b, we had a lot of space to work and organize our samples and gear. One huge benefit was having enough space to access the fumehood for processing and preservation of samples which has been more difficult in previous years due to a much larger scientific crew.

10 Phytoplankton Production and Biomass – legs 2 and 4b

Project leaders: Michel Gosselin[1] (michel_gosselin@uqar.ca) and Michel Poulin[2]
Cruise participants – leg 2a: Joannie Charette[1], François Genin[1] and Aude Boivin-Rioux[1]
Cruise participants – leg 2b: Joannie Charette[1] and Aude Boivin-Rioux[1]
Cruise participants – leg 4b: François Genin[1] and Kim Doiron[1]
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10.1 Introduction

Primary production plays a central role in the oceans as it supplies organic matter to the higher trophic levels, including zooplankton, fish larvae, marine mammals and birds. Marine polar ecosystems are particularly sensitive to any changes in primary production due to their low number of trophic links (Grebmeier et al. 2006; Moline et al. 2008; Post et al. 2009). The Arctic Ocean is changing as evidenced by the decrease in sea ice thickness and extent (Stroeve et al. 2007; Kwok et al. 2009), the early melt and late freeze-up of sea ice (Markus et al. 2009) and the enhancement of the hydrological cycle (Peterson et al. 2006; Serreze et al. 2006). These environmental changes have already altered the phytoplankton biomass distribution in the Arctic Ocean (Arrigo et al. 2008; Pabi et al. 2008). In this context, the general objectives of our research project are (1) to determine the spatial and temporal variability in production, biomass, abundance and taxonomic composition of the phytoplankton communities, and (2) to determine the role of environmental factors on the phytoplankton dynamics and its variability along Hudson's strait, in the Labrador sea, along Hudson Bay's Quebec coast, in Baffin Bay, in the Canadian Arctic Archipelago and in Foxe Basin.

The specific objectives of leg 2 were to determine

1) the downwelling incident irradiance, every 10 minutes, with a Li-COR 2 pi sensor;
2) the transparency of the upper water column with a Secchi disk;
3) the underwater irradiance profile with a PNF-300 probe;
4) the concentrations of dissolved organic carbon (DOC), total organic carbon (TOC), total dissolved nitrogen (TDN) and total nitrogen (TN) with a Shimadzu TOC-VCPN analyzer;
5) the chlorophyll a and phaeopigment concentrations with a Turner Designs fluorometer (3 size-fractions: >0.7 µm, >5 µm, >20 µm);
6) the abundance and taxonomic composition of phytoplankton using the inverted microscopy method;
7) the abundance of pico- and nanophytoplankton and heterotrophic bacteria by flow cytometry;
8) the phytoplankton production using the 14C assimilation method (2 size-fractions: >0.7 µm, >5 µm).

The specific objectives of leg 4 were to determine

1) the downwelling incident irradiance, every 10 minutes, with a Li-COR 2 pi sensor;
2) the concentrations of dissolved organic carbon (DOC), total organic carbon (TOC), total dissolved nitrogen (TDN) and total nitrogen (TN) with a Shimadzu TOC-VCPN analyzer;

3) the chlorophyll a and phaeopigment concentrations with a Turner Designs fluorometer (3 size-fractions: >0.7 µm, >5 µm, >20 µm);
4) the abundance and taxonomic composition of phytoplankton using the inverted microscopy method;
5) the abundance of pico- and nanophytoplankton and heterotrophic bacteria by flow cytometry.

10.2 Methodology

10.2.1 *Leg 2*

At each water column station, we collected water samples with 12 L Niskin-type bottles attached to the CTD-rosette. During daytime, we determined the depth of the euphotic zone with the Secchi disk and the PNF-300 probe. Size-fractionated (3 size-classes: >0.7 µm, >5 µm and >20 µm) chlorophyll a concentrations were measured on board the ship at each sampling depth with a Turner Designs fluorometer (model 10-AU). Size-fractionated (2 size-fractions: >0.7 µm and >5 µm) primary production was estimated at 7 optical depths in the water column (i.e. 100%, 50%, 30%, 15%, 5%, 1%, and 0.2% of the surface irradiance), following JGOFS's protocol for simulated in situ incubations. The other samples collected during this expedition will be analyzed at ISMER. Detailed sampling activities are summarized in Table 11.1. Our chlorophyll a data will be used for the calibration of the CTD-Rosette's chlorophyll a fluorescence sensor.

Table 9.3 Sampling operations during leg 2 of the ArcticNet 2017 expedition on board the CCGS *Amundsen*.

Leg	Station	Cast	Date	Position (min)		Chlorophyll a			POC / PON	DOC/DN TOC/TN	HPLC	Taxonomy	Flow cytometry	Primary production	
			jjmmyy	Lat (°N)	Long (°W)	>0.7 µm	>5 µm	>20 µm						>0.7 µm	>5 µm
2a	St.732	1	070717	55°23.275	77°59.524	x	x	x		x	x	x	x		
2a	St.GWR		070717			x				x					
2a	St.736	2	070817	58°25.544	078°18.221	x	x	x		x	x	x	x		
2a	St.720	5	070917	60°41.764	078°33.860	x	x	x		x	x	x	x		
2a	St.694	6	071017	62°30.766	078°29,333	x	x	x		x	x	x	x		
2a	St.688	7	071117	62°22.018	074°39.716	x	x	x		x	x	x	x		
2a	St.688z	zodiac	071117			x				x	x	x	x		
2a	St.684	8	071117	61°47.208	071°54.743	x	x	x		x	x	x	x		
2a	St.682	9	071117	61°2.514	069°42.984	x	x	x		x	x	x	x		
2a	St.682z	zodiac	071117			x				x	x	x	x		
2a	St.676	10	071217	60°7.568	069°3.884	x	x	x		x	x	x	x		
2a	St.670	11	071217	58°59.779	067°56.132	x	x	x		x	x	x	x		
2b	St.A16	13	071517	63°38.360	068°37.574	x	x	x	x	x	x	x	x	x	x

2b	St.180	18	071817	67°24.678	061°26.874	x	x	x	x	x	x	x	x	x	x
2b	St. Disko Fan (ROV)	20	071917	67°58.052	059°30.199	x	x	x	x	x	x	x	x		
2b	St.Float 2 (Takuvik)	22	072017	69°38.653	060°44.687	x					x				
2b	St.176	23	072017	69°36.781	065°23.490	x	x	x	x	x	x	x	x	x	x
2b	St.BB2	26	072217	72°46.108	067°1.019	x	x	x	x	x	x	x	x	x	x
2b	St.Float 3 (Takuvik)	28	072217	72°45.850	066°59.458	x					x				
2b	St.101	32	072417	76°23.110	077°24.310	x	x	x	x	x	x	x	x	x	x
2b	St.105	38	072517	76°19.098	075°45.878	x	x	x	x	x	x	x	x		
2b	St.115	44	072617	76°20.234	071°13.213	x	x	x	x	x	x	x	x	x	x
2b	St.129	49	072717	78°19.433	074°4.860	x	x	x	x	x	x	x	x	x	x
2b	St.Trinity (TS233)	52	072817	77°46.859	076°30.148	x	x	x	x	x	x	x	x	x	x
2b	St.111	58	072917	76°18.143	073°13.483	x	x	x	x	x	x	x	x	x	x
2b	St.108	62	072917	76°15.707	074°36.251	x	x	x	x	x	x	x	x	x	x
2b	St.323	64	073117	74°9.370	080°28.698	x	x	x	x	x	x	x	x	x	x
2b	St.Pond (ROV Pond Inlet)	66	080117	72°49.660	077°36.220	x	x	x	x	x	x	x	x		
2b	St.Navy (ROV Navy Board Inlet)	67	080217	73°43.646	081°6.034	x	x	x	x	x	x	x	x		
2b	St.301	73	080317	74°16.361	083°22.765	x	x	x	x	x	x	x	x	x	x
2b	St.304	76	080417	74°14.822	091°30.510	x	x	x	x	x	x	x	x	x	x
2b	St.305b	79	080517	74°21.140	093°34.936	x	x	x	x	x	x	x	x		
2b	St.QMGM	84	080717	68°18.150	101°44.244	x	x	x	x	x	x	x	x	x	x
2b	St.QMG4	86	080817	68°29.172	103°25.751	x	x	x	x	x	x	x	x		
2b	St.QMG1	89	080917	68°29.473	099°53.718	x	x	x	x	x	x	x	x		
2b	St.312	92	081017	69°10.136	100°41.837	x	x	x	x	x	x	x	x	x	x
2b	St.Bellot	93	081117	71°59.568	094°49.136	x	x	x	x	x	x	x	x		
2b	St.333	95	081317	68°46.033	080°50.375	x	x	x	x	x	x	x	x	x	x

10.2.2 *Leg 4*

At each water column station, we collected water samples with 12 L Niskin-type bottles attached to the CTD-rosette. Size-fractionated (3 size-classes: >0.7 µm, >5 µm and >20 µm) chlorophyll a concentrations were measured on board the ship at each sampling depth with a Turner Designs fluorometer (model 10-AU). The other samples collected during this expedition will be analyzed at ISMER. Detailed sampling activities are summarized in Table 12.2. Our chlorophyll a data will be used for the calibration of the CTD-Rosette's chlorophyll a fluorescence sensor.

Table 9.4 Sampling operations during leg 4 of the ArcticNet 2017 expedition on board the CCGS *Amundsen*

Leg	Station	Cast	Date	Position (min)		Chlorophyll a			POC/ PON	DOC/DN TOC/TN	HPLC	Taxo- nomy	Flow cyto- metry	Primary production	
			jjmmyy	Lat (°N)	Long (°W)	>0.7 µm	>5 µm	>20 µm						>0.7 µm	>5 µm
4b	St.356	1	070717	60°48.359	64°42.410	x	x	x		x	x	x	x		
4b	St.354		070717	60°57.937	60°50.281	x	x	x		x	x	x	x		
4b	St.DFO-1	2	070817	60°27.210	61°15.191	x	x	x	x	x	x	x	x		

10.3 Preliminary Results

10.3.1 *Leg 2*

Chlorophyll a concentrations varied from about 5 to 413 mg m-2. Large cells (> 5µm) generally dominated the biomass throughout the study, with some exceptions in Baffin Bay (Figure 8.9). The highest chlorophyll a biomass was found in Hudson and Ungava Bay regions, with a dominance of very large cells (>20 µm).

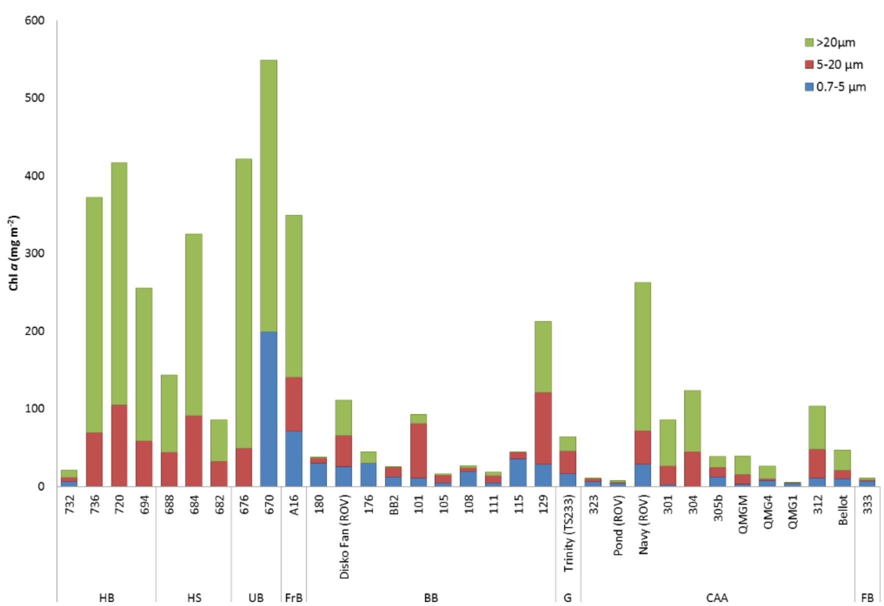

Figure 9.9 Chlorophyll a concentrations integrated over 100 m for different size fractions, 0.7-5 µm, 5-20 µm and > 20 µm, at stations sampled during leg 2. HB: Hudson Bay; HS: Hudson strait; UB: Ungava Bay; FrB: Frobisher Bay; BB: Baffin Bay; G: Glacier; CAA: Canadian Arctic Archipelago; FB: Foxe Basin

10.3.2 *Leg 4*

Chlorophyll a concentrations varied from about 8.5 to 54.5 mg m-2. They are much higher in the two Hudson's strait stations (536 and 354), which are coastal, than in the Labrador sea, which is an offshore station (Figure 8.10). Large cells (> 5µm) dominated the biomass in the Hudson's strait and smaller cells dominated in the Labrador sea.

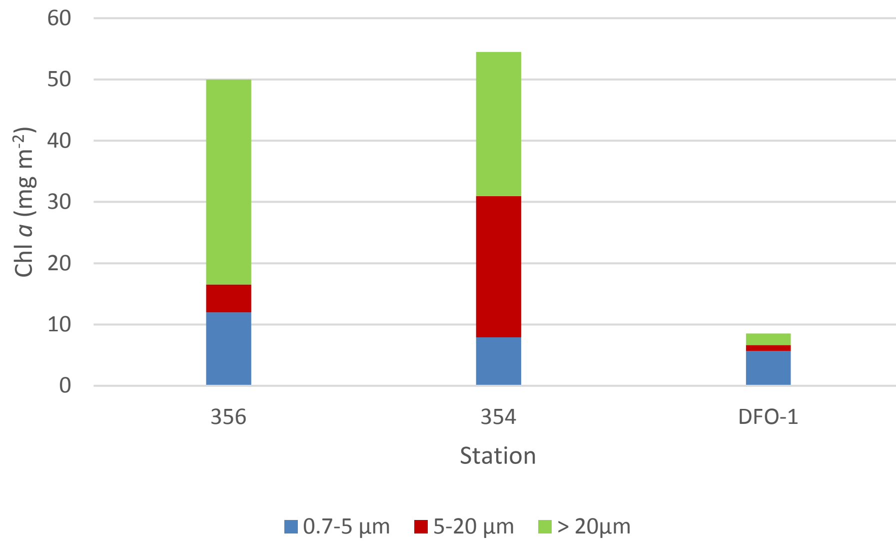

Figure 9.10 Chlorophyll a concentrations integrated over 100 m for different size fractions, 0.7-5 µm, 5-20 µm and > 20 µm, at stations sampled during leg 4.

10.4 Comments and Recommendations

Water budget for Short Basic stations were not clear prior to the beginning of the leg, which led to last-minute requests, for which we were not prepared (not enough material). Many station types were added for this cruise, compared to previous years (Short Basic, Short Full in addition to Nutrient, Basic, Full; the usual station types), which might have led to this confusion.

We had many problems with the Sanyo Incubator in the 551 AFT-lab. It stopped by itself many times during leg 2. There was water infiltration problems in the entrance of the Radvan (water coming from the fume hood exit). The crew had fixed the problem during leg 2.

Since Storage is not always available in the cold room and the Sanyo incubator has a recurrent problem keeping temperature at 4°C (mentioned in reports from previous years), it will be great to have a refrigerator in the AFT-lab instead of an incubator.

We cannot hear the all calls in the RadVan. As important information is announced via all calls throughout the day, a system that allows scientists in the RadVan to get these all calls or to receive this much needed information should be developed.

Some blue barrels used for radioactive waste have small caps on them (i.e. chemical waste barrels). However, those caps allow rain water to penetrate inside the barrels. Therefore, these barrels accumulate rain water prior, during and after their utilization. Since we do not need caps on those barrels, we suggest using some tops without caps for all radioactive waste barrels. Some of the barrels didn't have caps this year and no water infiltration was reported.

I suggest to do a "Scientific familiarization tour" for the scientists that have never been on the ship before. This tour might include the chemical room and waste location, a tour of the different labs, including what can be used in which lab (according to fume hood or mercury for example), the storage container (4°C) and the -80°C freezer just to name a few. Some of that information is assessed during the Life on board meetings, but so much information is given that some of it is lost.

As of now, the TV that shows the schedule is a useful tool when we are on time. However, when we are late or in advance, mostly during the night, it is not that useful. For example, we can only see that an operation that should have been finished at 4h00 is already done at 3h00, since it is written completed, but we don't know at what exact time the operation is finished.

We still have problems with the pump for the incubators. It stops when there is ice or even just frazil. A level sensor might be installed in the incubator (or in the new incubator system), to know when the water level in the incubator is getting low. Moreover, the water from the incubator seems to go back to the pump by the input.

<u>Reference</u>

Arrigo KR, van Dijken G, Pabi S (2008) Impact of a shrinking Arctic ice cover on marine primary production. Geophys Res Lett 35:L19603, doi:10.1029/2008GL035028

Grebmeier JM, Overland JE, Moore SE, Farley EV, Carmack EC, Cooper LW, Frey KE, Helle JH, McLaughlin FA, McNutt SL (2006) A major ecosystem shift in the northern Bering Sea. Science 311:1461-1464

Kwok R, Cunningham GF, Wensnahan M, Rigor I, Zwally HJ, Yi D (2009) Thinning and volume loss of the Arctic Ocean sea ice cover: 2003-2008. J Geophys Res 114:C07005, doi:10.1029/2009JC005312

Landry, M.R., Brown, S.L., Yoshimi M.R., Selph, K.E., Bidigare, R.R., Yang, E.J., & Simmons, M.P. (2008). Depth-stratified phytoplankton dynamics in Cyclone Opal, a subtropical mesoscale eddy. Deep-Sea Research II 55: 1348– 1359

Markus T, Stroeve JC, Miller J (2009) Recent changes in Arctic sea ice melt onset, freezeup, and melt season length. J Geophys Res 114:C12024, doi:10.1029/2009JC005436

Moline MA, Karnovsky NJ, Brown Z, Divoky GJ, Frazer TK, Jacoby CA, Torrese JJ, Fraser WR (2008) High latitude changes in ice dynamics and their impact on polar marine ecosystems. Ann N Y Acad Sci 1134:267-319

Pabi S, van Dijken GL, Arrigo KR (2008) Primary production in the Arctic Ocean, 1998-2006. J Geophys Res 113, C08005, doi:10.1029/2007JC004578

Peterson BJ, McClelland J, Curry R, Holmes RM, Walsh JE, Aagaard K (2006) Trajectory Shifts in the Arctic and Subarctic Freshwater Cycle. Science 313:1061-1066

Post E, Forchhammer MC, Bret-Harte MS, Callaghan TV, Christensen TR, Elberling B, Fox AD, Gilg O, Hik DS, Hoye TT, Ims RA, Jeppesen E, Klein DR, Madsen J, McGuire AD, Rysgaard S, Schindler DE, Stirling I, Tamstorf MP, Tyler NJC, van der Wal R, Welker J, Wookey PA, Schmidt NM, Aastrup P (2009) Ecological Dynamics Across the Arctic Associated with Recent Climate Change. Science 325:1355-1358

Serreze MC, Barrett AP, Slater AG, Woodgate RA, Aagaard K, Lammers RB, Steele M, Moritz R, Meredith M, Lee CM (2006) The large-scale freshwater cycle of the Arctic. J Geophys Res 111:C11010, doi:10.1029/2005JC003424

Stroeve J, Holland MM, Meier W, Scambos T, Serreze M (2007) Arctic sea ice decline: Faster than forecast. Geophys Res Lett 34:L0950, doi:10.1029/2007GL029703

11 Distribution and Biodiversity of Microorganisms in the Canadian Arctic – Leg 2a

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11.1 Introduction

Our research is aimed firstly at surveying and mapping the biodiversity and structure of microbial communities in the Canadian Arctic. Microbes here are considered as any single celled organism that routinely cannot be observed without a microscope and therefore includes: phytoplankton, heterotrophic protists (microbial eukaryote), Bacteria and Archaea. These groups are responsible for the net production in the Arctic and their interactions within the microbial food web determine the amount of fixed carbon (lipids, sugars, proteins etc.) that is available to higher trophic levels. Microbes also mediate biogeochemical cycling including Carbon, Nitrogen and Sulfur. This work is in the context of the ArcticNet project let by Dr. Jean-Éric Tremblay and is a contribution to ArcticNet ARC3Bio program.

This program was planned to investigate the microbial community along the eastern side of Hudson Bay, the southern side of Hudson strait and the Ungava Bay. Our goal is to reveal the diversity and function of marine microbes with a specific focus on microbes involved in the nitrogen cycle. For this reason, we will be using genomic approaches to characterize the microbial diversity from different water masses and if possible in river and shore area.

11.2 Methodology

From 7 July to 12 July 2017, seawater was collected at each basic station using the CTD-rosette system onboard the CCGS *Amundsen* to sample a maximum of 6 depths per station (Table 10.1), surface samples were sampled using a bucket instead of the rosette. Depths were chosen for sampling based on characteristics of the water column as profiled by the downcast of the CTD. The surface and bottom of the water column were always sampled, along with up to two other depths of interest such as the nitricline, or temperature features indicating water masses from the Atlantic or Hudson bay. We attempted always to sample the surface, the bottom and subsurface chlorophyll maximum (SCM), an important feature of northern oceans; however, at some stations the peak in fluorescence that indicates the DCM was broad and unstable.

Table 11.1 Samples collected during Leg 2b.

Date	Time (UTC)	Station	Latitude (N)	Longitude (W)	Number of depth sampled
07/07/2017	17h30	GWR	TBD	TBD	3
07/07/2017	23h51	732	55º23.275	77º59.525	7
07/08/2017	22h03	736	58º25.544	78º18.221	5

07/10/2017	9h10	694	62º30.766	78º29.333	6
07/10/2017	22h15	688C	62º15.87	74º43.50	1
07/11/2017	19h31	682	61º2.514	69º42.984	6
07/12/2017	TBD	682C	TBD	TBD	2
07/12/2017	TBD	670C	TBD	TBD	2

DNA and RNA

Samples for DNA and RNA were collected by filtering up to 6 liters of seawater onto a 3 µm polycarbonate filter and a 0.2 µm Sterivex cartridge (Millipore) using a peristaltic pump. This method gives us access to two distinct size fractions of the microbial community. Filters were stored in RNAlater buffer (Ambion) at -80ºC. Both DNA and RNA will be extracted upon returning to Université Laval; the first represents simple presence of the cell or gene, while the second indicates the community's capacity for protein production, sometimes conceptualized as the “active community” since it excludes cysts and dormant cells.

Because RNA in particular degrades at ambient temperature, filtering was stopped after a maximum of three hours, meaning that sometimes less than 6 liters was filtered.

Epifluorescence Microscopy

Slides were made for epifluorescence microscopy at each station and depth sampled. These slides will be used to estimate abundance of eukaryote cells. Seawater was fixed with 2.5 % glutaraldehyde and processed within 6 hours of sampling. Fifty ml of fixed sample was filtered through a 0.8 µm black polycarbonate filter and stained with DAPI, a nucleic acid stain. This filter was mounted on slide using a drop of immersion oil and stored in darkness at -20ºC.

Flow Cytometry (FCM)

FCM is more accurate than microscopy to count cells in the “pico” size range (0.2–2 µm), and can include some functional information such as prokaryote versus eukaryote cells and the presence of photosynthetic pigments. FCM samples were taken from each station and depth, and fixed with 0.5% glutaraldehyde in duplicate for “dead” samples, or preserved in glycerol-TE buffer in triplicate for “live” samples. After a short incubation at ambient temperature in the fixative or buffer, samples were flash frozen in liquid nitrogen and stored at -80°C

Fluorescent in situ Hybridization (FISH)

FISH is a technique that uses fluorescent-labelled nucleic acid probes to identify a specific phylogenetic group of organisms under the microscope. Samples for FISH were collected in duplicate for eukaryotes and bacteria at each station and depth sampled. Seawater was fixed with 3.7 % formaldehyde and processed within 24 hours of sampling. For eukaryotic organisms, 90 ml of fixed sample was filtered onto a 0.8 µm polycarbonate filter. For bacteria, 35 ml was filtered onto a 0.2 µm polycarbonate filter. Filters were stored at -80 ºC.

Conventional Light Microscopy

At each station, for the surface water sample and DCM (where present), 225 ml of seawater was collected and fixed using FNU fixative (1 % paraformaldehyde, 0.1 % glutaraldehyde). At Université Laval, these samples will be allowed to sediment in Utermöhl chambers and larger organisms, such as diatoms and dinoflagellates, will be identified to the highest possible taxonomic resolution on an inverted microscope.

11.2.1 *Side project*

To investigate the potential of future collaboration two side projects were developed on board.

Great Whale River

To study the impact of the great whale river on the marine environment we selected three stations, the first one in the great whale river (Surface salinity 0), the second at the anchorage site (Surface salinity 12.1) and the third at the open sea station 732.At each station we took triplicates of the surface layer and processed them as described previously.

Incubations

In collaboration with J-É Tremblay lab, we took samples during an incubation experiment they set up. Briefly they incubate water from the surface and the SCM with ammonium or gaseous nitrogen to measure the ammonium and gaseous nitrogen by the cells. The T0 sample of the community will informed us on the diversity of microbes and the genes presents in the sample. The T24h samples will be used to track any community changed that are influenced by the incubation. (Table 10.2)

Table 11.2 Nitrogen cycle incubation's samples

Date	Station	Feature	Ammonium_T0		Ammonium_T1		Fixation_T1	
			GFF	Sterivex	GFF	Sterivex	GFF	Sterivex
07/08/2017	736	Surface	X	0.6	X	1	X	1
07/08/2017	736	SCM	X	0.6	X	1	X	1
07/10/2017	694	Surface	X	0.6	X	1	X	1
07/10/2017	694	SCM	X	0.6	X	1	X	1
07/11/2017	684	Surface	X	0.6	X	1	X	1
	682	SCM	X	0.6	X	1	X	1
07/12/2017	676	Surface	X	0.6	X	1	X	1
07/12/2017	676	SCM	X	0.6	X	1	X	1

11.3 Comments and Recommendations

We had good weather and all sampling operation went well. The lab space allocated allowed good working conditions. We thank the chief scientist for a well-organised cruise and captain and crew for their professionalism and support.

12 Biogeochemistry of the Arctic Ocean – Leg 2

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12.1 Introduction

The biogeochemical cycling of carbon and other dissolved gases within the Arctic Ocean is predicted to be perturbed by climate change. The Arctic Ocean itself has undergone significant change in recent years, with increasing sea surface temperatures, increased freshwater inputs and large reductions in sea ice cover, the latter leading to higher gas exchange rates and subsequent ocean acidification. In 2017, our group measured several gases and biogeochemical tracers to provide insight into chemical processes within the water column. We measured the three most prominent anthropogenic greenhouse gases, CO_2, CH_4, and N_2O (carbon dioxide, methane, and nitrous oxide). CH_4 emissions from the Arctic are expected to increase as a consequence of global warming due to the thawing of permafrost on land and methane hydrates in the ocean. N_2O emissions in a changing Arctic Ocean are highly uncertain since different microbial processes can produce or consume these gases.

We also measured N_2, O_2, and four noble gases (Ne, Ar, Kr and Xe) at select stations. Oxygen is a tracer of net photosynthetic production and N_2 is a tracer of denitrification (conversion of nitrate to N_2 by heterotrophic microbes in anoxic waters and sediments). Noble gases, which are chemically and biologically inert, can be used to parameterize physical processes in the ocean, and the insight from these measurements can be applied to biologically-active gases.

A new addition to our sampling program this year was the collection of river samples within the Canadian Arctic Archipelago region. While sea ice loss is the most visible impact of climate change on the Arctic Ocean, increases in river discharge and organic carbon supply (which is transported to the ocean, in part, by rivers) also have large impacts on biogeochemical cycling, and there is currently very little geochemical data on rivers in this region. This data is needed to understand the impact of rivers on the Arctic Ocean and identify the presence of river-influenced water in the ocean. Recent studies have shown extremely high CH_4 emissions from some Arctic lakes, however, data on CH_4 fluxes from Arctic rivers are extremely sparse, especially in the Canadian Arctic Archipelago. The sampling sites for this project were chosen from places that other groups have conducted geochemical sampling at least once within the past 5 years. In this program, we included measurements of inorganic carbon parameters (both DIC and alkalinity), CH_4, and N_2O that were not collected by previous groups.

12.2 Methodology

Seawater was collected at a number of nutrient, basic, and full stations (see Table 10.1) primarily from the ship's CTD rosette system. We collected seawater samples for the analysis of methane (CH_4), nitrous oxide (N_2O), dissolved inorganic carbon (DIC), total alkalinity (TA), pH, stable oxygen isotopes (^{18}O-H_2O), stable carbon isotopes of DIC (^{13}C-DIC), barium, and salinity. As many DIC/TA samples as possible were analyzed onboard the ship using a VINDTA system in the ship's aft chemistry lab. The VINDTA is an automated titration system which carries out two separate titrations to measure both DIC and TA. TA is measured using a basic HCl titration, whereas DIC is measured using coulometry. Additionally, pH samples were analyzed onboard after each rosette cast by spectrophotometry, at room temperature (25°C) using Phenol Red and Cresol Purple indicators to measure absorbance at specific wavelengths, the ratio of which translates into pH values. Salinity samples were analyzed onboard using the ship's Autosal salinometer.

At a subset of stations surface water was collected using a single 5L niskin bottle deployed from the foredeck. In these instances, a RBR CTD was also deployed prior to the 5L niskin in order to collect temperature and salinity data in the top 7 m of the water column. Using the single niskin from the foredeck, we collected water from the surface, 1m , and 2m depths for the analysis of dissolved inorganic carbon and total alkalinity, stable oxygen isotopes, and salinity. Surface sampling was completed at stations 736, 720, 694, 688, 684, 682, 676, 670, BB1, 176, BB3, 129, TS233, 111, 108, ROV Pond Inlet, 312, QMG-M, QMG-4, QMG-1, 333, A8, and A2. At full station 301 we were able to use the zodiac to preform our surface sampling instead of lowering the niskin from the foredeck.

Table 12.1 Rosette Sampling Stations

Stn	Typ e	Cas t	Lat (N)	Lon (W)	Date	DI C	p H	CH_4/N_2O	^{13}C, Sal, Ba, ^{18}O	^{15}N- N_2O	Nobl e
732	B	1	55 23.24	077 59.52	Jul 07 2017	✓	✓	✓	✓		
736	B	2	58 25.50	078 18.27	Jul 08 2017	✓	✓	✓	✓		
720	B	5	60 41.71	078 33.93	Jul 09 2017	✓	✓		✓		
694	B	6	62 30.72	078 29.33	Jul 10 2017	✓	✓	✓	✓		
688	B	7	62 22.03	074 39.68	Jul 10 2017	✓	✓		✓		
684	B	8	61 47.22	071 54.80	Jul 11 2017	✓	✓		✓		
682	B	9	61 02.51	069 43.01	Jul 11 2017	✓	✓		✓		
676	B	10	60 07.58	069 03.86	Jul 12 2017	✓	✓		✓		
670	B	11	58 59.78	067 56.13	Jul 12 2017	✓	✓		✓		
A16	B	14	63 38.36	068 37.45	Jul 15 2017			✓			
BB1	N	17	66 51.66	059 03.47	Jul 18 2017	✓	✓	✓	✓	✓	

180	B	19	67 25.56	061 23.31	Jul 18 2017	✓	✓	✓	✓		
Float Stn 2	-	21	69 33.20	060 46.13	Jul 20 2017	✓	✓	✓	✓	✓	✓
Float Stn 2	-	22	69 38.65	060 44.69	Jul 20 2017	✓	✓	✓	✓	✓	✓
BB3	N	25	71 24.89	068 36.78	Jul 22 2017	✓	✓	✓	✓	✓	✓
BB2	F	26	72 46.11	067 00.27	Jul 22 2017	✓	✓	✓	✓	✓	✓
BB2	F	27	72 45.84	066 59.37	Jul 22 2017						
101	F	31	76 22.98	077 24.28	Jul 24 2017	✓	✓	✓	✓	✓	
101	F	32	76 23.11	077 24.31	Jul 24 2017						✓
105	B	37	76 19.05	075 45.62	Jul 25 2017	✓	✓	✓	✓	✓	
115	F	43	76 19.93	071 11.83	Jul 26 2017	✓	✓	✓	✓	✓	
115	F	44	76 20.23	071 13.21	Jul 26 2017						✓
126	N	45	78 19.43	074 53.60	Jul 27 2017			✓			
129	F	48	78 19.56	074 07.62	Jul 27 2017	✓	✓	✓	✓	✓	
131	N	51	78 19.70	073 05.28	Jul 28 2017			✓			
TS233	F	53	77 45.29	076 36.35	Jul 28 2017	✓	✓	✓	✓		
111	B	57	76 18.54	073 13.19	Jul 29 2017	✓	✓	✓	✓	✓	
108	F	61	76 15.84	074 36.14	Jul 29 2017	✓	✓	✓	✓	✓	
108	F	62	76 15.71	074 36.25	Jul 30 2017						✓
323	F	64	74 09.37	080 28.70	Jul 31 2017	✓	✓	✓	✓	✓	
323	F	65	74 09.56	080 27.88	Jul 31 2017						✓
325	N	68	73 49.10	080 29.77	Aug 02 2017	✓	✓	✓	✓		
322	N	71	74 29.40	080 33.08	Aug 03 2017	✓	✓	✓	✓		
301	F	72	74 16.66	083 21.88	Aug 03 2017	✓	✓	✓	✓		
304	B	77	74 14.875	091 31.986	Aug 04 2017	✓	✓	✓	✓		
305B	B	79	74 21.140	093 34.936	Aug 05 2017	✓					
Site 5.10	N	82	74 29.395	099 5.437	Aug 06 2017	✓	✓	✓	✓	✓	
QMG-M	B	83	68 18.172	101 44.464	Aug 08 2017	✓	✓	✓	✓		
QMG-4	B	86	68 29.172	103 25.751	Aug 09 2017	✓	✓	✓	✓		
QMG-3	B	87	68 19.675	102 56.478	Aug 09 2017	✓	✓	✓	✓		
QMG-1	B	89	68 29.473	99 53.718	Aug 09 2017	✓	✓	✓	✓		
QMG-2	B	90	68 18.367	100 48.091	Aug 09 2017	✓	✓	✓	✓		
312	B	91	69 10.238	100 42.260	Aug 10 2017	✓	✓	✓	✓		
BELLOT	B	93	71 59.568	94 49.136	Aug 11 2017	✓	✓	✓	✓		
333	B	95	68 46.033	80 50.375	Aug 13 2017	✓	✓	✓	✓		
A8	N	96	65 27.040	83 15.469	Aug 15 2017	✓	✓	✓	✓		
A2	N	98	63 33.150	78 43.300	Aug 16 2017	✓	✓	✓	✓		

* $^{13}C-CH_4$ samples were also collected at stations 180 and 129

12.2.1 *River Sampling*

At each river, and one surface ocean station, we measured temperature and conductivity and collected samples for CH_4 and N_2O concentration, DIC, total alkalinity, Barium, nutrients, dissolved organic carbon, major ions as well as isotopic tracers: $^{87}Sr/^{86}Sr$, $\delta^{18}O$-H_2O, $\delta^{2}H$-H_2O, $\delta^{13}C$-CH_4, $\delta^{13}C$-DIC, and dual isotope ($\delta^{15}N$ and $\delta^{18}O$) analysis of NO_3- and N_2O. We did not measure pH on the river samples because our on-board setup for pH analysis was not capable of freshwater measurements.

The list of river sampling sites is below (see Table 11.2). We sampled from 6 of the 9 rivers on our list of potential sites developed before the cruise, along with two "bonus" rivers selected from locations the glaciology team was planning to visit. Two rivers were not sampled because there was fog present when we passed by them, and one river was removed as it was too far from the final cruise track. We were extremely pleased with this outcome.

We initially included 15 rivers on our list, however, we were not able to obtain permits to sample from rivers in national parks or bird sanctuaries as the application deadline to obtain permits was in February and we did not start the permitting process until early March. We would encourage others interested in collecting river samples from the Amundsen (or any scientific sampling activities in Nunavut outside of the Amundsen) to start the permitting process as soon as possible.

Table 12.2 River Sampling Sites

Station ID	Station description	Island	Latitude	Longitude	Date	Time (EST)
CMCMG	River at Cunningham Mountains/Glacier	Devon Island	74.60486	-80.36816	02-Aug	18:07
CMMB	River near Maxwell Bay	Devon Island	74.5114	-88.4919	04-Aug	8:38
CMMB	Glacial river at Blaney Bay	Devon Island	74.5471	-87.312	04-Aug	10:15
CMGR	Garnier River	Somerset Island	73.9443	-90.0652	04-Aug	13:04
CMMR	Mecham River near Resolute	Cornwallis Island	74.6943	-94.7717	05-Aug	11:30
CMCR	Cunningham River	Somerset Island	74.0215	-93.6455	06-Aug	9:00
CMLFI	River in Le Feuvre Inlet	Prince of Wales Island	72.33	-96.8762	06-Aug	14:15
CMCR2	Creswell River	Somerset Island	72.8485	-93.3865	11-Aug	16:30

CMBS	Bellot Strait (surface seawater, Ca093, Ni23)	n/a	71.9928	-94.819	11-Aug	13:03

12.3 Preliminary Results

We analyzed samples onboard for DIC/TA using the VINDTA. Below are some preliminary results from two rosette casts at stations 111 and QMG-M.

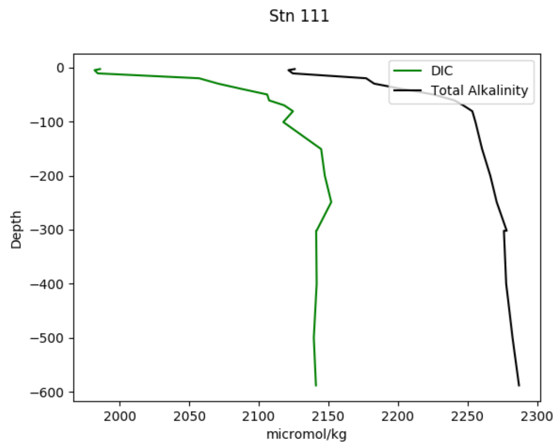

Figure 12.1 DIC/TA – Station 111

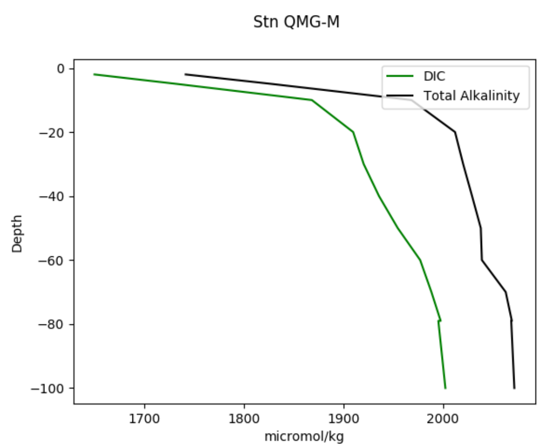

Figure 12.2 DIC/TA – station QMG-M

12.4 Comments and Recommendations

The water budgeting process for rosette operations could be improved. We would recommend making the rosette sampling requests by all groups available to all participants in advance of the cruise. This information should include the amount of water needed, itemized by each parameter being measured and not just the total volume of water. Cruise participants should be responsible for checking over these budgets in advance of the cruise and could be told that modifications to the rosette budgets during the cruise will be strongly discouraged (in order to get them to verify the information).

We are providing this feedback based on a number of experiences. First, for Leg 2a, we were getting emails just a few days before the cruise started from other participants asking what parameters our water budgets included and which stations we were planning to sample. We were asked by another group to add in measurements at more stations than we had planned for when we shipped our supplies in April. Since Leg 1 was cancelled, we had enough spare bottles to add in these extra stations at the last minute, but this would not have been possible otherwise. Furthermore, the water budgets for Leg 2b were not made up until the end of Leg 2a and the person who initially developed the budgets was an intern who had not been involved in the longer-term expedition planning.

Additionally, one member of our team learned that another group was planning to measure the same parameter as them at some of the same stations as them just a few days before they arrived on the ship. This sampling was not mentioned in the sampling operations sheet distributed on 22 June. Furthermore, one member of our group had the understanding that another group was measuring a specific chemical species (based on all of the Sampling Operations lists distributed in advance of the cruise) so they did not pack the supplies to collect this type of sample. When they arrived on board they found out this parameter was not being measured by the group and so will be missing a key measurement they had been counting on. If the water budgets, parameters being measured by each group, and stations of interest had been made available to all cruise participants earlier, and cruise participants had been told that modifying the water budgets at sea was discouraged, both of these issues could have been identified and resolved before the cruise.

Acknowledgement

We would like to thank all of the Coast Guard and scientific crew for making this expedition a success and pleasure to participate in.

We would like to thank Jean-Eric Tremblay's lab and the rosette operators for allowing our group to sample at some of the closely-spaced nutrient stations even though, and the Bio-Argo team (Claudie and Jose) for allowing us to sample on the Float Station 2 cast. We also thank Jonathan Gagnon for analyzing the nutrient data from river stations.

For the river sampling, we greatly appreciated that both chief scientists (Jean-Éric Tremblay and Martine Lizotte) and commanding officer kept the river sampling a high priority during the cruise and helped to ensure the success of this part of our sampling program. We would like to thank Anissa Merzouk for her assistance with the time-intensive process of obtaining permits for scientific sampling in Nunavut.

13 Marine Productivity: Carbon and Nutrients Fluxes – Legs 2 and 4b

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Cruise participants - leg 2: Gabriele Deslongchamps[1], Jean-Éric Tremblay[1], Jonathan Gagnon[1] and Kasey Bergeron[1]
Cruise participant leg - 4b: Gabriele Deslongchamps[1]
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13.1 Introduction

The Arctic climate displays high inter-annual variability and decadal oscillations that modulate growth conditions for marine primary producers. Much deeper perturbations recently became evident in conjunction with globally rising CO_2 levels and temperatures (IPCC 2007). Environmental changes already observed include a decline in the volume and extent of the sea-ice cover (Johannessen et al. 1999, Comiso et al. 2008), an advance in the melt period (Overpeck et al. 1997, Comiso 2006), and an increase in river discharge to the Arctic Ocean (Peterson et al. 2002, McClelland et al. 2006) due to increasing precipitation and terrestrial ice melt (Peterson et al. 2006). Consequently a longer ice-free season was observed in both Arctic (Laxon et al. 2003) and subarctic (Stabeno & Overland 2001) environments. These changes entail a longer growth season associated with a greater penetration of light into surface waters, which is expected to favoring phytoplankton production (Rysgaard et al. 1999), food web productivity and CO_2 drawdown by the ocean. However, phytoplankton productivity is likely to be limited by light but also by allochtonous nitrogen availability. The supply of allochtonous nitrogen is influenced by climate-driven processes, mainly the large-scale circulation, river discharge, upwelling and regional mixing processes. In the global change context, it appears crucial to improve the knowledge of the environmental processes (i.e. mainly light and nutrient availability) interacting to control phytoplankton productivity in the Canadian Arctic. Also, changes in fatty acid proportions and concentrations will reflect shifts in phytoplankton dynamics including species composition and size structure, and will reveal changes in marine energy pathways and ecosystem stability.

13.1.1 *Objectives – leg 2*

The main goals of our team for Leg 2 of ArcticNet 2016 were to:

- Establish the horizontal and vertical distributions of phytoplankton nutrients;
- Measure the primary production located at the surface of the water column using O_2/Ar ratios;
- Assess the fatty acids concentrations in phytoplankton as well as zooplankton.

Auxiliary objective was to calibrate the ISUS nitrate probe attached to the Rosette.

13.1.2 *Objectives – leg 4b*

The main goals of our team for Leg 4b of ArcticNet 2017 were to:

- Establish the horizontal and vertical distributions of phytoplankton nutrients;
- Collect fatty acid samples from phytoplankton and zooplankton to access their lipid contents.

13.2 Methodology

Samples for inorganic nutrients (ammonium, nitrite, nitrate, orthophosphate and orthosilicic acid) were taken at all NUTRIENTS/BASIC/FULL stations (Table 12.1 and Table 12.2) to establish detailed vertical profiles. Samples were stored at 4°C in the dark and analyzed for nitrate, nitrite, orthophosphate and orthosilicic acid within a few hours on a Bran+Luebbe AutoAnalyzer 3 using standard colorimetric methods adapted for the analyzer (Grasshoff et al. 1999). Additional samples for ammonium determination were taken at stations where incubations were performed and processed immediately after collection using the fluorometric method of Holmes et al. (1999). A quadrupole mass spectrometer (PrismaPlus, Pfeiffer Vacuum) was used to measure the dissolved gases (N_2, O_2, CO_2, Ar) coming for the underway seawater line located in the 610 laboratory. O_2 to Ar ratios will later be analyzed to measure primary production that occured up to 10 days prior of the ship's passage in all the areas visited.

In order to examine the potential effects of environmental conditions (e.g. acidity, alkalinity, free CO_2) on energy transfer through food chain, we realized at Full and Basic stations, 3L filtration in duplicate from water surface and SCM with pre-combusted GF/C, to analyse the lipids composition, which is the densest form of energy, in particulate organic matter. Samples of 100 to 1000mg of earlier and adult stage of copepods were also realized and stored on GF/F filters by -80°C to aims our objectives. Moreover the pH of SCM and surface water has been measured by spectrophotometer by using red phenol and cresol purple colorants. Then we stored 500ml of water from each depth to determine the alkalinity in laboratory as soon as possible after the end of the mission. Finally we continue the long term analysis conducted during previous year such as filtration of POC/PN, POP, BSi and incubation of phytoplankton with 15N. To determine nitrate, ammonium and urea uptake rates and primary production, water samples from the surface were incubated with 15N and 13C tracers. The bottles were then incubated for 24 h using on deck incubator and light controlled incubators to establish the relation between photosynthesis and irradiance. After 24 h, the water samples were filtered through a pre-combusted GF/F filters and the filters dried for 24 h at 60°C for further analyses. Nutrients at T0 were measured with the Auto-Analyzer. Incubations were then terminated by filtration through a pre-combusted GF/F filters and stored for further analyses. Isotopic ratios of nitrogen and carbon from all GF/F filters will further be analyzed using mass spectrometry.

Table 13.1 List of sampling stations and measurements during leg 2. See rosette's Logbook for metadata.

Station	NO3, NO2, Si, PO4	NH4	Urea (surface and SCM only)	CHN, POP, BSi, Fatty acids (phyto), Fatty acids (zoo)	15N-tracers uptake experiments
732	X	X	X	X	X
736	X	X	X	X	X

720	X	X	X	X	X
694	X	X	X	X	X
688	X	X	X	X	X
684	X	X	X	X	X
682	X	X	X	X	X
676	X	X	X	X	X
670	X	X	X	X	X
A16	X	X			
Bell11	X				
OFB14	X				
BB1	X				
180	X	X			
Disko Fan	X	X			
Float2	X	X			
176	X	X			
BB3	X	X			
BB2	X	X			
Float BB2	X				
101	X	X			
103	X				
105	X	X			
107	X				
115	X	X			
126	X				
127	X				
129	X	X			
130	X				
131	X				
TS233	X	X			
113	X				
111	X	X			
110	X				
108	X	X			
Jones Sound	X	X			
323	X	X			
ROV_Pond_inlet	X				
ROV_Navy_Board	X				
325	X				
324	X				
300	X				

322	X				
301	X	X			
303	X				
304	X	X			
305A	X				
305B	X				
305C	X				
305D	X				
5.10	X				
QMGM	X				
QMG4	X				
QMG1	X				
QMG2	X				
QMG3	X				
312	X				
Bellot Strait	X				
A15	X				
333	X				
A8	X				
A1	X				
A2	X				
A3	X				

Table 13.2 List of sampling stations and measurements during leg 4b. See rosette's Logbook for metadata.

Station	NO3, NO2, Si, PO4	Fatty acids (phyto)	Fatty acids (zoo)	POC/PN
356	X	X	X	X
354	X	X	X	X
DFO-1	X	X	X	X

13.3 Comments and Recommendations

I believe a guide on HOW TO NAME THE STATIONS should be put in place to help out the people at ArcticNet/Amundsen Science and the chief scientist on board name the new stations with a more descriptive name. This would be useful to name opportunistic stations on the go. For example, we could use a combination of initials of the area we sample in (e.g. BB for Baffin Bay, LS for Lancaster Sound, HB for Hudson Bay, etc.) + NSWE (North-South-West-East) + number. For example, a new station on the Greenland side of Baffin Bay near Disko Bay could be named BBE01.

The new software used for the daily activities (which replaces the white board) is a great tool, though it is under-developed at this time. The officer on watch should have access to the file to change the time or at least indicate the operations are running late or early, and by how much. All the activities names should be included and accessible from a scrollable menu on the Ipad they have on the bridge. Time brackets should also be selectable from a scrollable menu.

I would also appreciate if ArcticNet could send a message about the use of nitrile gloves on the nutrients rosettes. They contaminate our samples. We recommend vinyl or polyethylene gloves. I would also appreciate if the sampling depths were distributed to the people sampling on this particular rosette. The fact that other people show up on this rosette means that sometimes, we run out of bottle and nutrients are ALWAYS the ones being cut off the rosette, even though this is the nutrients rosette.

<u>Reference</u>

Arts, M. T., Brett, M. T., Kainz, M. J. Lipids in aquatics ecosystems. Journal of Chemical Information and Modeling 53, (2013).

Wynn-Edwards, C. King, R., Davidson, A.,Wright, S., Nichols, P.D., Wotherspoon, S., Kawaguchi, S. Virtue, P. Species-specific variations in the nutritional quality of southern ocean phytoplankton in response to elevated pCO2. Water (Switzerland) 6, 1840–1859 (2014).

Lee, R. F., Hagen, W., Kattner, G. Lipid storage in marine zooplankton. Marine Ecology Progress Series 307, 273–306 (2006).

Comiso (2006) Geophys Res Lett 33, L18504, doi:10.1029/2006GL027341

Comiso et al. (2008) Geophys Res Lett 35, L01703, doi:10.1029/2007GL031972

Grasshoff et al. (1999) Methods of seawater analyses, Weinheim, New-York

Holmes et al. (1999) Can J Fish Aquat Sci 56:1801–1808

IPCC (2007) Climate change 2007: The physical science basis. Cambridge University Press, Cambridge and New York

Johannessen et al. (1999) Science 286:1937–1939

Laxon et al. (2003) Nature 425:947–950

McClelland et al. (2006) Geophys Res Lett 33, L06715, doi:10.1029/2006GL025753

Overpeck et al. (1997) Science 278:1251–1256

Peterson et al. (2002) Science 298:2171–2174

Peterson et al. (2006) Science 313:1061–1066

Rysgaard et al. (1999) Mar Ecol Prog Ser 179:13–25

Stabeno & Overland (2001) EOS 82:317–321

14 Settlement of Deep-Sea Marine Invertebrates – Leg 4b

Project leaders: Annie Mercier[1] (amercier@mun.ca) and David Côté[1]
Cruise participant – Leg 4b: Jean-François Hamel[1]
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14.1 Introduction

One way to assess the importance of a specific area in terms of productivity and richness (especially at the benthic level) is to better understand the diversity of larvae/settlers that are present at a certain depth. How many larval species will decide to settle and start growing in a precise area on various substrate types (wood, fine mesh, rocks, etc.) may help evaluate or scale the richness/biodiversity of the studied site. As part of the DFO initiative to generate supporting data in favour of a candidate MPA site (in north-east Labrador) we planned to deploy settlement arrays (designed through the international initiative INDEEP, based in Southampton UK) to test the capacity of various substrates to attract a range of benthic marine invertebrate settlers (including molluscs, sponges, corals, sea anemones, worms, etc.).

14.2 Methodology

Only one of the two settlement arrays was ultimately deployed. It was attached with to the flotation device on the 90-m long mooring. More precisely, 8 zip-ties were used to fix the array firmly to the first orange plastic sphere closest to the bottom (about 10 meters). It is expected to be in the water from October 7, 2017 until mid-summer 2018, at which time it will be brought back to the surface and preserved in ethanol for further analysis.

14.3 Comments and Recommendations

My experience as a scientist aboard the Amundsen was short but amazing. From the transport to the ship in helicopter and the feeling that security is a priority, to the excellent food, the positive attitude of everyone, the cooperation, as well as the tidiness of the ship (everywhere, including corridors, kitchen, toilets, room, labs), everything was great. I wish to express my thanks to the commanding staff (starting with the Captain); I felt extremely safe throughout this fantastic journey.

15 Measurement of pH and Total Alkalinity (TA) in Seawater – Leg 4b

Project leaders: Annie Mercier[1] (amercier@mun.ca) and David Côté
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15.1 Introduction

Since the beginning of the industrial period in the late 18th century, humans have emitted large quantities of CO_2 into the atmosphere, mainly as a result of fossil-fuel burning, but also because of changes in land-practices (e.g., deforestation). Whereas atmospheric concentrations oscillated between 180 and 280 ppm over much of the past 400,000 years, current atmospheric concentrations have now reached 403 ppm, diverging wildly from the very reproducible, eleven last glacial-interglacial cycles. Hence, it is hard to argue that anthropogenic activities are unrelated to this increase in atmospheric CO_2 concentration and the associated rise in global temperatures.

The impact of climate change is disproportionately large in the high latitudes. Rapid warming in the northern polar region has resulted in significant glacial and sea-ice melt, affecting the fresh water budget and circulation of the Arctic Ocean and feeding back on Earth's radiation balance. Likewise, the uptake of anthropogenic CO_2 is accelerated in high latitude waters because the solubility of CO_2 in water increases with decreasing water temperature and salinity. Consequently, high latitude waters are more susceptible to ocean acidification.

A study of large-scale processes that modulate the spatial and temporal variability of the pH in surface waters, the pCO_2 gradient at the air-sea interface, and exchange of CO_2 with sub-thermocline waters and across oceanic basins. In addition to measurements of carbonate parameters (pH, TA), the stable carbon isotope composition, $\delta^{13}C$ (DIC), of dissolved inorganic carbon (DIC) will be determined to differentiate between inorganic (atmospheric CO_2 uptake, alkalinity exclusion, ikaite precipitation/ dissolution) and metabolic processes (photosynthesis, microbial degradation of allochtonous and autochtonous organic matter) in the ice and water column to CO_2 exchange. These results will be combined with historical data acquired since 2003 (i.e., CASES, IPY-CFL, IPY-Geotraces, Malina) to construct time-series of the saturation state of the waters with respect to aragonite in order to evaluate the impact of increasing atmospheric CO_2 concentrations, physical and biological processes on Arctic water acidification.

In order to elucidate the role physical mixing of various source waters, the stable oxygen isotope composition, $\delta^{18}O$ (H_2O), of water will be combined to other conservative (e.g., SP, T, TA) and non-conservative tracers (e.g., O_2, Ba, nutrients) to quantify the relative contribution of freshwater inputs (river, sea-ice melt, snow and glacier melt) and oceanic water masses (Pacific, Atlantic) to the vertical structure of the water column and the transfer of heat, salt and carbon between the North Pacific and North Atlantic through the Canadian Arctic Archipelago. Results of this water mass analysis will also serve as a template for the interpretation of the distribution of trace elements and their isotopes that are measured by other researchers involved in the Geotraces program.

15.2 Methodology

pH samples (Table 14.1) were collected from the rosette using a rubber tube and stored in LDPE 125 ml bottles. While sampling the Niskin bottle, with a low water flow, the air was carefully removed from the sampling tube which was held at the bottom of the bottle. The water was then allowed to overflow at about the same volume as the bottle before the tube was slowly removed from it, in order to leave enough water at the neck of the bottle to avoid having air inside while putting the cap on or having as little air as possible. The bottle was then closed air tight. The samples were, right after the sampling, equilibrated at 25°C, in a Digital One Rte 7 temperature controlled water bath, and analyzed immediately by colorimetry, using a UV-VIS spectrophotometer, model HP 8453 from Agilent Technology, using two pH indicators: phenol red and cresol purple. The sample was poured in a 50-mm quartz cell and used to measure the blank. Absorbance measurements were taken after adding the pH indicator to the sample. The method is described in Baldo, Morris and Byrne (1985) and in Clayton and Byrne (1993). TRIS buffers, prepared in our laboratory with the method described in Millero & al (1993), of salinities 35 and 25 were used to calibrate the spectrophotometer.

Total alkalinity analyses will be performed later in our laboratory in McGill University. The samples were collected from the Niskin bottles, using a rubber tube, and, stored in 250 ml glass bottles. They were poisoned, right after they were collected, with 250 microliters of a mercuric chloride saturated solution as a preservative. Apiezon grease was put on the glass stoppers before closing the bottles and they were then clipped to keep them air tight.

Samples for $\delta^{18}O$ and $\delta^{13}C$ were also collected. The $\delta^{13}C$ samples were collected in 30 ml amber glass bottles and poisoned with mercuric chloride for preservation. The $\delta^{18}O$ samples were collected in 13 ml plastic test tubes with no special treatment. Those samples will be analyzed at Geotop, UQAM further in time.

Table 15.1 List of the station samples and the type of analysis performed on each depth

Station	Cast	Lat. (N)	Long. (W)	Analyses	Depth (m)
356	1	60°48.359'	64°42.410'	$\delta^{13}C$, $\delta^{18}O$	bottom, 250, 200, 160, 120, 80, 60, 40, 20, 10, surface
354	2	60°58.078'	64°49.211'	pH, TA, $\delta^{13}C$, $\delta^{18}O$	bottom, 500, 400, 300, 250, 200, 160, 120, 80, 60, 40, 20, 10, surface
DFO-1	3	60°27.210'	61°15.191'	pH, TA, $\delta^{13}C$, $\delta^{18}O$	Bottom, 500, 300, 200, 160, 120, 80, 60, 40, 20, 10, 5

15.3 Comments and Recommendations

The cancellation, due to time constraints, of two important stations (352 and DFO-2), altered the significance of our study characterising the extent of ocean acidification in the Arctic, especially past the continental shelf. I wish to thank, in particular, the Chief Scientist and the Captain for a pleasant stay on board.

16 High Resolution Survey of Oceanic Dimethylsulfide in Contrasted Marine Environments of the Canadian Arctic – Leg 2

Project leaders: Maurice Levasseur[1] (maurice.levasseur@bio.ulaval.ca) and Guillaume Massé[1]
Cruise participants – leg 2: Martine Lizotte[1] and Joanie St-Onge[1]
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16.1 Introduction

Conspicuous alterations in the Arctic Ocean are underway and include reductions in snow cover as well as sea ice extent and thickness, the occurrence of which is linked to profound modifications in light availability in surface waters below the ice and at its margin. How these physical changes will impact the dynamics of bloom-forming micro-organisms and their production of the biogenic climate-active gas dimethylsulfide (DMS) are still unknown. Within both ArcticNet and BOND (Sentinel North) research programs, the main objectives of Leg 2 included:

1) Deploying a high-frequency autonomous underway sampling instrument (MIMS – Membrane Inlet Mass Spectrometer) in order to obtain greater spatial and temporal resolution of surface concentrations of DMS across contrasted environments (open waters, ice, marginal ice zones, etc);
2) Cconduct high resolution sampling of DMSPd and DMSPt (precursors of DMS) to assess the type of DMS regime encountered (stressed versus productive regime). Constant monitoring of ship coordinates, sea surface temperature, salinity and chlorophyll will allow our team to establish potential correlation between environmental factors and methylated sulfur compounds.

16.2 Methodology

The MIMS was successfully deployed between 6 July 2017 and 16 August 2017. During this time we prioritized the ship's transits between stations to increase the chances of capturing fronts and physical features related to the presence of ice and we conducted maintenance/cleaning procedures on the instrument during stationary stations. One major difference from last year's system requirements was the replacement of the liquid nitrogen multi-modal injection system with a -90°C compressor tubing and aluminum housing for the injection port. This new device allowed us to cool down the back inlet to the desired temperature (0°C) without the need for constant monitoring and liquid nitrogen filling of large dewars. The system was therefore theoretically operational 24/7. The large and constant requirement of liquid nitrogen from last year was one significant bottleneck of the system because the liquid N_2 plant on board was not able to furnish the daily requirements (35L) to our system and we could only deploy the MIMS every other day, at best, in order to allow the N_2 plant to replenish its reservoir. Finding an alternative for this issue was a main goal for the 2017 expedition, and this was a success for us.

16.3 Preliminary Results

Almost 6 weeks of DMS data at 10 minute frequency are available now for AN2017 Leg 2. The large data matrix will need validation and post-sampling processing before it can be used. However, preliminary results show that the presence of ice cover conveys a specific DMS signature to the underlying surface waters, a feature that had been observed during the AN2016 cruise. Higher concentrations of DMS were measured in heavy and moderate ice conditions. Further analysis of the dataset will determine if modifications in salinity and temperature may help explain these features.

Major Challenges

Deploying a high precision and complex instrument onboard an icebreaker can potentially be associated with many challenges. One issue encountered by our team, and likely related to ice-breaking and the intense shaking that goes along with it, was the loosening and bending of a cable that supplies power to the Mass Spectrometer filament. Because of this problem, 2 filaments had to be replaced, a tricky operation on a ship, and even trickier when this ship is breaking ice. Furthermore constant maintenance of certain parts of the system need to be done almost daily in order to prevent the decrease in sensitivity and resolution of the instrument caused by environmental factors such as high humidity in the air, temperature fluctuations et al.

16.1 Comments and Recommendations

The success of AN2017 Leg 2 cruise is largely attributable to the rigorous planning and preparations done by ArcticNet/Amundsen Science personnel, namely Alexandre Forest and Anissa Merzouk as well as their entire team. The generous leadership of Captain Claude Lafrance and the remarkable work conducted by the entire coast guard personnel on board the ship and both chief scientists is also at the core of the success of this cruise. Thank you to ArcticNet/Amundsen Science technicians Thomas Linkowski, Christopher Beasly, Colline Gombault, Claudie Marec. Our sincerest acknowledgements to Engineers Éric Lapointe and Thomas Mainville for punctual help along the way, as well as chef Djamel Bouazza and all the kitchen staff and stewards for keeping us incredibly well fed and very comfortable during the cruise.

One major issue that we had this year was the blockage of the seawater pump on the TSG line. In heavy ice conditions, it kept blocking which resulted in air being pumped to our system with possible irreversible damage. The only way to contour this on our part was to place our system on hold resulting in loss of valuable data (especially because of the potentially dynamic DMS cycling associated with ice).

17 Contaminants and Microplastics – Leg 2b

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17.1 Introduction

This work is funded by the Northern Contaminants Program, ArcticNet and Environment and Climate Change Canada.

17.2 Methodology

17.2.1 *Air Sampling*

The purpose of the air samples is to continue the trends of pesticides in air the Canadian arctic that was started in 1992 by this group. Over the years, we have added more contaminants that are monitored, including current use pesticides, flame retardants, plasticizers, per-fluorinated compounds (PFCs, neutral and ionic) and poly aromatic hydrocarbons. We also will be screening the samples for microplastics.

We collected 10 samples running at 48 hours during Leg 2b. The air was drawn through a sampling train of a glass fiber filter to collect the particles followed by a column of packed polyurethane foam and XAD-2 resin that collects the gas phase and very small particles. These samples will be returned to the ECCC lab, where they will be processed and analyzed.

Table 17.1 Air sample data collected while on board 2b

Sample ID	Date	Lat/Long
AN17Air 01	July 14,17	ON - 63° 7.4636N 67° 25.6374W OFF -62° 19.3676N 63° 12.4013W
AN17Air02	July 16,17	ON - 62° 19.3676N 63°12.4013W OFF- 67°25.1888N 61°22.2734W
AN17Air03	July 20,17	ON- 69° 24.437N 64° 43.929W OFF- 72° 45.8241N 67° 0.4041W
AN17Air04	July 24,17	ON 75° 45.8222N 71° 11.4496W OFF 76° 20.4681N 71°11.6755W
N17Air05	July 28, 17	ON - 77° 45.6134N 76°22.5568W OFF- 75° 52.322N 80° 54.8183W
AN17Air06	Aug 5, 17	ON- 74°33.2469N 95°53.6407W
AN17Air07	Aug 7, 17	ON-69° 46.444N 99°41.1851W OFF-68°25.1041N 100°18.4234W
AN17Air 08	Aug 9, 17	ON-68°20.5998N 101°3.1201W OFF-71°28.493N 91°59.791W

AN17Air 09	Aug 12,17	ON-70° 12.4468N 89°56.6536W OFF- 67° 47.838N 80°50.782W
AN17Air 10	Aug 14,17	ON- 67°47.838N 80°50.782W OFF- n/a (off Aug 16, 17)

17.2.2 *Water Sampling*

As with the air samples, these samples continue the work started in the early 1990s and the target list has expanded over time. This year we collected 4 types of water samples:

1. 100-L water samples were collected for pesticides, flame retardants, plasticizers, per-fluorinated compounds (neutral) and poly aromatic hydrocarbons. A solid phase absorbent (XAD-2) was used to concentrate the target compounds. (HV)
2. 1-L water samples for ionic PFCs, the water was collected and will be processed in the lab. (PFC)
3. 1000-L water particle samples for taken to research pesticides, flame retardants, plasticizers, per-fluorinated compounds (neutral) and poly aromatic hydrocarbons. Water was filtered by the TSG water line in the engine room using a glass fiber cartridge filter. (Part)
4. 4-L water samples were collected for organophosphate esters flame retardants and plasticizers, the water was collected and will be processed in the lab. (OPE)

Table 17.2 High volume water samples collected while on board 2b

Sample ID	Date	Notes – Lat/Long
AN17HV01	July 15, 17	Lat – 63° 38.778N Long – 68° 37.5680W A16
AN17HV02	July 18, 17	Lat – 67° 25.1888N Long – 61° 22.2734W Stn 180
AN17HV03	July 25, 17	Lat –75° 48.4400N Long – 70° 11.5690W Ba05
AN17HV04	July 28, 17	Lat – 77° 45.294N Long – 76° 36.355W TS233
AN17HV05	Aug 1, 17	Lat – 72° 50.0381N Long – 77° 35.9233W Pond Inlet ROV
AN17HV06	Aug 4, 17	Lat – 74° 14.753N Long – 91° 30.652W 304
AN17HV07	Aug 8, 17	Lat – 68° 29.183N Long – 103° 25.708W QMG-4
AN17HV08	Aug 13, 17	Lat – 68° 46.091N Long –80°50.205W Stn 333

Table 17.3 Particle sample data collected while on board 2b

Sample ID	Date	Notes – Lat/Long
AN17Part 01	July 18, 17	ON Lat – 67° 24.7009N Long – 61° 26.6127W
AN17Part 02	July 21, 17	ON Lat – 71° 3.3796N Long – 67° 2.0543W
AN17Part 03	July 25, 17	ON Lat – 75° 59.5781N Long – 72° 50.1945W
AN17Part 04	July 27, 17	ON Lat – 78° 19.5446N Long – 73° 51.5350W
AN17Part 05	Aug 5, 17	ON Lat – 74° 26.9072N Long – 97°47.9072W
AN17Part 06	Aug 9, 17	ON Lat –68° 28.6753N Long – 101° 17.4079W
AN17Part 07	Aug 12, 17	ON Lat – 70° 8.7507N Long – 89° 43.4576W

Table 17.4 PFC water samples (1L) collected while on board 2b

Sample ID	Date	Notes
AN17PFC 1, 2, 3	July 15, 17	Surface, 80m, 130m A16
AN17PFC 4, 5, 6	July 18, 17	Surface, 60m, 175m BB1
AN17PFC 7, 8, 9	July 28, 17	200m, 100m, 60m TS233
AN17PFC 10, 11, 12	Aug 4, 17	100m, 60m, 20m 304
AN17PFC 13, 14, 15	Aug 9, 17	20m, 40m, 60m QMG-2
AN17PFC 16, 17, 18	Aug 13 ,17	5m, 10m, 16.3m 333

Table 17.5 OPE water samples collected while on board 2a and 2b

Sample ID	Date	Notes – Lat/Long
AN17OPE 1	July 7, 17	55° 23.1383N 77° 39.5483 W Stn732 @ 19:20
AN17OPE 2	July 8, 17	58° 25.4357N 78° 18.5401W Stn 736 @ 17:41

AN17OPE 3	July 9, 17	60° 39.0993N 78° 33.8352W Stn 720 @ 12:03
AN17OPE 4	July 10, 17	61° 24.0982N 78° 42.697W Stn 694 @ 4:46
AN17OPE 5	Jul y 10, 17	62° 21.7728N 74°40.20074W Stn 688 @ 16.26
AN17OPE 6	July 11, 17	61° 47.1225N 71°54.573W Stn 684 @ 5:00
AN17OPE 7	July 11, 17	61° 02.665N 69°42.931W Stn 682 @ 15:05
AN17OPE 8	July 12, 17	60° 07.58N 69° 03.86W Stn 676 @ 0:13
AN17OPE 9	July 12, 17	59° 00.19N 67°97W Stn 670 @ 10:20
AN17OPE 10	July 15, 17	63° 38.778N 68°37.5608W Stn A16
AN17OPE 11	July 15, 17	63° 21.6800N 68° 10.8822W Stn Bell11 @ 18:44
AN17OPE 12	July 16, 17	62° 23.0085N 66° 1.6396W Stn OF B14@ 5:04
AN17OPE 13	July 28, 17	77° 45.294N 76° 36.355W Stn TS233
AN17OPE 14	Aug 8, 17	68° 29.143N 103° 26.340W Stn QMG-4
AN17OPE 15	Aug 10, 17	69° 10.177N 100°42.511W Stn 312
AN17OPE 16	Aug 13, 17	68° 46.091N 80°50.205W Stn 333

17.2.3 *Passive Water Sampling*

Our goal with the SPMD and other passive strips is to monitor concentrations of persistent organic pollutants (POPs) in the mixed surface layer, the Pacific water mass and the deep Atlantic waters. The SPMDs were placed close to CTDs and/or ADCPs located in each of these layers to allow us to relate our results to information gathered from them and confirm which water mass they were sampling. These sites are also part of a global passive water monitoring network call AQUA-GAPS, which is a collaboration between Canada, USA and China. Additional GAPS samplers were deployed this year near at both BA05 and BA06 sites.

We have recovered 2 passive cages on ArcticNet moorings as outlined below. Sampling went smoothly for both retrieval and deployment operations

Table 17.6 Mooring data and passive water samples collected during 2b

Site Name	Sample ID	Retrieval or Deployed	Date	Depth
BA06	AN17SPMD1 AN17PE1 AN17PDMS1	R	July 23,17	324m
BA05	AN17SPMD2 AN17PE2 AN17PDMS2	R	July 23,17	424m
BA06	2 PDMS 2 PE 2 LDPE (GAPS) 2 SSP(GAPS)	D	Jul 25, 17	474m
BA05	2 PDMS 2 PE 2 LDPE (GAPS) 2 SSP(GAPS)	D	Jul 25, 17	460m

17.2.4 *Sediment Sampling*

As with the water and air sampling, the purpose of collecting these samples was to quantify the occurrence and level of contaminants. Additionally, they will be screened for the occurrence and if found, the types of microplastics.

Table 17.7 Sediment samples for contaminants collected while on board 2a and 2b

Sample ID	Date	Depth (m)	Notes – Lat/Long
Sediment Stn 732	July 7, 17	125m	55° 27.0249N 77° 52.2197W
Sediment Stn 670	July 12,17		58° 59.36N 67° 56.25W
AN17SED03	July 15,17	142m	63° 38.2943N 68° 37.6714W Stn A16
AN17SED04	July 19,17	950m	68° 0.9265N 59°34.7769W Stn DiskoFan – Patch
AN17SED05	July 20,17	1055m	69° 24.437N 64° 43.929W Stn 8.1
AN17SED06	July 22,17	2373m	72° 46.0024N 67° 0.6851W Stn BB2
AN17SED07	July 24,17	378m	76° 21.4525N 77° 30.9115W Stn 101
AN17SED09	July 25,17	665m	76° 20.0805N 71°21.4937W Stn 115
AN17SED10	July 28,17	396m	76° 19.9794N

			71°10.8776W Stn TS 233
AN17SED11	July 30,17	628m	75° 42.1362N 80°45.1599W Stn Belcher Glacier
AN17SED12	July 31,17	791m	74° 9.3765N 80°28.2140W Stn 323
AN17SED13	Aug 3,17	715m	74°16.6618N 83°19.1627W Stn 301 (first of 4)
AN17SED14	Aug 4, 17	315m	74° 14.775N 91° 30.784W Stn 304
AN17SED15	Aug 5, 17	224m	74° 29.303N 99° 4.587W Stn 5.10
AN17SED16	Aug 8, 17	114m	68° 18. 180N 101° 44.525W QMG-M
AN17SED17	Aug 8, 17	71m	68°29.057N 103° 25.602W QMG-4
AN17SED18	Aug 9, 17	40m	68° 29.551N 99°53.882W QMG-1
AN17SED19	Aug 10,17	65m	69°10.231N 100°41.757W Stn 312
AN17SED20	Aug 11,17	414m	72°5.336N 96°3.996W Stn 3.7
AN17SED21	Aug 11,17	270m	71°28.519N 91° 59.590W Stn 3.4
AN17SED22	Aug 12,17	224m	70°26.183N 91°14.199W Stn 3.5
AN17SED23	Aug 13,17	27m	68°26.515N 80°50.956W Stn 333
AN17SED24	Aug 15, 17	424m	Stn 1.1

17.2.5 *Microplastics*

Arising issues regarding the levels of microplastics in our oceans is becoming very clear, but with limited information from Polar Regions. Although there is some evidence of microplastics in the arctic (Obbard, et al., 2014; Lusher, et al., 2015), little is understood about the sources, fate and extent of contamination. Efforts were made while aboard the Amundsen legs 2a and 2b to obtain various media samples to quantify data and identify microplastic abundance in the Arctic Ocean. 40L surface water samples were filtered through a 10μm polycarbonate filter (2 samples per site). Sediment samples were taken from box core operations. The first few centimeters of sediment were carefully scooped and stored for further processing (~30g). Zooplankton samples were taken at opportunistic sites, stored in isopropyl alcohol and filtered water until further processing can take place.

Table 17.8 Microplastic surface water samples collected while on board 2b

Sample ID	Date	Notes
AN17MP 1a	July 16, 17	Stn OF B14 62
AN17MP 2a	July 18, 17	Stn 180
AN17MP 2b	July 18, 17	Stn 180
AN17MP 3a	July19, 17	Stn DiskoFan
AN17MP 3b	July 19, 17	Stn DiskoFan
AN17MP 4a	July 22, 17	Stn BB2
AN17MP 4b	July 22, 17	Stn BB2
AN17MP 5b	July 26, 17	Stn 115
AN17MP 6a	July 27, 17	Stn 129
AN17MP 6b	July 27, 17	Stn 129
AN17MP 7a	July 31, 17	Stn 323
AN17MP 7b	July 31, 17	Stn 323
AN17MP 8a	Aug 1, 17	Pond Inlet
AN17MP 8b	Aug 1, 17	Pond inlet
AN17MP 9a	Aug 5, 17	Resolute Bay
AN17MP 9b	Aug 5, 17	Resolute Bay
AN17MP 10a	Aug 8,17	Stn QMG-M
AN17MP 10b	Aug 8, 17	QMG-M
AN17MP 11a	Aug 9, 17	Stn QMG-2
AN17MP 11b	Aug 9, 17	QMG-2
AN17MP 12a	Aug 10, 17	Stn 312
AN17MP 12b	Aug 10, 17	Stn 312
AN17MP 13a	Aug 11, 17	Stn 3.7
AN17MP 13b	Aug 11, 17	Stn 3.7

AN17MP 14a	Aug 12, 17	Stn 3.5
AN17MP 14b	Aug 12,17	Stn 3.5
AN17MP 15a	Aug 15, 17	Stn 1.1
AN17MP15b	Aug 15, 17	Stn 1.1

Table 17.9 Microplastic – zooplankton samples collected while on board 2b

Sample ID	Date	Notes
AN17ZOO 01	July 15, 17	Stn A16
AN17ZOO 02	July 18, 17	Stn 180
AN17ZOO 03	July 22, 17	Stn BB2
AN17ZOO 04	July 24, 17	Stn 101
AN17ZOO 05	July 25,17	TS233
AN17ZOO 06	Aug 3,17	Stn 301
AN17ZOO 07	Aug 4, 17	Stn 304
AN17ZOO 08	Aug 9, 17	QMG-3
AN17ZOO 09	Aug 9, 17	QMG-1
AN17ZOO 10	Aug 11, 17	Stn 3.4
AN17ZOO 11	Aug 13, 17	Stn 333

Table 17.10 Microplastic – sediment samples collected while on board 2b

Sample ID	Date	Notes
AN17MP-Sed01	July 19, 17	Stn DiskoFan
AN17MP-Sed02	July 20, 17	Stn 8.1
AN17MP-Sed03	July 22, 17	Stn BB2
AN17MP-Sed 04	July 24, 17	Stn 101
AN17MP-Sed 05	July 26, 17	Stn 115
AN17MP-Sed 06	July 28,17	TS233
AN17MP-Sed 07	July 30, 17	Stn Belcher Glacier

AN17MP-Sed 08	July 31, 17	Stn 323
AN17MP-Sed 09	Aug 3,17	Stn 301 (first of 4)
AN17MP-Sed 10	Aug 4, 17	Stn 304
AN17MP-Sed 11	Aug 5, 17	Stn 5.10
AN17MP-Sed 12	Aug 8, 17	QMG-M
AN17MP-Sed 13	Aug 8, 17	QMG-4
AN17MP-Sed 14	Aug 9, 17	QMG-1
AN17MP-Sed 15	Aug 10, 17	Stn 312
AN17MP-Sed 16	Aug 11, 17	Stn 3.7
AN17MP-Sed 17	Aug 11, 17	Stn 3.4
AN17MP-Sed 18	Aug 12, 17	Stn 3.5
AN17MP-Sed 19	Aug 13, 17	Stn 333
AN17MP-Sed20	Aug 15, 17	Stn 1.1

17.3 Preliminary Results

See Table 16.11 for a summary of all samples collected.

Table 17.11 Summary of Air, Water and Zooplankton samples collected.

	Locations	Number	Depth	Comments
Air Samples; pesticides, poly aromatic hydrocarbons, perfluorinated compounds and flame retardants	Continuously	10 +2 blks	n/a	Sample runs for 48 hours at various locations.
High volume water samples; pesticides, poly aromatic hydrocarbons, perfluorinated compounds and flame retardants	Submersible Pump Stations: A16, 180, BA05 (at 450m), TS233, Pond Inlet ROV site, 304, QMG-4, 333	8 +2 blks	Surface	~100L Water is collected in large containers then contaminates are extracted with XAD column
Water Particle samples; pesticides, poly aromatic hydrocarbons, perfluorinated compounds and flame retardants	Continuously	7 +1 blk	surface	In-line TSG water line Wound glass fiber filter cartridge ~1000L each
Water Samples; Perfluorinated compounds	Rosette Stations: A16, BB1, TS-233, 304, QMG-2, 333	18 +2 blks	3 depths. Reliant of thermocline	1-L per sample taken from Rosette
Sediment	A16, Disko Fan, 8.1, BB2, 101, 115, TS	20+ +3 blks	Box core	Surface sediment

	233, Belcher Glacier, 323, 301, 304, 5.10, QMG-M, QMG-4, QMG-1, 3.7, 3.4, 3.5, 333, 1.1			
(OPE)Water samples; Organophosphate flame retardants and plasticizers	2a Stations: n/a, n/a, n/a, 688, 694, 682, 684, 670, 676 2b Stations: A16, Bell11, OFB14, TS 233, QMG-4, 312,333	16 +3blks	surface	2a from raw water inline (geopaleo lab) 2b from submersible pump
Passive Water samples (moorings); pesticides, poly aromatic hydrocarbons, perfluorinated compounds and flame retardants	Retrieved 2016 passive strips (PDMS, PE, and SPMD) at BA05 and BA06, also deployed new 2017 strips and GAPS samplers at BA05 and BA06	2 of each strip per cage (12 retrieved, 12 deployed) 2 of each for blanks (x2 – one retrieval blank and one deploy blank)	BA05 – 474m BA06 – 460m	Moorings
Micro plastics Water	OFB14, 180, DiskoFan, BB2, 115, 129, 323, Pond Inlet ROV site, Resolute Bay, QMG-M, QMG-2, 312, 3.7, 3.5, 1.1	Many various samples taken at opportunistic sites 10+	Water – surface Sediment- varied (bottom depth) Zoo- vertical tow	Water – Surface samples. Buckets over side of ship with permission Sediment – Box core Zoo – Vertical tow net
Micro plastics Sediment	DiskoFan, 8.1, BB2, 101, 115, TS233, Belcher Glacier, 323, 301, 304, 5.10, QMG-M, QMG-4, QMG-1, 312, 3.7, 3.4, 3.5, 333, 1.1			
Micro plastics Zooplankton	A16, 180, BB2, 101, TS233, 301, 304, QMG-3, QMG-1, 3.4, 333			

17.4 Comments and Recommendations

Overall an outright amazing experience, vast amount of respectable work being conducted! We were able to complete all work planned (and further) for leg 2b without any major issues. Some hiccups with our equipment or sampling processes were easily ironed out with the help of the crew, maintenance, and other scientists without hesitation. One issue along the way to mention is in regards to smoking around scientific equipment. Otherwise, thoroughly enjoyed our experience on the Amundsen and hope to return next year to continue research objectives.

Reference

Lusher, A.L., Tirelli V., O'Connor, I., and Officer, R. 2015. Microplastics in Arctic Polar waters: The first reported values of particles in surface and subsurface samples. Scientific Reports, 5.

Obbard, R.W., Sadri, S., Wong, Y.Q., Khitun, A.A., Baker, I., and Thompson, R.C. 2014. Global warming releases microplastic legacy frozen in Arctic Sea ice. Earth's Future, 2(6), 315-320.

18 Synergistic Impact of Ocean Acidification and Microplastics on Pteropods in the Canadian Arctic – Leg 2b

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Cruise participant – Leg 2b: Victoria Peck[1]
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18.1 Introduction

The Arctic Ocean is experiencing physical and chemical change as a result of anthropogenic perturbations. Understanding the impacts of ocean acidification (OA) and micro-plastic pollution on the Arctic marine ecosystem is the focus of this collaborative project. Calcifying planktonic and pelagic organisms are considered to be particularly under threat in the Arctic as OA is causing Arctic waters to rapidly approach the threshold where they become corrosive to certain calcifying organisms such as pteropods, or sea butterflies.

Polar pteropod Limacina helicina, with a shell made of aragonite, the more soluble form of calcium carbonate, is considered to be particularly vulnerable to OA. Recently L. helicina has been shown to exhibit shell damage and repair when exposed to sub-sea ice waters in the Greenland Sea which were seasonally undersaturated with respect to aragonite (Ar<1). Similar field studies on pteropods within the Canadian Arctic have not yet been made despite several locations reported to have been undersaturated with respect to aragonite as early as 2003-2005. In addition to stressor presented by OA we are also investigating the potential impact that microplastics may have on L. helicina. With Pacific and Atlantic source waters entering the Canadian Arctic the incidence of microplastic contamination is likely to be increasing.

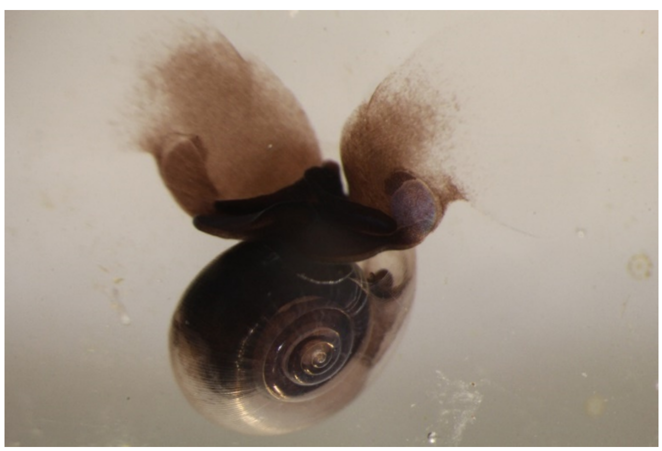

Figure 18.1 Specimen of Limacina helicina recovered on 10th August 2017 at Stn 312. Shell diameter ~ 4 mm.

Assessment of the impact of these two stressors on L. helicina in the Canadian Arctic determined four prinicpal objectives on board Amundsen Expedition 2017 Leg 2b:

1. To quantify the abundance and distribution of pteropod in the Canadian Arctic: Our knowledge of these basic parameters in this region is very limited. Plankton net samples will be used to determine the abundance and life stage distribution in this region.

2. To evaluate the impact of Ocean Acidification on pteropod shells: The incidence of shell dissolution/damage will be determined and compared with measurements of Ar.
3. To estimate the amount of microplastic in Canadian Arctic surface water: Surface water samples will be collected throughout Leg 2b to determine the nature and abundance of microplastics.
4. To assess the impact of microplastics on pteropods: Measurements of zooplankton ingested microplastics will be used to assess the potential impact of microplastics on pteropods in the Canadian Arctic.

18.2 Methodology

18.2.1 *Pteropod Collection*

Pteropods were collected within the Monster net and the WP2 net.

18.2.2 *Monster Net*

Samples from one of 200 µm nets on the Monster were provided by the zooplankton team (Gerald Darins, Thibault and Mathieu) for pteropod analysis. Deployed to within 10 m of the seafloor, the Monster net samples the entire water column. See Zooplankton section for full details of Monster net deployments.

18.2.3 *WP2 Net*

The WP2 net, with a 200 µm mesh, was deployed at 11 stations (Table 17.1) to 200 m where water depth permitted and hauled vertically at a rate of 30 m/min. The net was gently hosed down with sea water and the sample decanted into a bucket containing ~10 cm of sea water to minimise trauma to the pteropod shells.

Figure 18.2 WP2 Net Deployment

Table 18.1 Details of the 11WP2 net deployments on Leg 2b

Date	Station	Start time (local)	Lat	Long	Water depth (m)	Deployed depth (m)
18/07/2017	177	15:48	67° 25.080’	-61° 23.238’	680	200
22/07/2017	BB2	19:34	72° 46.030’	-67° 00.499’	2372	200
24/07/2017	101	15:12	76° 23.058’	-77° 23.387’	350	200
26/07/2017	115	10:42	76° 20.014’	-71° 12.891’	653	200
27/07/2017	129	14:45	78° 18.926’	-74° 07.068’	514	200
28/07/2017	Trinity	12:22	77° 45.020’	-76° 42.816’	374	200
03/08/2017	301	18:09	74° 16.481’	-83° 22.125’	714	200
05/08/2017	305	03:47	74° 20.936’	-93° 35.399’	164	150
08/08/2017	QMGM	03:47	68° 18.349’	-101° 44.537’	111	100
10/08/2017	312	03:37	69° 10.181’	-100° 41.972’	66	50
13/08/2017	333	17:03	68° 46.416’	-80° 50.652’	26	20

18.2.4 *Cataloguing of Pteropods Onboard*

Pteropods from both the Monster and WP2 nets were immediately extracted from the sample by a process of gently swirling the water within the bucket to create a vortex within which the pteropods collected. A wide-mouthed plastic pipette was used to transfer the pteropods into a deep petri dish. Pteropods were then individually placed into a watch glass and rinsed with buffered-milliQ water to remove salts and debris from the shell. Specimens were then placed in individual cells of a specimen slide, orientated to be apical side-up, air-dried and photographed. This method of storing pteropods minimises the possibility of post-collection change in shell condition which may result from storage in inadequately buffered solution. In addition, cataloguing individual specimens at the time of collection allows shell diameters and quantification of shell condition to be determined immediately without further interaction with the specimens.

Specimens of veliger stage L. helicina were found at all stations sampled with the Monster net, with the exception of A16, inner Frobisher Bay. Where veligers were too numerous for them all to be extracted individually they were stored in 70% ethanol for future analysis. Juveniles/sub-adults were recovered from most stations. No other species of shelled-pteropod were encountered on Leg 2b.

18.2.5 *Microplastic Analysis*

The Manta net (aperture 700 mm x 400 mm with 300 µm net) was deployed at 9 stations (see table 2) to sample for microplastics floating at or just below the sea surface. The Manta net was towed alongside the ship for 20 minutes at 3 knots. Enough cable was paid out to allow the net opening to sample surface waters. When too much cable was paid out the opening would sink below the sea surface, too little cable and the net would bounce in the bow waves. Paying out enough cable that positioned the net opening in line with the last port hole before the accommodation block worked well.

Upon recovery the net was gently hosed down with sea water to ensure all sample was collected in the cod send. The entire net was unzipped from the frame and the net folded over to minimise contamination from the deck and lab. Within the benthic lab the soft cod end was removed and the sample was transferred into a brass sieve (300 µm) with underway sea water. The sample was then transferred into a sample container (dependent of volume of sample) and preserved in ethanol (70%).

The transfer of the sample from the deck to lab and preservation steps were performed as ‘blanks’ on three occasions during the cruise to quantify any background contamination. Glass fibre filters were placed in the lab during the preservation of each sample to document any changes in the contamination levels within the lab where the sample where most exposed. The net was stored folded and the cod end was stored in a sealed bag to minimise any contamination entering the net between deployments. Samples will be analysed in a controlled environment in Cambridge.

Figure 18.3 Manta Net Deployment

Table 18.2 Details of the 9 Manta net deployments on Leg 2b. Lat and long are of starting position.

Date	Station	Start time (local)	Latitude	Longitude
22/07/2017	BB2	13:55	72° 46.631’	-67° 02.156’
26/07/2017	115	07:36	76° 20.004’	-71° 12.195’
28/07/2017	Trinity	10:58	77° 45.347’	-76° 38.851’
31/07/2017	323	15:12	74° 08.993’	-80° 30.035’
03/08/2017	301	18:51	74° 16.555’	-83° 22.180’
05/08/2017	305	03:20	74° 21.341’	-93° 33.741’
08/08/2017	QMGM	04:14	68° 18.357’	-101° 44.963’
10/08/2017	312	03:06	69° 10.164’	-100° 42.168’
13/08/2017	333	16:30	68° 45.980’	-80° 50.664’

Acknowledgement

Thank you to Captain Claude Lafrance and the crew of CCGS *Amundsen* for enabling this expedition and their cheerfull assistance throughout the leg. Thank you also to chief scientists Jean-Éric Tremblay & Martine Lizotte. I am particularly grateful to Gerald Darins, Thibaud Dezutter and Mathieu LeBlanc for providing samples from the Monster net. I acknowledge the United Kingdom & Canada Arctic Partnership: 2017 Bursaries Programme for funding this project

19 Distribution of Mercury Species in Seawater of the Canadian Arctic – Leg 2b

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19.1 Introduction

In the Arctic marine ecosystem, mercury (Hg) is a contaminant of major concern for its high toxicity and biomagnification in the food web, and the main culprit for both features is monomethylmercury (MMHg) (Wang et al., 2012). While major progress has been made with respect to the Hg distribution and speciation in the atmosphere and biota, much less is known about the source and distribution of Hg species (MMHg in particular) in the Arctic seawater, which is the direct Hg exposure to marine biota (Macdonald et al., 2008).

Though release from sediment was postulated as the primary source of MMHg in seawater (Hammerschmidt and Fitzgerald, 2006), sub-surface peak of methylated Hg (MeHg, sum of MMHg and dimethylmercury (DMHg)) observed in different oceans suggest Hg methylation in situ in the water column is a more important source (Mason and Fitzgerald, 1996; Mason and Fitzgerald, 1990). In addition, the subsurface MeHg peak always shows up in the depth with nutrient maximum and low concentrations of dissolved oxygen (DO), suggesting an association of in-situ MeHg production and organic matter (OM) remineralization (Cossa et al., 2009; Sunderland et al., 2009). Previous studies in Beaufort Sea and Central Arctic Ocean also found subsurface peaks of MeHg, which were believed to originate from Hg methylation associated with OM remineralization in the seawater (Heimbürger et al., 2015; Wang et al., 2012). However, data sets of Hg species distribution with high resolution are scarce in the eastern Canadian Arctic. During the ArcticNet/GEOTRACES 2015 cruise, researchers observed extensive OM remineralization in deep Baffin Bay, which may indicate enhanced MeHg production.

Considering the knowledge gap in distribution and source of MeHg in the Arctic Ocean, the objectives of this project are:

1) to map the distribution of Hg species, including total Hg (HgT), MMHg and MeHg in the Canadian Arctic seawater;
2) to examine whether production of MeHg is enhanced in deep water of Baffin Bay.

19.2 Methodology

Seawater samples were collected from Niskin bottles on a Rosette along the route of Amundsen during Leg 2b (Table 18.1), for the measurement of Hg species. To prevent potential contamination, the clean hands-dirty hands protocol was strictly followed during sampling process. Meanwhile, samples for ancillary data (e.g., nutrients, DO, salinity, temperature, etc.,) were also collected, for the interpretation of Hg species data. Samples for Hg species were acidified immediately upon collection, and refrigerated before being analyzed onboard the ship at the Portable In-Situ Laboratory for Mercury Speciation (PILMS). Within 48h after sample collection, HgT was measured in PILMS, on a Tekran 2600 following the USEPA method 1631. On the other hand, samples for MMHg and MeHg will be shipped back to Winnipeg for analysis at University of Manitoba.

Table 19.1 Stations sampled during Leg 2b

Station	Location	Latitude	Longitude	Depth (m)	Samples
A16	Frobisher Bay	63.639°N	68.624°W	140	Hg_T, MeHg
OF-B14	Frobisher Bay	62.385°N	66.031°W	400	Hg_T
BB1	Baffin Bay	66.861°N	59.058°W	1045	Hg_T, MeHg, MMHg
180	Baffin Bay	67.426°N	61.388°W	705	Hg_T, MeHg
DiskoFan	Baffin Bay	67.968°N	59.503°W	1040	Hg_T
Float Station	Baffin Bay	69.553°N	60.769°W	1713	Hg_T, MeHg
176	Baffin Bay	69.603°N	65.394°W	375	Hg_T
BB3	Baffin Bay	71.415°N	68.613°W	1273	Hg_T, MeHg
BB2	Baffin Bay	72.768°N	67.005°W	2373	Hg_T, MeHg, MMHg
101	Nares Strait	76.383°N	77.405°W	357	Hg_T, MeHg, MMHg
105	Nares Strait	76.317°N	75.760°W	317	Hg_T
115	Nares Strait	76.332°N	71.197°W	672	Hg_T, MeHg, MMHg
108	Nares Strait	76.264°N	74.602°W	447	Hg_T, MeHg
129	Nares Strait	78.326°N	74.127°W	507	Hg_T, MeHg
TS233	Nares Strait	77.755°N	76.606°W	391	Hg_T, MeHg
Jones Sound	Jones Sound	76.085°N	81.941°W	769	Hg_T, MeHg
323	Parry Channel	74.159°N	80.465°W	792	Hg_T, MeHg, MMHg
322	Parry Channel	74.490°N	80.551°W	652	Hg_T, MeHg
301	Parry Channel	74.278°N	83.365°W	721	Hg_T, MeHg
304	Parry Channel	74.248°N	91.533°W	312	Hg_T, MeHg, MMHg
305B	Parry Channel	74.352°N	93.582°W	163	Hg_T, MeHg
5.10	Parry Channel	74.490°N	99.091°W	217	Hg_T, MeHg, MMHg
QMGM	Queen Maud	68.303°N	101.741°W	101	Hg_T, MeHg
A15	Foxe Basin	69.270°N	80.605°W	54	Hg_T, MeHg
A2	Foxe Basin	63.634°N	79.258°W	179	Hg_T, MeHg

19.3 Preliminary Results

While MMHg and MeHg are to be measured in University of Manitoba, concentrations of HgT were analyzed in PILMS onboard. In Baffin Bay, Nares Strait and Parry Channel, HgT averages at 0.27 ng/L, lower than measured in the previous study (0.40 ng/L) covering many stations in the same region but with much lower vertical resolution (Kirk et al., 2008). Generally, HgT profiles follow transient type distribution: with high concentrations in surface water by atmospheric deposition, relatively low concentrations in middle depth due to particle scavenging, and increasing concentrations in deep water from releasing Hg by OM remineralization.

19.4 Comments and Recommendations

The distribution of Hg species in bottom Baffin Bay was a major objective of this study. However, sampling of seawater in the bottom 700m could not be done, as the cable for the Rosette was not long enough. Hope this issue can be properly solved in future expeditions, as much of the Canadian Arctic Ocean (e.g., Baffin Bay, Canada Basin) is very deep, and deep water is very important, not only for Hg species, but also for other biogeochemical and physical processes.

<u>Reference</u>

Cossa, D., Averty, B., and Pirrone, N. (2009). The origin of methylmercury in open Mediterranean waters. Limnol Oceanogr 54, 837-844.

Hammerschmidt, C.R., and Fitzgerald, W.F. (2006). Methylmercury cycling in sediments on the continental shelf of southern New England. Geochimica et Cosmochimica Acta 70, 918-930.

Heimbürger, L.-E., Sonke, J.E., Cossa, D., Point, D., Lagane, C., Laffont, L., Galfond, B.T., Nicolaus, M., Rabe, B., and van der Loeff, M.R. (2015). Shallow methylmercury production in the marginal sea ice zone of the central Arctic Ocean. Scientific reports 5

Kirk, J.L., St. Louis, V.L., Hintelmann, H., Lehnherr, I., Else, B., and Poissant, L. (2008). Methylated mercury species in marine waters of the Canadian high and sub Arctic. Environmental science & technology 42, 8367-8373.

Macdonald, R.W., Wang, F., Stern, G., and Outridge, P. (2008). The overlooked role of the ocean in mercury cycling in the Arctic. Marine pollution bulletin 56, 1963-1965.

Mason, R., and Fitzgerald, W. (1996). Sources, sinks and biogeochemical cycling of mercury in the ocean. In Global and Regional Mercury Cycles: Sources, Fluxes and Mass Balances (Springer), pp. 249-272.

Mason, R.y., and Fitzgerald, W. (1990). Alkylmercury species in the equatorial Pacific.

Sunderland, E.M., Krabbenhoft, D.P., Moreau, J.W., Strode, S.A., and Landing, W.M. (2009). Mercury sources, distribution, and bioavailability in the North Pacific Ocean: Insights from data and models. Global Biogeochemical Cycles 23.

Wang, F., Macdonald, R.W., Armstrong, D.A., and Stern, G.A. (2012). Total and Methylated Mercury in the Beaufort Sea: The Role of Local and Recent Organic Remineralization. Environmental science & technology 46, 11821-11828

20 Invertebrate and Sediment Sampling for Contaminants – Leg 2a

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20.1 Introduction

As the average global temperature increases, the sea ice cover in the Arctic is declining. With a reduced ice cover throughout the year, the amount of cargo traffic and oil exploration and exploitation throughout the Arctic is expected to increase, putting this pristine environment at a higher risk of cargo-related pollution.

As a part of Arctic Net, GENICE, and BaySys, our group aims to collect baseline contaminant data in invertebrates and in sediments in the Arctic. More specifically, we measure hydrocarbon levels in sediment and benthos, as well as mercury in our biota samples.

20.2 Methodology

On board the CCGS *Amundsen*, we collected zooplankton alongside the Fortier group with the Tucker (1 m^2 750 µm mesh) and the Monster (1 m^2 200 µm mesh) nets. We also obtained sediment core samples from the box core for the GENICE project. Some benthic invertebrate samples were collected by Marie Pierrejean from the Agassiz trawl for us, as well. The following tables list all of the samples obtained during Leg 2a and the associated sampling parameters.

Table 20.1 Zooplankton samples collected during Leg 2a

Station	Location	Date	Tow	Start Time (UTC)	Bottom Time (UTC)	End Time (UTC)	Latitude START (N)	Longitude START (W)	Latitude END (N)	Longitude END (W)	Bottom Depth (m)	Sampler Depth (m)	Species
732	Hudson Bay	08-Jul-17	Oblique Tow	01:14:15	01:21:42	01:26:52	55 23.240	77 59.306	55 23.694	77 57.936	118	66	Themisto libellula (2.0-3.0 cm)
732	Hudson Bay	08-Jul-17	Oblique Tow	01:35:10	01:40:35	01:46:07	55 23.191	77 58.832	55 24.207	77 58.825	109	56	Themisto libellula (2.0-3.0 cm)
732	Hudson Bay	08-Jul-17	Oblique Tow	01:14:15	01:21:42	01:26:52	55 23.240	77 59.306	55 23.694	77 57.936	118	66	Ctenophora
732	Hudson Bay	08-Jul-17	Oblique Tow	01:35:10	01:40:35	01:46:07	55 23.191	77 58.832	55 24.207	77 58.825	109	56	Ctenophora
732	Hudson Bay	08-Jul-17	Oblique Tow	01:14:15	01:21:42	01:26:52	55 23.240	77 59.306	55 23.694	77 57.936	118	66	Chaetognaths
732	Hudson Bay	08-Jul-17	Oblique Tow	01:35:10	01:40:35	01:46:07	55 23.191	77 58.832	55 24.207	77 58.825	109	56	Chaetognaths
732	Hudson Bay	08-Jul-17	Oblique Tow	01:14:15	01:21:42	01:26:52	55 23.240	77 59.306	55 23.694	77 57.936	118	66	Thysanoessa sp.
732	Hudson Bay	08-Jul-17	Oblique Tow	01:35:10	01:40:35	01:46:07	55 23.191	77 58.832	55 24.207	77 58.825	109	56	Thysanoessa sp.
732	Hudson Bay	08-Jul-17	Oblique Tow	01:14:15	01:21:42	01:26:52	55 23.240	77 59.306	55 23.694	77 57.936	118	66	O-TOW BULK >710um
732	Hudson Bay	08-Jul-17	Oblique Tow	01:35:10	01:40:35	01:46:07	55 23.191	77 58.832	55 24.207	77 58.825	109	56	O-TOW BULK >710um
736	Hudson Bay	08-Jul-17	Oblique Tow	23:06:37	23:12:04	23:16:36	58 25.196	78 18.524	58 25.574	78 18.271	103	53	Chaetognaths
736	Hudson Bay	08-Jul-17	Oblique Tow	23:06:37	23:12:04	23:16:36	58 25.407	78 18.728	58 25.372	78 18.731	103	53	Hydromedusae
736	Hudson Bay	08-Jul-17	Oblique Tow	23:06:37	23:12:04	23:16:36	58 25.196	78 18.524	58 25.574	78 18.271	103	53	Themisto libellula (1.0-1.5 cm)
736	Hudson Bay	08-Jul-17	Oblique Tow	23:06:37	23:12:04	23:16:36	58 25.407	78 18.728	58 25.372	78 18.731	103	53	Sympagohydra tuuli
736	Hudson Bay	08-Jul-17	Oblique Tow	23:06:37	23:12:04	23:16:36	58 25.196	78 18.524	58 25.574	78 18.271	103	53	O-TOW BULK >710um
736	Hudson Bay	09-Jul-17	Vertical Tow	0:24:30	0:27:43	0:31:25	58 25.407	78 18.728	58 25.372	78 18.731	95	85	V-TOW BULK >180um
720	Hudson Bay	09-Jul-17	Oblique Tow	17:51:54	17:58:15	18:04:35	60 41.482	78 33.345	60 41.452	78 33.276	94	61	Chaetognaths
720	Hudson Bay	09-Jul-17	Oblique Tow	17:51:54	17:58:15	18:04:35	60 41.482	78 33.345	60 41.452	78 33.276	94	61	Ctenophora
720	Hudson Bay	09-Jul-17	Oblique Tow	17:51:54	17:58:15	18:04:35	60 41.482	78 33.345	60 41.452	78 33.276	94	61	Calanus hyperboreas
720	Hudson Bay	09-Jul-17	Oblique Tow	17:51:54	17:58:15	18:04:35	60 41.482	78 33.345	60 41.452	78 33.276	94	61	Themisto libellula (0.0-0.5 cm)
720	Hudson Bay	09-Jul-17	Oblique Tow	17:51:54	17:58:15	18:04:35	60 41.482	78 33.345	60 41.452	78 33.276	94	61	Themisto libellula (0.5-1.0 cm)
720	Hudson Bay	09-Jul-17	Oblique Tow	17:51:54	17:58:15	18:04:35	60 41.482	78 33.345	60 41.452	78 33.276	94	61	Themisto libellula (1.0-1.5 cm)
720	Hudson Bay	09-Jul-17	Oblique Tow	17:51:54	17:58:15	18:04:35	60 41.482	78 33.345	60 41.452	78 33.276	94	61	Themisto libellula (2.0-2.5 cm)
720	Hudson Bay	09-Jul-17	Oblique Tow	17:51:54	17:58:15	18:04:35	60 41.482	78 33.345	60 41.452	78 33.276	94	61	Themisto libellula (2.5-3.0 cm)
720	Hudson Bay	09-Jul-17	Oblique Tow	17:51:54	17:58:15	18:04:35	60 41.482	78 33.345	60 41.452	78 33.276	94	61	O-TOW BULK >710um
720	Hudson Bay	09-Jul-17	Vertical Tow	18:34:02	18:37:26	18:41:12	60 41.482	78 33.345	60 41.452	78 33.276	85	75	V-TOW BULK >180um
694	Hudson Strait	10-Jul-17	Oblique Tow	7:12:36	17:19:32	7:26:31	62 30.450	78 30.037	62 30.525	78 29.785	100	58	Chaetognaths
694	Hudson Strait	10-Jul-17	Oblique Tow	7:12:36	17:19:32	7:26:31	62 30.811	78 28.986	62 30.851	78 28.905	100	58	Hydromedusae
694	Hudson Strait	10-Jul-17	Oblique Tow	7:12:36	17:19:32	7:26:31	62 30.450	78 30.037	62 30.525	78 29.785	100	58	Ctenophora
694	Hudson Strait	10-Jul-17	Oblique Tow	7:12:36	17:19:32	7:26:31	62 30.811	78 28.986	62 30.851	78 28.905	100	58	Calanus hyperboreas
694	Hudson Strait	10-Jul-17	Oblique Tow	7:12:36	17:19:32	7:26:31	62 30.450	78 30.037	62 30.525	78 29.785	100	58	Clione limacina
694	Hudson Strait	10-Jul-17	Oblique Tow	7:12:36	17:19:32	7:26:31	62 30.811	78 28.986	62 30.851	78 28.905	100	58	Themisto libellula (0.5-1.0 cm)
694	Hudson Strait	10-Jul-17	Oblique Tow	7:12:36	17:19:32	7:26:31	62 30.450	78 30.037	62 30.525	78 29.785	100	58	Themisto libellula (1.0-1.5 cm)
694	Hudson Strait	10-Jul-17	Oblique Tow	7:12:36	17:19:32	7:26:31	62 30.811	78 28.986	62 30.851	78 28.905	100	58	Themisto libellula (1.5-2.0 cm)
694	Hudson Strait	10-Jul-17	Oblique Tow	7:12:36	17:19:32	7:26:31	62 30.450	78 30.037	62 30.525	78 29.785	100	58	O-TOW BULK >710um
694	Hudson Strait	10-Jul-17	Vertical Tow	8:23:07	8:26:05	8:30:22	62 30.811	78 28.986	62 30.851	78 28.905	95	85	V-TOW BULK >180um
688	Hudson Strait	10-Jul-17	Oblique Tow	22:25:36	22:31:40	22:37:56	62 22.135	74 39.971	62 21.887	74 40.047	106	67	Chaetognaths
688	Hudson Strait	10-Jul-17	Oblique Tow	22:25:36	22:31:40	22:37:56	62 22.135	74 39.971	62 21.887	74 40.047	106	67	Calanus hyperboreas
688	Hudson Strait	10-Jul-17	Oblique Tow	22:25:36	22:31:40	22:37:56	62 22.135	74 39.971	62 21.887	74 40.047	106	67	Limacina helicina
688	Hudson Strait	10-Jul-17	Oblique Tow	22:25:36	22:31:40	22:37:56	62 22.135	74 39.971	62 21.887	74 40.047	106	67	Ctenophora
688	Hudson Strait	10-Jul-17	Oblique Tow	22:25:36	22:31:40	22:37:56	62 22.135	74 39.971	62 21.887	74 40.047	106	67	Hydromedusae
688	Hudson Strait	10-Jul-17	Oblique Tow	22:25:36	22:31:40	22:37:56	62 22.135	74 39.971	62 21.887	74 40.047	106	67	Themisto libellula (0.5-1.0 cm)
688	Hudson Strait	10-Jul-17	Oblique Tow	22:25:36	22:31:40	22:37:56	62 22.135	74 39.971	62 21.887	74 40.047	106	67	Themisto libellula (1.0-1.5 cm)
688	Hudson Strait	10-Jul-17	Oblique Tow	22:25:36	22:31:40	22:37:56	62 22.135	74 39.971	62 21.887	74 40.047	106	67	Themisto libellula (1.5-2.0 cm)
688	Hudson Strait	10-Jul-17	Oblique Tow	22:25:36	22:31:40	22:37:56	62 22.135	74 39.971	62 21.887	74 40.047	106	67	Mycidae (1.0-1.5 cm)
688	Hudson Strait	10-Jul-17	Oblique Tow	22:25:36	22:31:40	22:37:56	62 22.135	74 39.971	62 21.887	74 40.047	106	67	Mycidae (2.0-2.5 cm)
688	Hudson Strait	10-Jul-17	Oblique Tow	22:25:36	22:31:40	22:37:56	62 22.135	74 39.971	62 21.887	74 40.047	106	67	Mycidae (3.0-3.5 cm)
688	Hudson Strait	10-Jul-17	Oblique Tow	22:25:36	22:31:40	22:37:56	62 22.135	74 39.971	62 21.887	74 40.047	106	67	O-TOW BULK >710um
688	Hudson Strait	10-Jul-17	Vertical Tow	23:07:08	23:10:57	23:15:27	62 22.171	74 39.845	62 22.183	74 39.733	107	97	V-TOW BULK >180um
684	Hudson Strait	11-Jul-17	Oblique Tow	10:20:08	10:29:28	10:38:20	61 47.432	71 55.014	61 47.629	71 54.741	108	76	Chaetognaths
684	Hudson Strait	11-Jul-17	Oblique Tow	10:20:08	10:29:28	10:38:20	61 47.432	71 55.014	61 47.629	71 54.741	108	76	Calanus hyperboreas
684	Hudson Strait	11-Jul-17	Oblique Tow	10:20:08	10:29:28	10:38:20	61 47.432	71 55.014	61 47.629	71 54.741	108	76	Thysanoessa sp. (2.0-3.0 cm)
684	Hudson Strait	11-Jul-17	Oblique Tow	10:20:08	10:29:28	10:38:20	61 47.432	71 55.014	61 47.629	71 54.741	108	76	Hydromedusae
684	Hudson Strait	11-Jul-17	Oblique Tow	10:20:08	10:29:28	10:38:20	61 47.432	71 55.014	61 47.629	71 54.741	108	76	Limacina helicina
684	Hudson Strait	11-Jul-17	Oblique Tow	10:20:08	10:29:28	10:38:20	61 47.432	71 55.014	61 47.629	71 54.741	108	76	Themisto libellula (0.5-1.0 cm)
684	Hudson Strait	11-Jul-17	Oblique Tow	10:20:08	10:29:28	10:38:20	61 47.432	71 55.014	61 47.629	71 54.741	108	76	Themisto libellula (1.0-1.5 cm)
684	Hudson Strait	11-Jul-17	Oblique Tow	10:20:08	10:29:28	10:38:20	61 47.432	71 55.014	61 47.629	71 54.741	108	76	Themisto libellula (1.5-2.0 cm)
684	Hudson Strait	11-Jul-17	Oblique Tow	10:20:08	10:29:28	10:38:20	61 47.432	71 55.014	61 47.629	71 54.741	108	76	O-TOW BULK >710um
684	Hudson Strait	11-Jul-17	Vertical Tow	11:00:36	11:04:07	11:08:36	61 47.308	71 54.830	61 47.228	71 54.759	105	95	V-TOW BULK >180um
682	Hudson Strait	11-Jul-17	Oblique Tow	20:41:34	20:48:50	20:55:14	61 02.632	69 43.239	61 02.662	69 42.225	108	61	Ctenophora
682	Hudson Strait	11-Jul-17	Oblique Tow	20:41:34	20:48:50	20:55:14	61 02.632	69 43.239	61 02.662	69 42.225	108	61	Hydromedusae
682	Hudson Strait	11-Jul-17	Oblique Tow	20:41:34	20:48:50	20:55:14	61 02.632	69 43.239	61 02.662	69 42.225	108	61	Chaetognaths
682	Hudson Strait	11-Jul-17	Oblique Tow	20:41:34	20:48:50	20:55:14	61 02.632	69 43.239	61 02.662	69 42.225	108	61	Themisto libellula (0.5-1.0 cm)
682	Hudson Strait	11-Jul-17	Oblique Tow	20:41:34	20:48:50	20:55:14	61 02.632	69 43.239	61 02.662	69 42.225	108	61	Themisto libellula (1.0-1.5 cm)
682	Hudson Strait	11-Jul-17	Oblique Tow	20:41:34	20:48:50	20:55:14	61 02.632	69 43.239	61 02.662	69 42.225	108	61	Themisto libellula (1.5-2.0 cm)
682	Hudson Strait	11-Jul-17	Oblique Tow	20:41:34	20:48:50	20:55:14	61 02.632	69 43.239	61 02.662	69 42.225	108	61	O-TOW BULK >710um
682	Hudson Strait	11-Jul-17	Vertical Tow	21:16:15	21:19:43	21:23:58	61 02.612	69 43.123	61 05.168	69 43.092	106	96	V-TOW BULK >180um
676	Ungava Bay	12-Jul-17	Oblique Tow	5:40:10	05:46:52	05:53:32	60 07.661	69 03.940	60 07.599	69 03.044	103	70	Chaetognaths
676	Ungava Bay	12-Jul-17	Oblique Tow	5:40:10	05:46:52	05:53:32	60 07.661	69 03.940	60 07.599	69 03.044	103	70	Hydromedusae
676	Ungava Bay	12-Jul-17	Oblique Tow	5:40:10	05:46:52	05:53:32	60 07.661	69 03.940	60 07.599	69 03.044	103	70	Calanus hyperboreas
676	Ungava Bay	12-Jul-17	Oblique Tow	5:40:10	05:46:52	05:53:32	60 07.661	69 03.940	60 07.599	69 03.044	103	70	Themisto libellula (0.5-1.0 cm)
676	Ungava Bay	12-Jul-17	Oblique Tow	5:40:10	05:46:52	05:53:32	60 07.661	69 03.940	60 07.599	69 03.044	103	70	Themisto libellula (1.0-1.5 cm)
676	Ungava Bay	12-Jul-17	Oblique Tow	5:40:10	05:46:52	05:53:32	60 07.661	69 03.940	60 07.599	69 03.044	103	70	Thysanoessa sp.
676	Ungava Bay	12-Jul-17	Oblique Tow	5:40:10	05:46:52	05:53:32	60 07.661	69 03.940	60 07.599	69 03.044	103	70	Mycidae
676	Ungava Bay	12-Jul-17	Oblique Tow	5:40:10	05:46:52	05:53:32	60 07.661	69 03.940	60 07.599	69 03.044	103	70	O-TOW BULK >710um
676	Ungava Bay	12-Jul-17	Vertical Tow	6:17:44	06:22:58	06:27:27	60 07.542	69 03.972	60 07.622	69 03.938	108	98	V-TOW BULK >180um
670	Ungava Bay	12-Jul-17	Oblique Tow	16:37:12	16:45:26	16:53:35	59 00.600	67 56.114	59 00.577	67 54.984	122	74	Chaetognaths
670	Ungava Bay	12-Jul-17	Oblique Tow	16:37:12	16:45:26	16:53:35	59 00.600	67 56.114	59 00.577	67 54.984	122	74	Ctenophora
670	Ungava Bay	12-Jul-17	Oblique Tow	16:37:12	16:45:26	16:53:35	59 00.600	67 56.114	59 00.577	67 54.984	122	74	Hydromedusae
670	Ungava Bay	12-Jul-17	Oblique Tow	16:37:12	16:45:26	16:53:35	59 00.600	67 56.114	59 00.577	67 54.984	122	74	Calanus hyperboreas
670	Ungava Bay	12-Jul-17	Oblique Tow	16:37:12	16:45:26	16:53:35	59 00.600	67 56.114	59 00.577	67 54.984	122	74	Themisto libellula (0.5-1.0 cm)
670	Ungava Bay	12-Jul-17	Oblique Tow	16:37:12	16:45:26	16:53:35	59 00.600	67 56.114	59 00.577	67 54.984	122	74	Themisto libellula (1.0-1.5 cm)
670	Ungava Bay	12-Jul-17	Oblique Tow	16:37:12	16:45:26	16:53:35	59 00.600	67 56.114	59 00.577	67 54.984	122	74	O-TOW BULK >710um
670	Ungava Bay	12-Jul-17	Vertical Tow	17:19:04	17:23:24	17:28:21	59 00.382	67 55.903	59 00.415	67 55.783	120	110	V-TOW BULK >180um

Table 20.2 Benthic invertebrate samples collected during Leg 2a

					Start	Stop	Location (Down)		Location (up)					
Station	Location	Date	Sampling trawl	Depth	Time (UTC)	Time (UTC)	Lat	Long	Lat	Long	Air T°C	Eau T°C	Ice	Species
732	Hudson Bay	08-Jul-17	Agassiz	118	2:17	2:29	55 24.511	77 58.738	55 24.833	77 58.343	10.7	10.92	0	Ctenodiscus crispatus
676	Ungava Bay	12-Jul-17	Agassiz	98	6:48	7:00	60 07.566	69 03.656	60 07.327	69 03.134	1.6	1.67	eau bergee	Gorgonocephalus arctica

20.1 Comments and Recommendations

Because we analyze our samples for mercury, it is always a concern if mercury chloride users spike their samples in the same vicinity as our samples. During this leg, the sink that we used to sieve our zooplankton samples in was the same laboratory that mercury chloride spiking occurred. Although both parties were aware of the issue, cross contamination may have still occurred, despite our best efforts, and such consideration will be taken into account during the analysis. To eliminate potential cross contamination woes, we suggest that this issue is considered during the allocation of lab spaces before the cruise.

Acknowledgement

Thanks to the Fortier group (Gerald, Matthieu, and Thibeau) for giving me a crash-course on zooplankton and to Kasey who split the V-tow samples with me.

Thanks to the Hubert group for being so well-organized and taking care of the box core sampling for the GENICE project.

Thanks to Marie for putting aside invertebrate samples for us.

Thanks to Schools on Board for bringing in a great group of people to share our science with.

Thanks to JET for being the chief scientist, planning and organizing our busy days, and dealing elegantly with the delay in Quebec.

And finally, to the wonderful captain and his crew that always do their best to help us make sure that we achieve all of our scientific needs.

21 Microbial Genomics for Oil Spill Preparedness in Canada's Arctic Marine Environment – Leg 2

Project leaders: Casey Hubert[1] (chubert@ucalgary.ca), Gary Stern[2] and Charles Greer[3]
Cruise participants – Leg 2: Amy Noël[1], Sean Murphy[1], Rhonda Clark[1], Alastair Smith[1], Emily Ellefson[1], Diana Chirokova[2] and Lars Schreibre[3]
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21.1 Introduction

The GENICE project will use microbial genomics to generate credible, science-based knowledge on the role and potential of bioremediation – the biodegradation of oil by naturally occurring microorganisms. Marine microbial communities are likely nature's 'first responders' in the event of a marine oil spill, yet little is known about this potential mitigation approach in the cold ice-laden Arctic marine environment. Integrating scientific outcomes with GE^{3}LS, the project will achieve key deliverables of:

1) new baselines using microbial genomics;
2) bioremediation viability case studies and demonstrations for Arctic marine habitats;
3) new approach to dynamic mapping of risks and mitigation potential using microbial genomic biomarkers.

These outcomes will interface with the complex milieu of economic policy development and learning around emergency preparedness and oil spill response in Canada's Arctic waters. Ongoing engagement and interactive exchange of knowledge between scientists and different end-user groups will include residents of potentially affected northern communities, different levels of government including regulatory agencies, non-governmental and Indigenous organizations, and the private sector. As a result, an additional key deliverable of GENICE will be (4) a Best Practices document for end users concerning bioremediation of oil spills in the Arctic that will be produced and available to Canadians at the end of the project.

21.1.1 *Research Questions*

How do different ice types :

- Control the microbial habitat and community structure?
- Provide the potential for bioremediation of oil spills?
- Interact with different contaminant mixtures?

Water:

- Are hydrocarbon-degrading communities similar to lower latitude waters?
- Are the rates of biodegradation similar?
- Will low temperatures or nutrient availability impact biodegradation?

Sediments:

- What are the baseline levels of hydrocarbons?
- What does an ‘unimpacted’ sediment-associated microbial community look like?
- How do hydrocarbon seeps shape the communities of hydrocarbon degrading microbes in the Arctic?
- What hydrocarbon-degraders are present/active before and after enrichment with hydrocarbons?
- How does the microbial biodegradation of oil at these sites differ between hydrocarbon type (crude, diesel, bunker fuel) and concentration?
- How do microbial communities and the rates of hydrocarbon-degradation change with the addition of limiting nutrients (N, P)?
- What are the lethal limits of oil concentration for hydrocarbon degraders at these sites?

21.1.2 *Objectives*

On leg 2 our goal was to collect sediment, water, and ice to vertically integrate the microbial response to marine hydrocarbon contamination. We also aimed to collect numerous samples for baseline microbial community analysis. During Leg 2b, we also aimed to characterise the fine-scale biogeography of the microbial communities around a cold seep at Scott Inlet.

21.2 Methodology

21.2.1 *Sediment Collection and Incubation*

- Triplicate box core at stations 732 and A16, unsuccessful box core at 694, 676, and 670 due to rocky bottom, though at 670 some surface was collected.
- Planned sediment collection during ROV operations at the Scott Inlet site cancelled due to heavy ice cover. This would have consisted have consisted of push cores and Ekman grabs (bulk surface sediment) collected by the ROV, as well as box cores in the vicinity of seep sites identified during an ROV reconnaissance dive.
- Preservation of surface sediment for the following parameters: DNA, RNA, cell counts, bulk hydrocarbon analysis, viruses, pore water HC analysis, pore water Sulfate, pore water organic acids
- Push cores taken at station 732 and sectioned as follows: 2cm sections (up to 30cm) preserved for the following parameters: DNA, RNA, cell counts, pore water HC analysis, pore water Sulfate, pore water organic acids, bulk hydrocarbon analysis,
- Sediment incubations (Sean Murphy and Alastair Smith) Triplicate 4°C incubations were established with 10mL of surface sediment with 40mL of artificial seawater and differing nutrient amendments (e.g. high: N 4.7mmol, P 1.5mmol; medium N 2.4mmol, P 0.75mmol; and low N 15umol P 2umol) and hydrocarbon types and concentrations (e.g. bunker, diesel, and crude, at 100 ppm and 1000ppm). These incubations will run for approximately 6 months or until carbon dioxide production plateaus.

  Incubations were set up to test the effect on hydrocarbon degradation of incubating sediments with bottom water instead of artificial seawater. Sediment was added to serum bottles containing either artificial seawater (15 µM N and 2 µM phosphate), bottom water from collected from the same sampling station, or autoclaved bottom water. These were amended with 100 ppm crude oil and incubated in the dark at 4 °C. Samples were collected every 3-4 days for DNA, cell counts and headspace gases.

Additionally, whole incubations were sacrificed in duplicate initially and after 14 days. An additional set of incubations will be maintained at 4°C until October.

21.2.2 *Seawater Collection and Incubation*

- Water was collected from various depths (surface, 5m, and bottom water) and preserved for following parameters: DNA, RNA, cell counting, viruses (only at Station 732)
- Water Incubations (Amy Noël, Lars Schreiber and Alastair Smith)
  Dispersants: Short-term incubations (5 days) were set up to test the effect of dispersant (Corexit) on hydrocarbon biodegradation by waterassociated microbial communities. Incubations were set up in serum bottles containing artificial seawater amended with collected seawater, 0.1% v/v hydrocarbons (diesel, crude oil), and 1/20 v/v dispersant. Half of the bottles were sacrificed for petroleomics and the remainder for microbiology (DNA extraction and cell counts).
  Water alone: Long term incubations (6 months) were set up in serum bottles containing artificial seawater amended with collected surface seawater, 0.1% v/v hydrocarbons (diesel, crude oil, bunker fuel). Triplicates will be sacrificed every 30 days throughout the duration of the experiment for microbiology (DNA, RNA, cell counts) and petroleomics.
  Medium term incubations (19 days) were set up to investigate the initial response to hydrocarbon addition (1000 ppm diesel) in greater detail. Serum bottles with 50 mL surface seawater were incubated in the dark at 4 °C with the added diesel. Triplicates were sacrificed immediately, and after 6, 13 and 19 days for DNA, RNA and petroleomics. In addition, samples of headspace gases and for cell counts were collected every 3-4 days.
  Freezing tolerance of hydrocarbon degraders in surface seawater. Serum bottles containing 50mL surface seawater were frozen at -20 °C for 12 hours before being allowed to thaw at 4 °C. A control set of incubations were maintained at 4 °C. Once thawed, diesel (100 ppm) was added to the bottles. Triplicate bottles were sacrificed immediately for DNA, RNA and petroleomics while another set of triplicates were incubated for 2 weeks before being sacrificed.

21.2.3 *Ice Collection*

Due to the lack of suitable sea ice and time constraint, we were not unable to land on icefloes, or sample from the ice cage. The helicopter was used to assess the ice conditions and determine where we could sample. Ice floes in South Eastern Ungava Bay were heavily rotten by the time we reached the area. Also, sea ice conditions in Frobisher Bay were about 20-30m of diameter and 14inchs thick of rotting first year and multiyear ice.

Planned physical samplings were to collect multiple ice cores (6” core barrel) and bring the cores back to the University of Calgary (microbiology) and the University of Manitoba (microstructure). We would have collected temperature profiles, salinity profiles, and ice to create a microcosm contaminated with hydrocarbons.

An Idronaut cast would have also been used with a CTD probe that could reach 15m deep from the top surface of the ice.

Table 21.1 Operations conducted

Station	Latitude	Longitude	Operation
732	55°23.201 N	077°59.534 W	CTD Rosette
	55°22.92 N	077°59.684 W	Box Core #1
	55°23.127 N	077°59.470 W	Box Core #2
	55°23.339 N	077°59.123 W	Box Core #3
736	58°25.493 N	078°18.263 W	CTD Rosette
720	60°41.711 N	078°33.895 W	CTD Rosette
694	62°30.735 N	078°29.317 W	CTD Rosette
688	62°22.023 N	074°39.693 W	CTD Rosette
684	61°47.227 N	071°54.815 W	CTD Rosette
682	61°02.502 N	069°42.981 W	CTD Rosette
676	60°07.571 N	069°03.877 W	CTD Rosette
670	58°59.782 N	067°56.119 W	CTD Rosette
	59°00.204 N	067°56.029 W	Box Core
A16	63°38.372 N	068°37.172 W	CTD Rosette
	63°38.355 N	068°37.567 W	Box Core #1
	63°38.353 N	068°37.648 W	Box Core #2
A16	63°38.287 N	068°37.672 W	Box Core #3
180	67°25.018 N	061°26.576 W	CTD Rosette
Coring 8.1	69°24.437 N	064°43.929 W	Box Core
176	69°36.618 N	065°23.130 W	CTD Rosette
BB2	72°46.114 N	067°01.256 W	CTD Rosette
101	76°23.012 N	077°23.970 W	CTD Rosette
	76°21.473 N	077°30.960 W	Box Core
115	76°20.698 N	071°15.549 W	CTD Rosette
	76°19.915 N	071°15.284 W	Box Core
129	78°18.713 N	074°06.894 W	CTD Rosette
	78°19.360 N	074°05.546 W	Box Core
TS233	77°46.142 N	076°32.193 W	CTD Rosette
	77°45.313 N	076°41.163 W	Box Core
108	76°15.563 N	074°37.650 W	CTD Rosette
323	74°09.164 N	080°29.654 W	CTD Rosette
	74°09.383 N	080°28.076 W	Box Core
301	74°16.701 N	083°22.036 W	CTD Rosette

21.3 Comments and Recommendations

Thank you very much for an excellent cruise! We really appreciate the attempts for triplicate box cores throughout the week, as well as support for ice operations. Unfortunately, neither of these worked out due to timing and sediments in Hudson Strait, but our team was still able to address some of our research questions on board (e.g. seawater incubations)!

The only feedback we have in general is that there could be a scientists logbook going in and out of the engine room for safety reasons.

22 Macrofauna Diversity across the Nearshore of the East of Hudson Bay and Hudson Strait - Leg 2

Project leaders: Philippe Archambault[1] (philippe_archambault@bio.ulval.ca) and Christian Nozais[2]
Cruise participant – Leg 2a: Marie Pierrejean[1]
Cruise participants – Leg 2b: Valérie de Carufel[2] and Cindy Grant[1]
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22.1 Introduction

In benthic ecosystems, the availability and quantity of food and the type of bottom influence the distribution, the abundance and the richness of benthic organisms. Generally, the rocky bottom presents a diverse assemblage of organisms (Posey and Ambrose 1994) whereas the soft bottom is more homogenous and the presence of organisms will depend of the grain size or of the availability of food. These types of bottom create heterogeneity and can be responsible of great concentrations of organisms and of the presence of the one species.

The main objective of the 2017 Expedition were :

1) (Leg 2a) - To describe and compare the biodiversity (using a variety of different diversity indices) across the nearshore of the East of Hudson Bay and Hudson Strait. These data will be used to modelling the distribution of benthic organisms across the nearshore of the East of Hudson Bay and Hudson Strait.
2) (Leg 2b) - To study ecosystem function in seapen, sponge and coral meadow sites, compared with sites without by performing incubations
3) (Leg 2b) - To advance biodiversity surveys of benthic communities with respect to the physical and chemical environment
4) (Leg 2b) – To elucidate fundamental ecological linkages between this diversity, biological productivity and biogeochemical functions

22.2 Methodology

22.2.1 *Leg 2a*

At 9 stations, the Agassiz trawl (Figure 21.1) was deployed to collect macrofauna (Table 21.2). Catches were passed through a 2 mm mesh sieve. When possible, specimens were identified to the lowest taxonomic level, then count and weight. The unidentified specimens were preserved in a 4% seawater-formalin solution. At all stations, organisms were frozen at -80°C for the JET team to measure lipids for the Sentinelle Nord project.

At 3 stations, the box core was deployed to quantitatively sample diversity, abundance and biomass of infauna and to sample sediment. Unfortunately, the bottom of 2 sites was sandy and the boxcore was empty. For the one sample, sediments of a surface area of 0.125 m^2 and 10-15 cm in depth were collected and sieved through a 0.5 mm mesh and preserved in a 4% formaldehyde solution for further identification in the laboratory (Table 18.1). Sub-cores of sediments were collected for sediment pigment content, organic matter, sediment grain size, porosity; for sediment pigments, the top 1 cm was collected, although for sediment grain size, the top 5 cm was collected. Sediment pigment samples were frozen at -80°C, and porosity, organic matter and sediment grain size samples were frozen at -20°C.

Figure 22.1: Sampling with the agassiz trawl

Figure 22.2 : Sample of macrofauna. All organisms have been sorted by species and weighted.

Table 22.1 Box coring stations during leg 2a.

Station ID	Date	Latitude (N)	Longitude (W)	Depth (m)	Diversity	Grain size	Pigments	Organic content
732	07/07/17	55°22.92	77°59.684	121	x	x	x	x
694	10/07/17	62°30.717	78°29.025	93	Sandy			
670	12/07/17	59°00.204	67°56.029	116	Sandy			

Table 22.2 Agassiz trawl stations during leg 2a.

		Start			End				
Stn	Date	Latitude (N)	Longitude (W)	Depth (m)	Latitude (N)	Longitude (W)	Depth (m)	Duration (min)	Comments
732	7/07/17	55°24.511	77°58.738	119	55°24.833	77°58.343	120	3	
736	8/07/17	58°25.393	78°18.305	91	58°25.738	78°17.968	75	3	
720	9/07/17	60°41.404	78°33.813	91	60°41.387	78°34.187	92	3	
694	10/07/17	62°31.046	78°29.340	103	62°31.276	78°29.663	108	3	One rock
688	10/07/17	62°22.267	74°40.382	107	62°21.924	74°40.325	106	3	Rocks
684	11/07/17	61°47.093	71°54.706	108	61°47.336	71°54.979	106	3	
682	11/07/17	61°02.514	69°42.770	95	61°02.374	69°43.016	101	1m30	Rocky bottom
676	12/07/17	60°07.566	69°03.656	98	60°07.327	69°03.134	93	2m30	Rocks
670	12/07/17	59°00.268	67°55.724	117	59°00.288	67°55.05	112	3	

22.2.2 *Leg 2b*

The box core was deployed to quantitatively sample diversity, abundance and biomass of endobenthic fauna and to obtain sediment cores for sediment analyses and incubations. From 33 box cores, sediments of usually a surface area of 0.125 m^2 and 10-15 cm in depth were collected and passed through a 0.5 mm mesh sieve and preserved in a 4 % formaldehyde solution for further identification in the laboratory (Table 19.3). Sub-cores of sediments were collected for sediment pigment content, organic carbon content, and sediment grain size; for sediment pigments, and organic carbon content, the top 1 cm was collected, although for sediment grain size, the top 5 cm was collected. Samples for sediment pigment were frozen at

-80°C, and organic carbon samples and sediment grain size samples were frozen at -20°C. All samples will be transported off the ship for analyses in the lab at the Université Laval.

At 4 specific stations, multiple box cores were deployed to study ecosystem function by performing incubations (Table 21.3). In Frobisher Bay (basic station A16), 2 box cores were collected in soft-bottom sponge gardens and 2 were collected in adjacent non-sponge habitats. At Disko Fan station, 2 box cores were collected in soft-bottom coral gardens and 2 were collected in adjacent bare sediment habitats. ROV dive allowed us to choose sampling sites in Lancaster Sound (full station 301); box cores were collected in soft-bottom seapen gardens. Two were collected in dense seapen habitat and 2 were collected in adjacent less-dense seapen habitat. In the North Water Polynia (full station 108), 2 box cores were collected to performed incubations in a bare sediment habitat considered as a hotspot for benthic biodiversity. Bottom water was collected from the rosette at those stations to allow incubations.

At 18 stations, an Agassiz trawl (1.5 m width × 0.7 m height, cod end of 0.5 cm mesh size) was towed on the seabed at a speed of 1.5 - 2 knots for 2-3 minutes to survey epibenthic species diversity, abundance, and biomass (Table 21.4). Catches were passed through a 2 mm mesh sieve. Specimens were identified to the lowest taxonomic level, then counted and weighted. The unidentified specimens were preserved in a 4% seawater-formalin solution for further identification in laboratory. At specific stations in Lancaster Sound and the NOW, organisms were frozen at -20°C for future isotopic analyses.

Table 22.3 Sampled variables during leg 2b (Amundsen 2017) using the box core

Station ID	Date	Latitude	Longitude	Depth (m)	Divesity	Grain size	Organic content	Pigments	Push cores	Porosity
A16 – BC1	15/07/2017	63°38,355’N	68°37,567’W	140	1	3	3	3	3	3
A16 – BC2	15/07/2017	63°38,353’N	68°37,648’W	137	1	3	3	3	3	3
A16 – BC3	15/07/2017	63°38,287’N	68°37,672’W	109	1	3	3	3	3	3
A16 – BC4	15/07/2017	63°38,312’N	68°37,637’W	135	1	3	3	3	3	3
Disko Fan – BC1	19/07/2017	68°00,909’N	59°34,732’W	947	1	3	3	3	0	3
Disko Fan – BC2	19/07/2017	68°01,373’N	59°34,807’W	937	1	3	3	3	0	3
Disko Fan – BC3	19/07/2017	67°59,545’N	59°33,953’W	1012	1	3	3	3	3	3
Disko Fan – BC4	19/07/2017	67°59,567’N	59°33,874’W	1004	1	3	3	3	3	3
Disko Fan – BC5	19/07/2017	67°57,890’N	59°29,106’W	873	1	3	3	3	3	3
Disko Fan – BC6	19/07/2017	67°58,082’N	59°29,405’W	874	1	3	3	3	3	3
176	21/07/2017	69°35,852’N	65°24,226’W	267	1	1	1	1	0	0
BB2	22/07/2017	72°45,080’N	67°00,910’W	2373	1	1	1	1	0	0
101	24/07/2017	76°21,473’N	77°30,960’W	378	1	1	1	1	0	0
105	25/07/2017	76°19,061’N	75°45,484’W	331	1	1	1	1	0	0
115	26/07/2017	76°19,915’N	71°15,284’W	668	1	1	1	1	0	0
129	27/07/2017	78°19,360’N	74°05,546’W	545	1	1	1	1	0	0
TS 233	28/07/2017	77°45,313’N	76°41,163’W	396	1	1	1	1	0	0
111	29/07/2017	76°18,486’N	73°12,428’W	593	1	1	1	1	0	0
108 – BC1	29/07/2017	76°15,861’N	74°36,373’W	448	1	3	3	3	3	3
108 – BC2	29/07/2017	76°15,781’N	74°36,349’W	449	1	3	3	3	3	3

323	31/07/2017	74°09,396'N	80°28,076'W	787	1	1	1	1	0	0
301 – BC1	03/08/2017	74°16,654'N	83°19,131'W	715	1	3	3	3	3	3
301 – BC2	03/08/2017	74°16,644'N	83°19,153'W	718	1	3	3	3	3	3
301 – BC3	03/08/2017	74°16,646'N	83°20,112'W	740	1	3	3	3	3	3
301 – BC4	03/08/2017	74°16,626'N	83°20,183'W	740	1	3	3	3	3	3
304	04/08/2017	74°14,786'N	91°30,902'W	315	1	1	1	1	0	0
QMG-M	08/08/2017	68°18,175'N	101°44,517'W	114	1	1	1	1	0	0
QMG-4	08/08/2017	68°29,057'N	103°25,890'W	71	1	1	1	1	0	0
QMG-3	09/08/2017	68°19,650'N	102°56,523'W	45	1	1	1	1	0	0
QMG-1	09/08/2017	68°29,551'N	99°53,882'W	40	1	1	1	1	0	0
QMG-2	09/08/2017	68°18,400'N	100°48,444'W	95	1	1	1	1	0	0
312	10/08/2017	69°10,235'N	100°41,732'W	65	1	1	1	1	0	0
333	13/08/2017	68°46,374'N	80°50,848'W	27	1	1	1	1	0	0

Table 22.4 Agassiz trawl stations during leg 2b

Stn	Date	Start			End			Duration
		Latitude (N)	Longitude (W)	Depth	Latitude (N)	Longitude (W)	Depth	
A16	15/07/2017	63°40,125'	68°25,652'	75	63°39,852'	68°25,246'	87	3 min
101	24/07/2017	76°21,507'	77°31,530'	373	76°20,898'	77°30,046'	377	2 min
105	25/07/2017	76°19,020'	75°46,255'	333	76°18,667'	75°48,315'	332	2 min
115	26/07/2017	76°19,996'	71°16,224'	665	76°20,081'	71°22,455'	668	2 min
129	27/07/2017	78°19,009'	74°04,541'	574	78°19,068'	74°06,092'	554	2 min
TS 233	28/07/2017	77°45,385'	76°38,987'	400	77°45,365'	76°40,939'	403	3 min
111	29/07/2017	76°18,776'	73°11,579'	601	76°18,703'	73°11,866'	602	3 min
108	30/07/2017	76°15,681'	74°35,372'	442	76°15,413'	74°36,945'	448	3 min
323	31/07/2017	74°09,418'	80°28,182'	786	74°09,433'	80°27,113'	803	3 min
301	03/08/2017	74°16,601'	83°21,872'	719	74°17,157'	83°21,990'	724	3 min
304	04/08/2017	74°14,709'	91°30,323'	314	74°14,313'	91°28,916'	316	3 min
QMG-M	08/08/2017	68°18,205'	101°44,627'	117	68°18,277'	101°45,785'	112	2 min
QMG-4	08/08/2017	68°29,097'	103°25,602'	71	68°29,214'	103°26,637'	72	2 min
QMG-3	09/08/2017	68°19,671'	102°56,026'	52	68°19,709'	102°55,399'	47	2 min
QMG-1	09/08/2017	68°29,562'	99°54,065'	40	68°29,313'	99°54,009'	50	2 min
QMG-2	09/08/2017	68°18,356'	100°48,567'	91	68°18,216'	100°47,438'	96	2 min
312	10/08/2017	69°10,218'	100°41,899'	66	69°10,447'	100°41,885'	68	2 min
333	13/08/2017	68°46,547'	80°50,929'	27	68°46,651'	80°51,318'	27	2 min

Acknowledgement

Leg 2a - We gratefully thank the chief scientist Jean-Éric Tremblay and the Captain of the Amundsen. We also thank the day and night deck crew for their help with the gear deployment.

Leg 2b - We would like to thank the CCGS *Amundsen* captain Claude Lafrance, and the ship crew for their help with deploying the gears. We thank the chief scientists Jean-Éric Tremblay & Martine Lizotte.

23 Collection and Characterization of Thyasirid Clams – Leg 2b

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23.1 Methodology

During the 2016 Amundsen expedition over a 100 thyasirids were found in sediment samples at Frobisher Bay. During the Leg 2b of the 2017 Amundsen expedition we inspected sediment from box-core samples in Frobisher Bay and all box-core stations in Baffin Bay (500 ml vials). Thyasirids were found at 4 stations in Frobisher Bay (16 individuals) and three stations at the North Water Polynya transect (stations 111, 115, and 119), and at Lancaster Sound (stations 323 and 301). A total of 56 individuals were found, being particularly abundant in Lancaster Sound (St. 323) where 30 individuals were found. Specimens were dissected aboard to obtain gills for DNA (fixed in 95% ethanol), Transmission Electron Microscopy (fixed in 2.5% glutaraldehyde), and stable isotope analysis (frozen at -20 °C), or they were directly fixed without prior dissection due to time constraints (Figure 22.1).

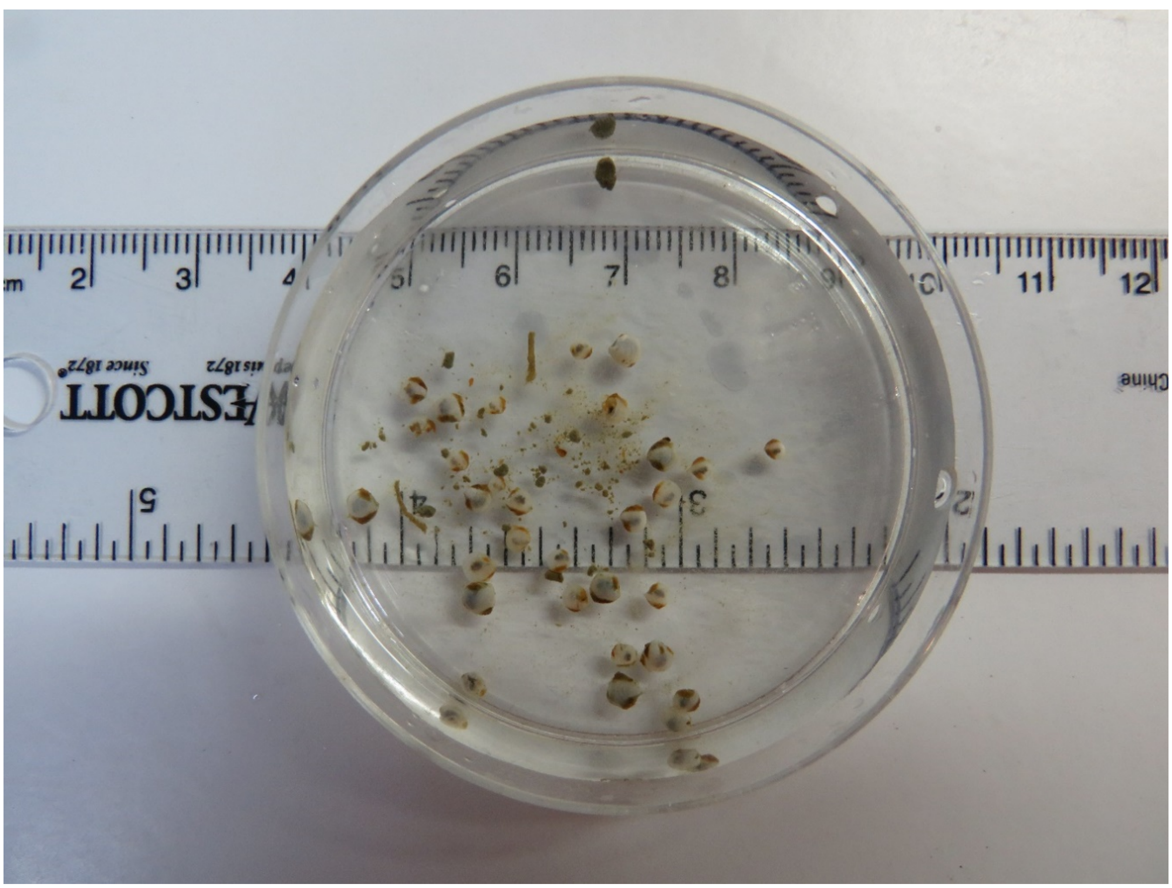

Figure 23.1 Thyasirids found in a subsample of a box core from Lancaster Sound. N= 30

Table 23.1 Thyasirids found in subsamples of sediment collected using a box core during the CCGS *Amundsen* 2017 expedition. All specimens from box cores except at station OF-S23 (Agassiz trawl)

Station	N	Latitude (N)	Longitude (N)	Depth (m)	Date	Status
OF-S23	1	62 49.126	66 56.354	507	14-07-2017	Ethanol 95%
OF-B5	8	62 27.810	65 52.957	278	14-07-2017	2 individuals fixed in ethanol 95%, 1 empty shell in ethanol 95%, 3 specimens dissected and fixed in 2.5% glutaraldehyde and 95% ethanol, and 2 frozen at -20 °C
FB2-2(5g)rep1	2	63 39.784	68 25.250	82	15-07-2017	1 individual fixed in ethanol 95%, and 1 individual fixed in 2.5% glutaraldehyde and 95% ethanol
OF-S22	5	62 52.017	66 44776	289	16-07-2017	2 individuals fixed in 2.5% glutaraldehyde and 95% ethanol, 1 in 95% ethanol, and 2 frozen at -20 °C
St. 115	2	76 19.915	71 15.284	668	26-07-2017	2 specimens in ethanol 95%
St. 129	1	78 19.360	74 05.546	545	27-07-2017	Ethanol 95%
St. 111	6	76 18.486	73 12.428	593	29-07-2017	Probably two different species (1-2 and 3-6). 3 specimens in ethanol 95%, 1 specimen frozen, and 2 specimens dissected and fixed in 2.5% glutaraldehyde (gills) and 95% ethanol. One broken shell
St. 323	30	74 09.396	80 28.076	787	31-07-2017	Specimens fixed in 95% ethanol (15), 2.5 % glutaraldehyde (10), and frozen at -20 C (5). Some of the frozen specimens were broken.
St. 301	1	74 16.654	83 19.131	715	03-08-2017	Specimen fixed in 95% ethanol, broken shell

24 Trophic Ecology of Nephtheid Soft Corals in Arctic Hard and Soft-Bottom Environments – Leg 2b

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24.1 Introduction

Corals, sediment, zooplankton, and water samples were collected as part of a study on the functional role of Nephtheidae soft corals (NSERC visiting post-doctoral fellowship at DFO NL). Samples of soft corals have been collected during the 2017 Amundsen expedition using Amundsen's ROV, box-cores, and Agassiz trawl. Specimens will be analyzed for C & N stable isotopes and lipids/fatty acids composition in order to investigate patterns in their trophic ecology. Corals have been subsampled and frozen at -80°C for lipids analysis, and kept in -20°C for isotopic composition.

24.2 Methodology

A total of 92 coral samples have been collected throughout leg 2b (Iqaluit-Resolute portion): 81 from the Agassiz trawl and/or box-cores, and 11 from the ROV (7 dive 59, Pond Inlet, and dive 61 in Lancaster Sound,Table 24.1). The remaining of the samples have been frozen at -20°C for stable isotopes, taxonomy, and examination of associated biodiversity.

Table 24.1 List of corals sampled during the 2017 Amundsen expedition including ROV, box cores, and Agassiz trawl.

Sample	Description	Latitude (N)	Longitude (W)	Depth (m)
ROV				
R59-4	Nephtheidae soft coral with sediment sac	72° 49.7521′	77° 36.4061′	806
R59-7	Soft coral - lost part of coral during collection.	72° 50.1625′	77° 35.7018′	456.6
R59-9	Coral broke on first attempt to collect it	72° 50.1666′	77° 0.0084′	455.6
R59-10	Soft coral on rock	72° 50.1946′	77° 35.6798′	428
R59-11	2 soft corals attached to *Chondrocladia* sponge	72° 50.2039′	77° 35.6477′	415.7
R59-12	Soft coral	72° 50.2067′	77° 35.6325′	414.3
R61-1	*Umbellula encrinus*	74° 16.6045′	83° 21.0056′	740.9
R61-2	*Umbellula encrinus*	74° 16.6024′	83° 20.994′	740.3
R61-3	*Umbellula encrinus*	74° 16.5972′	83° 20.9535′	741.2

R61-4	*Umbellula encrinus* – in ROV arms	74° 16.6014′	83° 21.0357′	740.7
Box core				
OF-B9	13 colonies (different Nephtheidae genera)	62° 34.014′	66° 16.942′	377
St. 129	2 Nephtheidae	78° 19.360′	74° 05.546′	545
Agassiz trawl				
OF-S23	4 Nephtheidae colonies	62 49.093	66 55.944	479
OF-S25	5 Nephtheidae soft corals	62 75.232	67 08.360	383
OF-S22	1 Nephtheidae	62 51.998	66 44.871	253
St. 105	3 Nephtheidae sp., 3 *Gersemia* cf. *rubiformis*, 1 *Drifa glomerata*	75 46.255	75 48.319	332
St. TS233	3 *Duva florida*, 1 *Gersemia rubiformis*, 7 *Gersemia* cf. *fruticosa*, 1 Nephtheidae sp.	76 38.987	76 40.939	403
St. 108	2 Nephtheidae	74 35.372	74 36.945	448
Belcher Glacier	1 Nephtheidae	75 42.130	80 45.122	623
St. 323	6 *Virgularia* sp., 2 *Gersemia* cf. *fruticosa*, 4 Nephtheidae sp.	80 27.113	80 28.182	803
ROV Pond Inlet	7 Nephtheidae colonies	72 49.6426	77 36.5976	855.4
St. 301	7 Umbellula, 2 *Gersemia* sp., 6 *Virgularia* sp.	74 17.157	83 21.990	719

Deep-water corals feed on particulate organic matter, with zooplankton being also potentially part of their diet (e.g. Sherwood et al., 2008, Baillon et al., 2016). Furthermore, Nephtheidae soft corals in Antarctica are known to also deposit-feed (Slattery et al., 1997). Therefore, we also collected sediment, zooplankton, and water samples at most stations in Baffin Bay, in order to better assess their potential as food sources for these deep-water corals. Surface sediment samples of about 20 ml each were obtained from box-cores at 19 stations and were frozen at -20 °C. Zooplankton samples were obtained from the plankton team aboard. Subsamples from the Monster vertical net (mesh size 200 µm) were obtained from 9 stations, and also frozen at -20 °C. Finally, bottom water from 11 rosette stations was collected (~20L/station) and filtered aboard using a peristaltic pump (Environment and Climate Change Canada) through pre-combusted 47 mm GF-F filters, which were also frozen at -20 °C.

Table 24.2 Water samples from rosette casts.

Station	Date	Cast	Latitude (N)	Longitude (W)	Depth (m)
St. 101	24-07-2017	031	76 22.944	77 24.521	345
St. 105	25-07-2017	038	76 19.080	75 45.893	320
St. 115	26-07-2017	043	76 19.925	71 12.011	659
St. 129	27-07-2017	049	78 19.286	74 5.807	533
St. TS233	28-07-2017	052	77 46.794	76 30.332	540
St. 111	29-07-2017	058	76 18.206	73 13.438	564
Jones Sound	30-07-2017	063	76 4.994	81 56.936	761
St. 323	31-07-2017	065	74 9.658	80 27.643	777
Pond Inlet - ROV 59	01-08-2017	066	72 49.663	77 35.876	815
Navy Board Inlet - ROV 60	02-08-2017	067	73 43.544	81 5.568	320
St. 301 ~ ROV 61	03-08-2017	073	74 16.471	83 22.342	701

*Latitude and longitude are bottom coordinates. Depth is cast depth.

Table 24.3 Subsamples of zooplankton from the Monster Net (200 μ m). Coordinates and depths are from the trawl ascent

Station	Date	Latitude (N)	Longitude (W)	Depth (m)
St. 176	21-07-2017	69 36.694	65 23.601	281
St. BB2	22-07-2017	72 45.992	67 01.310	2372
St. 101	24-07-2017	76 22.852	77 23.650	355
St. 105	25-07-2017	76 19.165	77 45.686	330
St. 115	26-07-2017	76 20.072	71 10.762	658
St. TS233	28-07-2017	77 46.305	76 35.472	504
St. 111	29-07-2017	76 19.037	73 11.290	606
St. 323	31-07-2017	74 09.489	80 27.914	787
St. 301	03-08-2017	74 16.613	83 21.233	719

-80°C freezer samples

A total of 8 vials (in a small Cryobox) and 23 plastic bags with samples wrapped in aluminum foil are stored in the -80 C freezer until the end of leg 2b in Puvirnituq. These samples should be transported south in -80 conditions (i.e. in dry ice).

Table 24.4 Freezer samples

Station	Vials	Aluminum foil	Description
OF-S25	0	2	coral fragment
OF-B9	0	4	coral fragment
St. 105	0	2	coral fragment
TS233	4	5	coral samples in foil, sediment samples in vials
ROV-59	4	4	coral samples in foil, sediment samples in vials

St. 323	0	1	sediment
FOB-25	0	1	coral fragment
ROV-61	0	4	coral fragment
Total	8	23	

25 Taxonomy of Arctic Sponges – Leg 2b

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25.1 Introduction

The goal of this student project is to collect and identify sponge biodiversity, distributions, and density in the Eastern Canadian Arctic using targeted ROV sampling, box core and Agassiz trawl operations.

25.2 Methodology

Sponges were opportunistically collected in all benthic sampling stations during leg 2b. Sponges found in box cores, Agassiz trawls, and collected by the SuMO ROV were catalogued, imaged on board, and given a sample number. A portion of larger sponges, or the whole specimen for smaller individuals was preserved in 95% ethanol for preservation of DNA for molecular identifications (DNA barcoding of cytochrome oxidase subunit I molecular markers). Preservative was exchanged with fresh ethanol twice, generally within 24 hours of collection to ensure that genomic DNA would not degrade. Pieces of some larger sponges were frozen for further taxonomic work and morphology analysis.

25.3 Preliminary Results

25.3.1 *Sponge Collections in Frobisher Bay*

Benthic sampling in Frobisher Bay included box core and Agassiz trawl operations to collect invertebrates in the inner and outer bay. In total, 34 sponges were collected in the entire bay during this leg (Table 24.1, Figure 24.1). Large pieces of the Iophon sponge and the garden forming arborescent or "finger" sponge seen near Hill Island in 2015 were collected using the Agassiz trawl. A second piece of the Tetilla siberica sponge collected and photographed in situ in 2015 was also collected. Notable sponges collected include large Mycale lingua specimens with small Craniella sponges attached. These Craniella specimens were collected in the SE Baffin Shelf Trawl site in 2016 and COI DNA sequences suggest that they are not a currently known species. Several small calcareous sponges (likely Sycon sp.), and one carnivorous Cladorhiza sp. sponge were collected as well. Several sponges that were not seen in ROV video from the inner bay were also collected. Until spicules are analyzed, identifications are coarse currently, but potential Iophon picium, Polymastia uberrima and P. grimaldii were collected.

In total, 26 distinct sponge morphotypes were collected during leg 2b in Frobisher Bay (Table 24.1). Including sponges from Frobisher Bay collected in 2015 and 2016, the total number of sponge morphotypes found using all sampling methods is approximately 32 morphospecies.

25.3.2 *Sponge Collections in Baffin Bay / North Water Polynya*

Agassiz trawl operations were cancelled in multiple sites in Baffin Bay due to heavy sea ice cover. Therefore, sponge sampling opportunities in the bay relied considerably on box core operations which often occurred in muddy sediment and yielded no sponges. The Disko fan ROV site also did not result in any sponge collections due to failure of the hydraulic arms. In total, 6 sponges were collected in the entire Baffin Bay sampling area (Table 24.2). Two sponges collected are known, Tentorium semisuberites and Mycale loveni (potentially M. lingua, spicules will confirm). A small calcareous sponge similar to those collected in Frobisher Bay was collected in the North Water Polynya sampling area. A box core yielded two species that do not appear to have been collected previously.

Table 25.1 Sponges collected in Frobisher Bay during Leg 2b of the 2017 CCGS *Amundsen* cruise. Specimens were collected using a box core and an Agassiz trawl

Samples	Description	Depth	Latitude (N)	Longitude (W)
001, 031a	*Mycale lingua*	402m	62° 57. 232’	67° 08.360’
002, 004, 008, 011	*Craniella sp. nov*.	402m	62° 57.232’	67° 08.360’
003	*Polymastia sp.*	402m	62° 57. 232’	67° 08.360’
005	*Cladorhiza sp.*	402m	62° 57.232’	67° 08.360’
006, 033	*Tentorium semisuberites*	402m 377m	62° 57. 232’ 62° 34. 014’	67° 08.360’ 66° 16.942’
007	*Thenea* sp.	402m	62° 57. 232’	67° 08.360’
009	Unknown cushion shaped	402m	62° 57. 232’	67° 08.360’
010	Unknown branching erect	402m	62° 57. 232’	67° 08.360’
012	Unknown hollow yellow sponge, *Haliclona*-like	402m	62° 57. 232’	67° 08.360’
014	*Polymastia grimaldii*?	84m	63° 39. 802’	68° 25.226’
015	*Halichondria sitiens*	87m	63° 39. 852’	68° 25.246’
016	*Iophon sp. nov.*	141m	63° 38. 390’	68° 37.642’
017, 026	Finger-like sponge, possible *Haliclona sp*. Abundant in Hill island video from 2015	141m 119m	63° 38. 390’ 63° 21. 591’	68° 37.642’ 68° 10.924’
018, 030	Unknown, massive, yellow, soft.	141m 288m	63° 38. 390’ 62° 52. 088’	68° 37 642’ 66° 44 740’

019	*Thenea sp.*	141m	63° 38. 390’	68° 37 642’
020	*Tetilla sp.?*	141m	63° 38. 390’	68° 37 642’
021	*Sycon sp.*	141m	63° 38. 390’	68° 37 642’
022, 029	Unknown collagenous sponge with thin skin	141m 288m	63° 38. 390’ 62° 52. 088’	68° 37 642’ 66° 44 740’
023	Two calcareous sponges (maybe *Sycon sp*.)	119m	63° 21. 591’	68° 10 924’
024	Unknown grey ball sponge growing on worm tube	119m	63° 21. 591’	68° 10 924’
025	Sponge encrusting barnacle shell	119m	63° 21. 591’	68° 10 924’
027	*Tetilla siberica*	288m	62° 52. 088’	66° 44 740’
028	Two unknown ball sponges	288m	62° 52. 088’	66° 44 740’
031	Unknown furrowed sponge	288m	62° 52. 088’	66° 44 740’
032	*Polymastia uberrima*	377m	62° 34. 014’	66° 16 942’

Figure 25.1 Sponges collected in Frobisher Bay during 2017 Amundsen cruise

(A) Mycale lingua with Craniella sp. nov. attached (see E), (B) Cladoriza sp., (C) Thenea sp., (D) Iophon sp. nov., A new species based on spicule complement of fragments collected in 2015 (E) Craniella sp. nov. This Craniella was found in SE Baffin Shelf site in 2016 also attached to Mycale lingua and DNA suggests that it is a new species, (F) Iophon picium, (G) Polymastia grimaldii? (H) Unknown “finger sponge” – very abundant in ROV Video of Hill Island, likely Haliclona sp.

Table 25.2 Sponges collected in Baffin Bay during Leg 2b of the 2017 CCGS *Amundsen* cruise. Specimens were collected using a box core and an Agassiz trawl

Samples	Description	Depth	Latitude (N)	Longitude (W)
034	*Mycale loveni*	333m	76°19.020	75° 46.255
035	Unknown	333m	76° 19.020	75° 46.255
036	*Sycon sp*.? Same as 023	333m	76° 19.020	75° 46.255
037	Stalked sponge on rock	545m	78° 19.360	74° 05.546
038	Spikey sponge on bryozoan	545m	78° 19.360	74° 05.546
039	*Tentorium semisuberites*	400m	77° 45.385	76° 38.989

Figure 25.2 Sponges collected in Baffin Bay during 2017 Amundsen cruise

(A) Mycale loveni, (B)Unknown sponge with large oscula, (C)Small calcareous sponge, potentially Sycon sp., (D)Unknown stalked sponge, (E)Unknown spiked sponge, maybe irregular Craniella, (F)Tentorium semisuberites

25.3.3 *Sponge Collections in Pond Inlet*

The ROV dive site in Pond Inlet allowed the visualization of a diverse sponge community along sandy bottom and steep rock face environments (Figure 24.3). The sponges of the sandy portions of the transect were generally the large carnivorous sponges *Cladorhiza sp.* and *Chondrocladia sp.*, with *Chondrocladia* occurring in fairly dense aggregations. *Cladorhiza* sponge collected appeared to be feeding on *Themisto abyssorum*, which were attached to sponge even after ascent. Smaller cushion shaped sponges and bushy demosponges were also found in the sediment bottom environments. Several The bedrock walls were home to many encrusting sponges (not sampled) and several *Hexactinellid* species. Large fan-shaped *Axinellid* sponges were also found growing on the rock walls. Throughout the dive many *Mycale lingua* sponges were seen but not sampled, and upon review of the high definition video, *Stylocordyla borealis* was seen amongst the carnivorous sponges. In total, 8 separate sponge samples were collected from this dive (Table 22.3).

Table 25.3 Sponges collected in Pond Inlet during leg 2b of the 2017 CCGS *Amundsen* cruise. Specimens were collected using the SuMO ROV

Samples	Description	Depth	Latitude (N)	Longitude (W)
041 (R59-1)	*Cladorhiza sp.*	874.8m	72° 49.6689’	77° 36.5413’
042 (R59-2)	Potential *Axinella sp*	855.5m	72° 49.7344’	77° 36.4314’
043 (R59-3)	Glass sponge with protruding spicules	808.2m	72° 49.7508’	77° 36.4122’
044 (R59-3-1)	Multi-papillated demosponge attached to R59-3	808.2m	72° 49.7508’	77° 36.4122’
045 (R59-3-2)	Likely second piece of R59-3-1	808.2m	72° 49.7508’	77° 36.4122’
046 (R59-5)	Large *Hexactinellid* with wide osculum	777m	72° 49.7632’	77° 36.389’
047 (R59-6)	Small piece of bushy sponge	767.4m	72° 49.934’	77° 36.1211’
048 (R59-8)	White ball sponge	456.4m	72°.50.1634’	77° 35.7056’
049 (R59-11)	*Chondrocladia*	415.7m	72° 50.2039’	77° 35.6477’

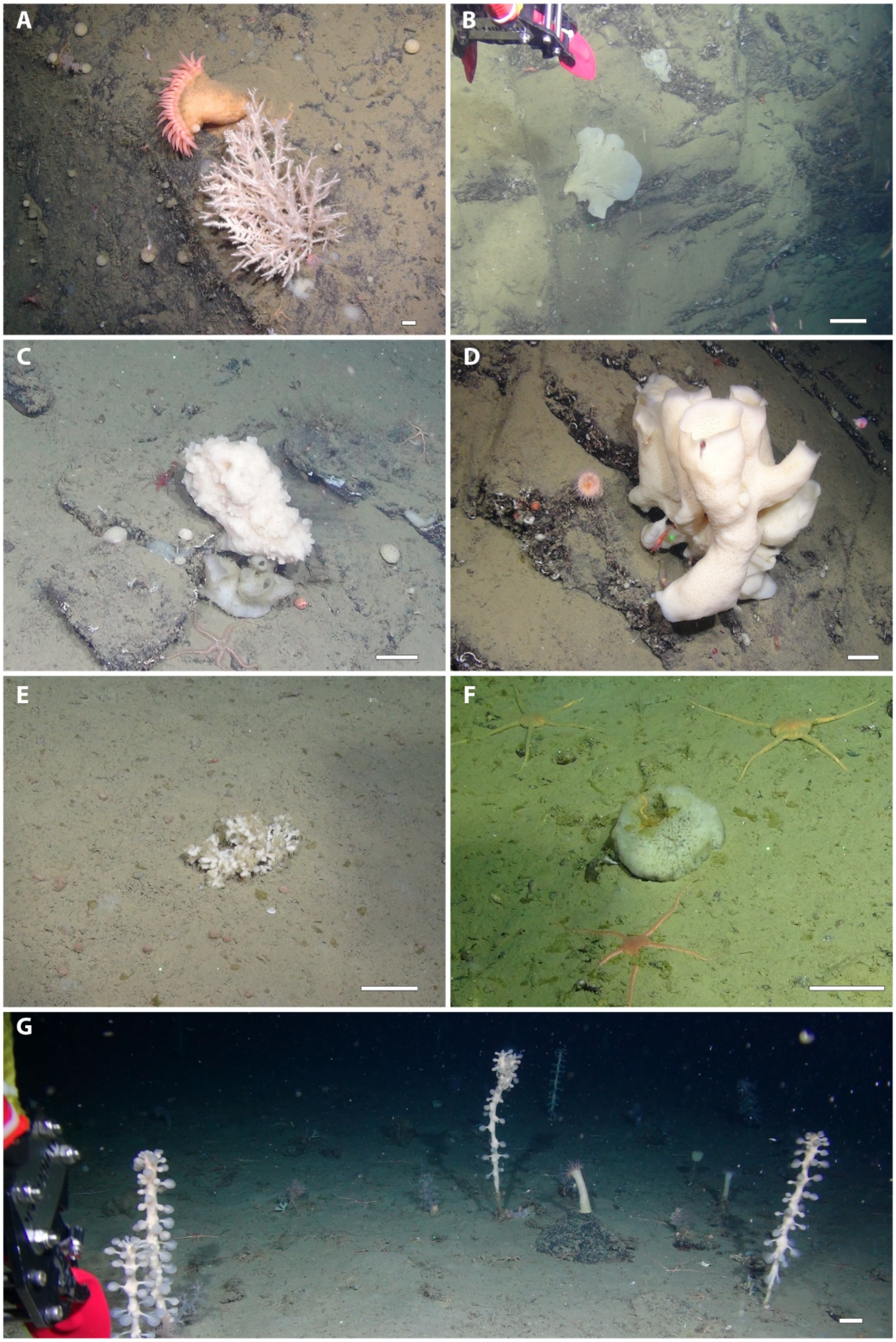

Figure 25.3 Sponges collected in Pond Inlet during 2017 Amundsen cruise.

(A)Cladorhiza sp., (B)Axinella sp., (C)Multilobate sponge with Hexactinellid underneath, (D)Unknown Hexactinellid, (E)Bush-like sponge, (F)Ball Sponge, (G)Field of Chondrocladia sp. sponge in lower left of image was collected.

25.3.4 *Sponge Collections in Lancaster Sound*

Table 25.4 Sponges collected in Lancaster Sound during leg 2b of the 2017 CCGS *Amundsen* cruise. Specimens were collected using an Agassiz trawl

Samples	Description	Depth	Latitude (N)	Longitude (W)
040	*Radiella sp.*	786m	74° 09.418'	80° 28.067'
050	*Chondrocladia sp.*	719m	74° 16.601'	83° 21.872'
051	*Chondrocladia sp.*	719m	74° 16.601'	83° 21.872'

26 Assessing Microbial Diversity in the Canadian Arctic using Molecular Tools – Leg 2b

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26.1 Introduction

Microbial communities, from all three domains of life, form the basis of marine food webs and have an important role in all biogeochemical cycles. Their distribution in the water column reflects water mass history as well as access to light and nutrients, and they are linked to the benthic community through processes such as sedimentation.

While microbial communities are highly diverse, the majority of organisms cannot be cultured, and are virtually impossible to distinguish morphologically. We must therefore use molecular tools to describe their genetic and functional diversity. High throughput sequencing, qPCR, and fluorescent in situ hybridization are all examples of such tools. Our goal for the 2017 cruise in Baffin Bay and areas of Lancaster Sound as well as the Queen Maud Gulf, was to collect samples for DNA- and RNA-based analyses, conventional and epifluorescence microscopy, and flow cytometry. These samples will be analysed in the laboratory at Université Laval.

26.2 Methodology

26.2.1 *Sampling Overview*

In 13 July–17 August, seawater was collected at all "Full" and "Basic" stations, as well as a few "Nutrient" stations when time allowed, and sampling at the location of the three ROV dives. Seawater was collected using the CTD-rosette system on board the CCGS *Amundsen*, with the option of sampling up to 8 depths per station, though in practice 5-6 depths was typical (Table 27.1). Depths were chosen for sampling based on characteristics of the water column as profiled by the downcast of the CTD. The surface and bottom of the water column and the subsurface chlorophyll maximum (SCM) were always sampled, along with other depths of interest such as the nitricline, or temperature and oxygen features indicating interleaving water masses.

Table 26.1 Number of depths sampled for each cast and station

Station	Rosette Cast	Number of Depths
A16	14	4
Bell 11	15	4
OF B14	16	5
BB1	17	8
180	19	5

Disko Fan	20	4
Float 2	21	5
176	23	5
BB3	25	8
BB2	26	5
101	32	8
105	38	6
115	44	8
129	48	5
TS233	53	5
111	57	8
108	61	7
Jones Sound	63	8
323	65	
ROV Pond Inlet	66	5
ROV NBI	67	5
301	73	5
304		

26.2.2 *DNA and RNA*

Samples for DNA and RNA were collected by filtering up to 6 litters of seawater onto a 3 µm polycarbonate filter and a 0.2 µm Sterivex cartridge (Millipore) using a peristaltic pump. This method gives us access to two distinct size fractions of the microbial community. Filters were stored in RNAlater buffer (Ambion) at -80ºC. Both DNA and RNA will be extracted upon returning to Université Laval; the first represents simple presence of the cell or gene, while the second indicates the community's capacity for protein production, sometimes conceptualized as the "active community" since it excludes cysts and dormant cells.

Because RNA in particular degrades at ambient temperature, filtering was stopped after a maximum of three hours, meaning that sometimes less than 6 litters was filtered. Sometimes, the filtration was quite slow - probably due to dense microorganisms in the different water masses. Sometimes, two polycarbonate filters (3 µm) were used during the filtration.

At a few stations, additional samples were collected for metagenomic work from the surface and SCM depth. The method of filtration for these samples was the same as for DNA and RNA.

26.2.3 *Epifluorescence Microscopy*

Slides were made for epifluorescence microscopy at each station and depth sampled. These slides will be used to estimate abundance of eukaryote cells. Seawater was fixed with 2.5 % glutaraldehyde and processed within 6 hours of sampling. Fifty ml of fixed sample was filtered through a 0.8 µm black polycarbonate filter and stained with DAPI, a nucleic acid stain. This filter was mounted on slide using a drop of immersion oil and stored in darkness at -20ºC.

26.2.4 *Flow Cytometry (FCM)*

FCM is more accurate than microscopy to count cells in the “pico” size range (0.2–2 µm), and can include some functional information such as prokaryote versus eukaryote cells and the presence of photosynthetic pigments. FCM samples were taken from each station and depth, and fixed with 0.5% glutaraldehyde in duplicate for “dead” samples, or preserved in glycerol-TE buffer in triplicate for “live” samples. After a short incubation at ambient temperature in the fixative or buffer, samples were flash frozen in liquid nitrogen and stored at -80°C. At stations where metagenomic samples were collected, additional “live” samples were prepared.

26.2.5 *Fluorescent in situ Hybridization (FISH)*

FISH is a technique that uses fluorescent-labelled nucleic acid probes to identify a specific phylogenetic group of organisms under the microscope. Samples for FISH were collected in duplicate for eukaryotes and bacteria at each station and depth sampled. Seawater was fixed with 3.7% formaldehyde and processed within 24 hours of sampling. For eukaryotic organisms, 100 ml of fixed sample was filtered onto a 0.8 µm polycarbonate filter. For bacteria, 50 ml was filtered onto a 0.2 µm polycarbonate filter. Filters were stored at -80 ºC.

26.2.6 *Conventional Ligth Microscopy*

At each station, for the surface water sample and SCM (where present), 225 ml of seawater was collected and fixed using FNU fixative (1% paraformaldehyde, 0.1% glutaraldehyde). At Université Laval, these samples will be allowed to sediment in Utermöhl chambers and larger organisms, such as diatoms and dinoflagellates, will be identified to the highest possible taxonomic resolution on an inverted microscope.

26.3 Preliminary Results

With the samples we have collected for molecular and microscopic analyses, we hope to arrive at a more detailed understanding of the phylogeny, structure, and function of microbial communities in the Canadian Arctic.

Acknowledgement

We thank Chief Scientist Jean-Éric Tremblay for a well-organized cruise, Captain Claude LaFrance and the crew of CCGS *Amundsen* for their professionalism and dedicated support of our research. We had good weather and all sampling went well—we even sampled at more stations than planned for. The lab space allocated allowed good working conditions. We thank

the rosette team for good for their preparedness and their hard work, as well as the good atmosphere.

27 Seabed Mapping – Legs 2a, 2b and 4b

Project leader: Patrick Lajeunesse[1] (papakyri@cc.umanitoba.ca)
Cruise participant Leg 2: Annie-Pier Trottier[1] and John Patrick McNeil[2]
Cruise participant Leg 4b: Gabriel Joyal[1] and Jean-François Bernier[1]
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27.1 Introduction

The *Marine Geosciences Lab.* (MGL – Université Laval) was onboard the Amundsen for legs 2 and 4b of the 2017 Expedition and responsible for multibeam and sub-bottom data acquisition. The MGL has been mainly involved in mapping the seabed morphology and in acquiring sub-bottom stratigraphy during transits, choosing appropriate coring sites, assisting mooring deployment and recovery as well as deploying the Moving Vessel Profiler (MVP). This cruise report presents the instruments, methods, preliminary results and encountered problems for the 2017 Expedition.

27.2 Methodology

27.2.1 *Kongsberg EM302 Multibeam Sonar*

The Amundsen is equipped with an EM302 multibeam sonar operated with the *Seafloor Information System* (SIS). Attitude is given by an *Applanix POS-MV* receiving RTCM corrections from a *CNAV 3050* GPS receiver. Position accuracies were approximatively < 0.8m in planimetry and < 1m in altimetry. Beam forming at the transducer head is done by using an *AML* probe. CTD-Rosette casts, when available, were used for sound speed corrections. During long periods without CTD casts, the WOA09 model was used.

27.2.2 *Knudsen 3260 CHIRP Sub-bottom Profiler*

Since May 2016, a new Knudsen 3260 deck unit has been installed onboard the Amundsen. It was acquired to replace the old 320-BR system that shown signs of high degradation at the end of the 2015 field season. The new system now operates using a USB connector instead of a SCSII communication port. We also installed a new operating computer (HP EliteDesk). Sub-bottom profiles were acquired all along transits at a frequency of 3.5 kHz to image sub-bottom stratigraphy of the seafloor.

27.2.3 *Moving Vessel Profiler (MVP) 300*

During Leg 2, 1 MVP transect was performed using a Moving Vessel Profiler (MVP 300) towed behind the ship at 6-11 kts. The MVP measures temperature, salinity, transmissivity, dissolved O_2, fluorescence and sound velocity. Mainly, our team uses MVP data to correct for sound velocity during transit mapping, but these transects were also used to visualize water column properties for physical and biological purposes.

27.3 Preliminary results

All the data acquired during the cruise were post-processed in real-time using the *CARIS HIPS&SIPS 9.0* software. This post-processing phase is essential to rapidly detect any anomaly in the data collection. The final addition of the 2017 data will be done upon the return of the ship in Quebec city.

27.3.1 *Transit Mapping*

The mapping of the Arctic seabed is an important objective of the ArcticNet program. Transits routes were surveyed systematically in order to increase the multibeam dataset. These data will be shared with the Canadian Hydrographic Service (CHS) to update marine charts and might be useful for future work within the ArcticNet program (Figure 26.1). Overall, the multibeam worked well and generated new data in previously poorly charted areas.

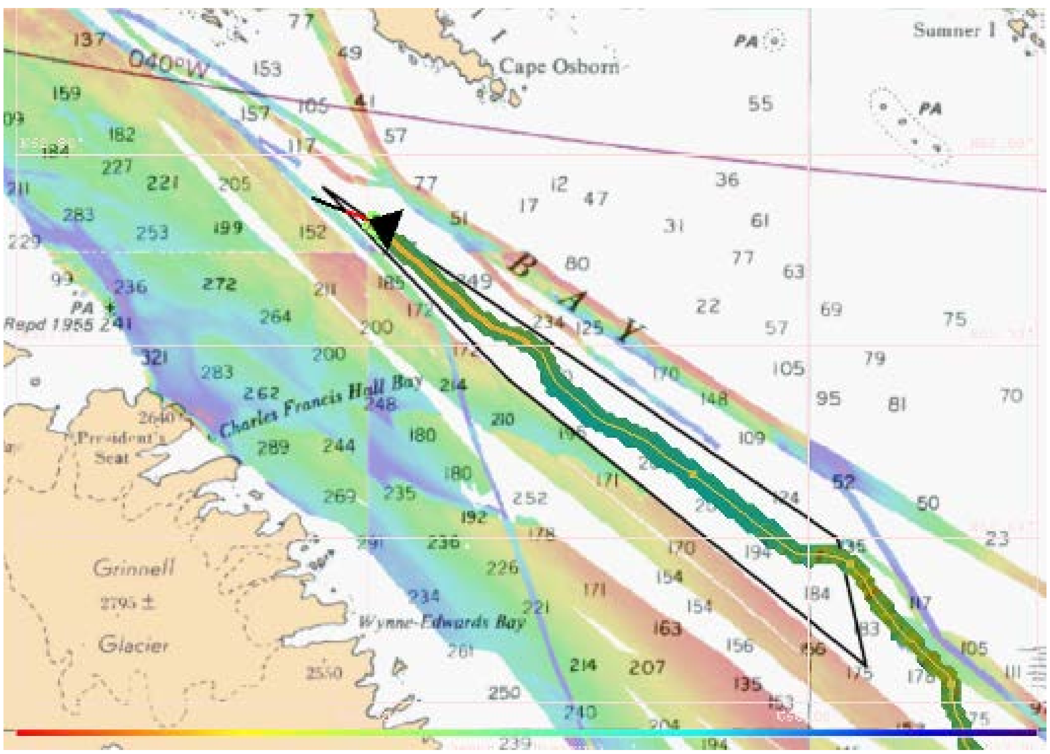

Figure 27.1Example of opportunistic mapping in Frobisher Bay

In 2016, our team has been developing a bathymetry database to easily access all the bathymetry data acquired since the beginning of the ArcticNet program. This ArcMap based database is a raster catalog of more than 3500 data grids (15’x30’ spatial extent) that can be rapidly added to navigation charts in order to improve the multibeam coverage of the Arctic (Figure 19.2). In 2017, the subbottom profiles acquired since 2003 were added to this database, making it easier to choose alternative coring sites during the cruise depending on ice conditions.

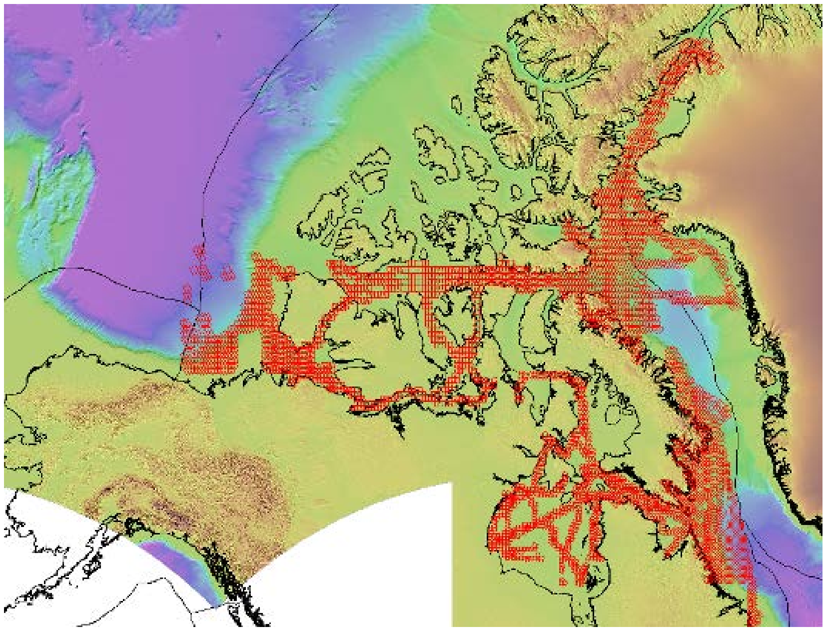

Figure 27.2 Image of the Amundsen Bathy-CHIRP Database for bathymetric and sub-bottom data collection.

Due to problems with the POS-MV, we were not able to collect as much multibeam data as we expected to, but the Knudsen sub-bottom profiler worked from Kuujuuaq to Belle-Isle Strait.

27.3.2 *Dedicated Mapping Surveys*

Table 26.1 presents dedicated mapping surveys information undertaken during Leg 2B. Some examples of bathymetric surfaces are presented at Figure 26.3 and Figure 26.4.

Table 27.1 Description of the dedicated mapping operations undertaken during Leg 2.

Location	Start Date/Time	End Date/Time	Total time (hr)	Area (km^2)	Description
Frobisher Bay	2017-07-14 01:34	2017-07-14 04:50	3,26	39	Memorial University (Endinger & al)
Manson Bay	2017-07-30 06:00	2017-07-30 10:00	4	28	Université Laval (Lajeunesse & al)
Jones Sound ROV stn	2017-07-30 13:44	2017-07-30 14:56	1,2	54	Mapping ROV dive site / Memorial University (Endinger & al)
Pond Inlet	2017-07-31 19:45	2017-07-31 20:30	0,75	36	Memorial University (Endinger & al)
Lancaster Sound ROV stn	2017-08-03 07:18	2017-08-03 08:15	1	55	Mapping ROV dive site / Memorial University (Endinger & al)

Total	10,21	212	

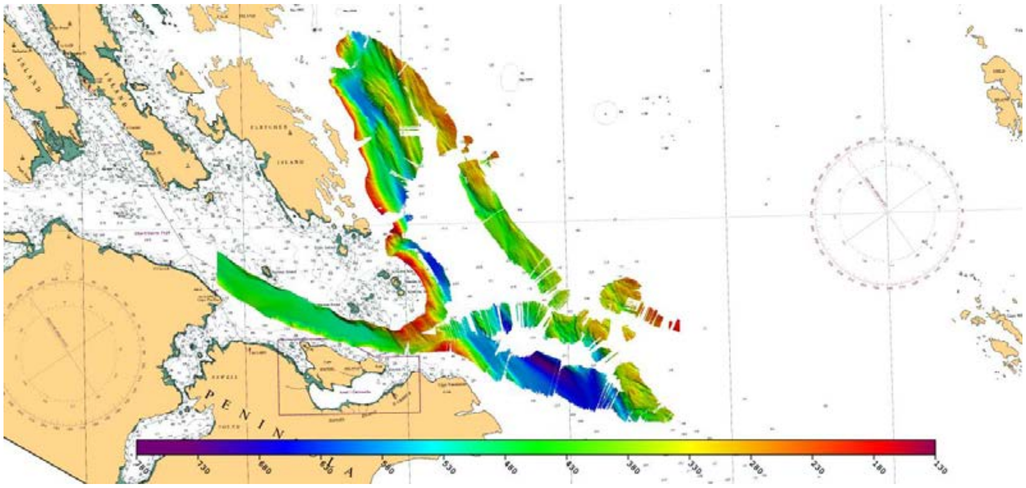

Figure 27.3 Bathymetric coverage of the dedicated mapping in Frobisher Bay

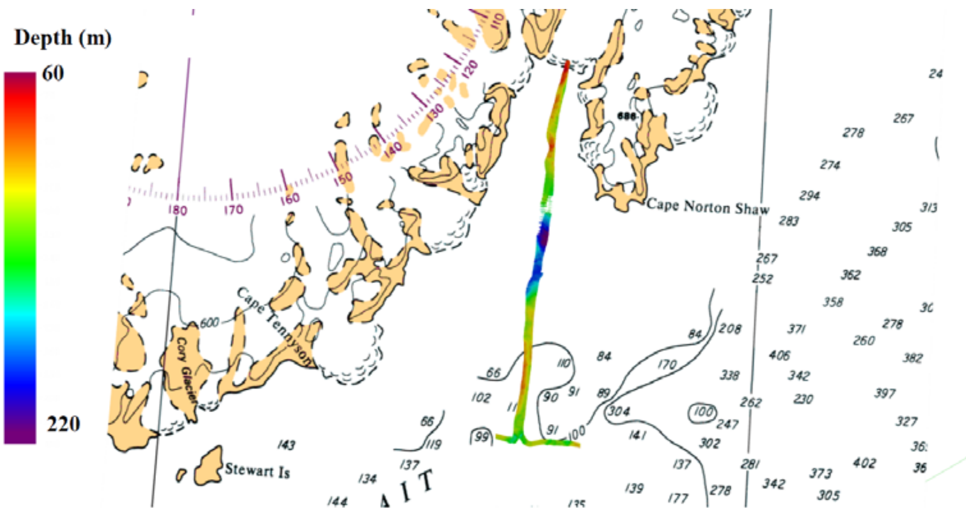

Figure 27.4 Bathymetric coverage of the dedicated mapping in Manson Bay

27.3.3 *MVP transects*

During Leg 2B, 1 MVP transect was performed. The transect was performed as part of the ArcticNet program. Table 19.2 describes the MVP transect performed during Leg 2 and Figure 19.5 shows the preliminary data.

Table 27.2 Description of the MVP transects

MVP transect	Location	Speed (kts)	Nb. of casts
1702001	Carry Island - Greenland	8-9	18

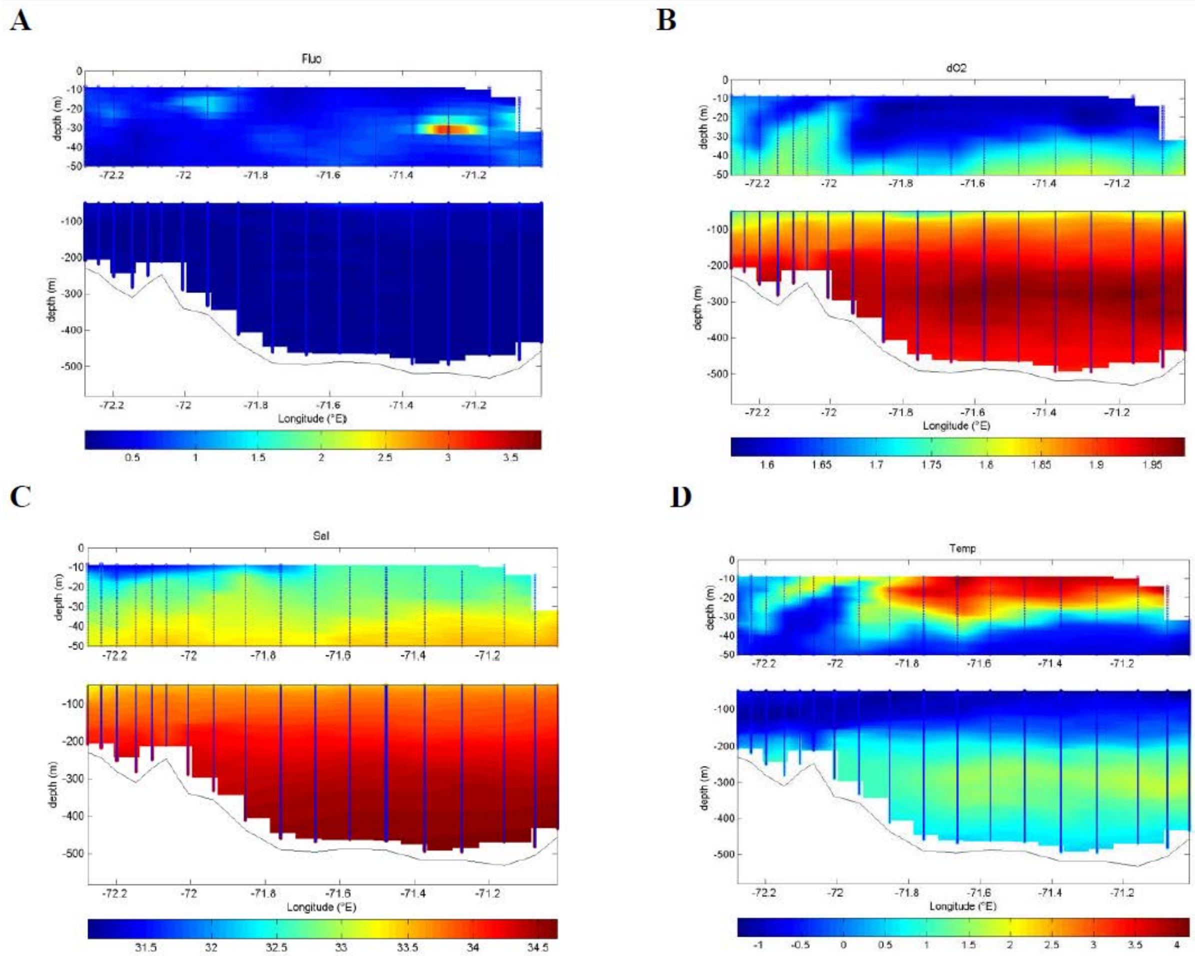

Figure 27.5 Premilinary results of the MVP transect performed during leg 2B

A)Fluorescence; B) Dissolve oxygene; C) Salinity; D) Temperature.

27.3.4 *Mooring Deployment*

The role of the mapping team during mooring deployment was to:

1) Ensure the mooring was still in its position (identify the buoys and the exact position);
2) Validate the depths of the deployment sites;
3) Map the surface morphology of the sites;
4) Determine the verticality of the moorings after deployment (Figure 26.6).

A multibeam survey over the mooring after deployment was systematically performed. The lines were processed in CARIS HIPS&SIPS right after to find the exact position of the mooring. The procedure started with the visualization of the water column data to find the buoys. The buoys scattering was added to bathymetry to find the final position of the deployment.

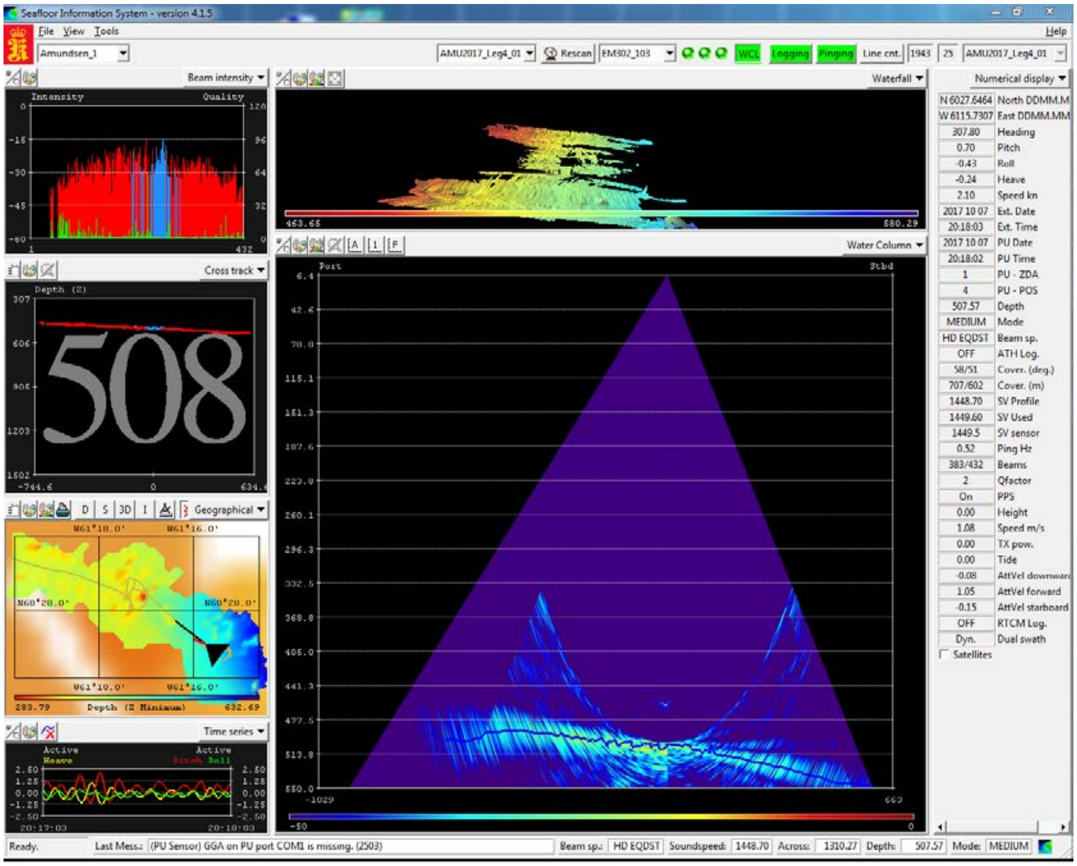

Figure 27.6 SIS water Column display of Mooring site HiBioA-17 after deployment. The yellow circle shows the top buoy

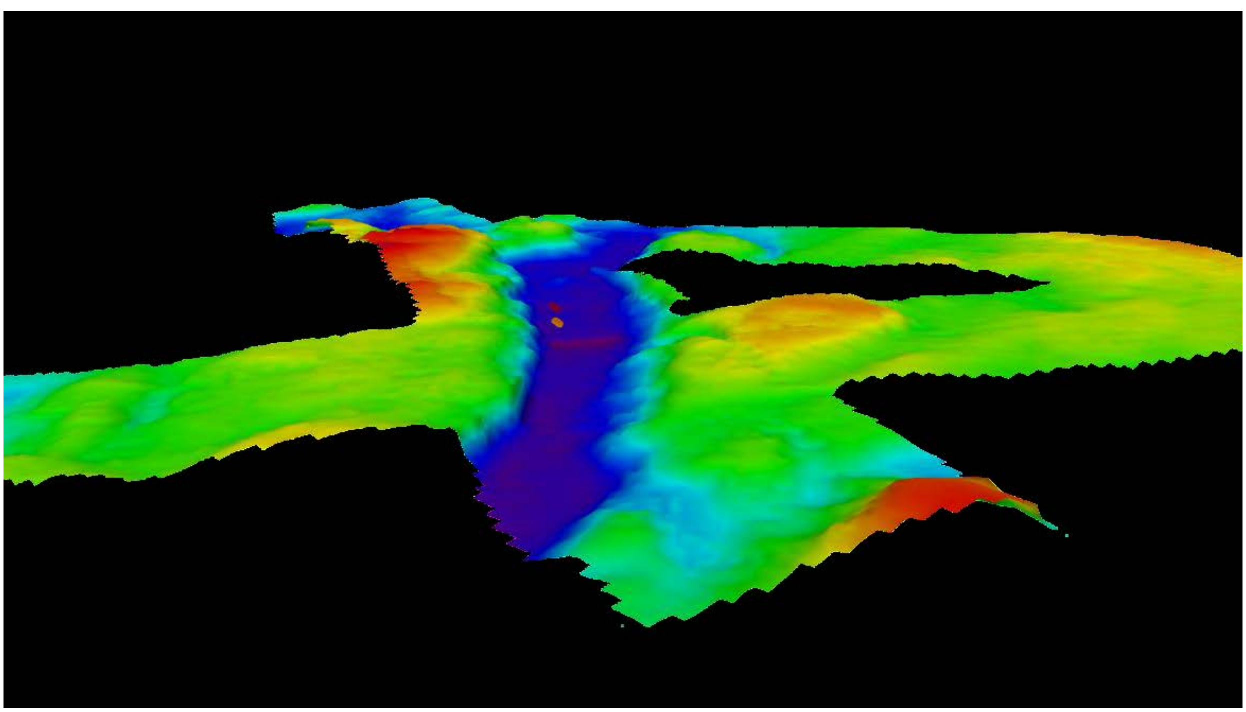

Figure 27.7 3D image of the high-resolution bathymetry of the sea floor and the buoys of mooring WF1 acquired before the recovery of the mooring

27.3.5 *Sediment Cores*

During Leg 2b, many box, gravity and piston cores were sampled. Coring sites were chosen in reel time while doing seismic survey, or by analysing subbottom profiles of previous years. Details of the cores, their location and length of recovery, as well as the targeted type of sediment/feature are presented in the coring team repport.

Figures were produce by the mapping team for every coring sites to indicate the target on the acoustic subbottom profile.

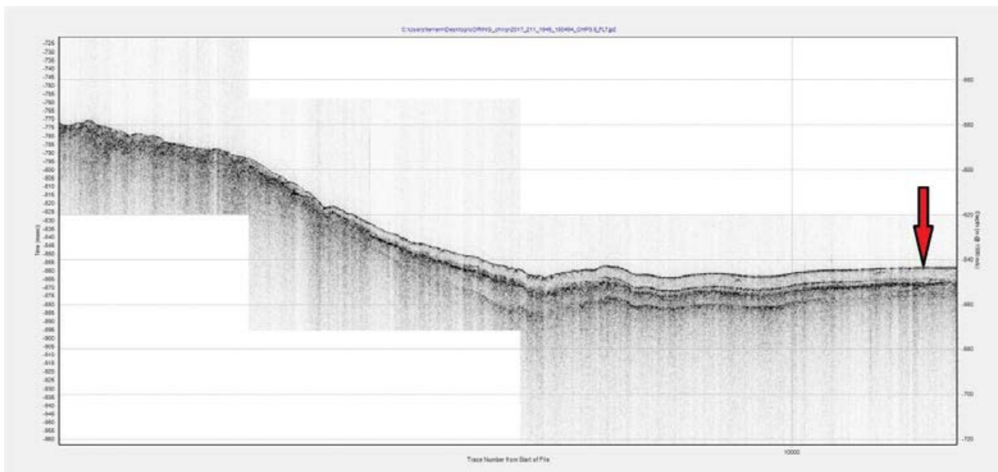

Figure 27.8 Location of the piston core site of Belcher glacier on the acoustic subbottom profile

27.4 Comments and Recommendations

- Given the performance of the MVP, this instrument could be deployed more often to acquire underway data for oceanographic studies, but as well as to get proper sound velocity correction for the multibeam sonar.
- Box core deployment at stations should be discussed more with the mapping team to avoid potential damages to the box core or other benthic trawls.
- Note that the multibeam process unit located in the scientific locker should not be change of UPS. We found out with the electrician and ArticNet tech that this caused many problems during the cruise, leading to high instability of the multibeam and repeat crash down.
- Since the beginning of Leg 4b, we encountered multiple problems with the multibeam sonar. We first thought the problem was due to a low power input to the processing unit, so changes have been made in the UPS power supply. However, the problem persists. A deeper look into the problem led us to think the Applanix POSMV motion sensor might have something to do with the pinging issues. We discovered that the motion sensor have been sending ‘bad frames’ to the system.
  We are currently in communication with the Applanix technical support and might have to send the unit to an Applanix facility for maintenance. This will have to be done quickly upon arrival in Quebec city to make sure the unit is ready before the November dry dock. We will have to reinstall the unit once the ship is in dry dock in order to re-measure the angular offsets and lever arms.

- A BIST (built-in self test) has also been performed on the multibeam sonar. Acocrding to the Kongsberg technical support, the internal components of the processing units are in general good shape, except some electronic boards that show low power voltage. It has been suggested to remove all the electronic boards and dry clean them. This will be done during demobilization in Quebec.

Acknowledgement

The mapping team acknowledge the crew of the CCGS *Amundsen* for their help and professionalism during the mission

28 Integrated Marine Geoscience for Environmental Impact Assessment and Sustainable Development in Frobisher Bay – Leg 2b

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28.1 Introduction

Coastal regions of the Canadian Arctic face increasing pressures from climate change, resource exploitation, and infrastructure development. These pressures come together in a crucial region of the Eastern Arctic (IRIS region 2) in Frobisher Bay. Adjacent to the rapidly growing City of Iqaluit, the bay faces potential impacts from expanding commercial and subsistence fisheries, expanded terrestrial mining, increasing marine traffic, and infrastructure development for both the city and the proposed new port at Iqaluit.

As a large macrotidal embayment, Frobisher Bay presents interesting new opportunities and challenges, including the possibility of in-stream hydro-electric power generation, and localized rapid sediment transport and coastal erosion associated with sea-level rise and a macrotidal setting. Infrastructure requirements for the City of Iqaluit, for the government of Nunavut, and for the proposed deep-water port facilities near Inuit Head in the Port of Iqaluit place additional possible stressors on Frobisher Bay, from eutrophication, sedimentation, potential oil spills, and potential introduction of marine invasive species through ballast water. Plastic contamination from terrestrial activities in Iqaluit, marine activities in Frobisher Bay, and from wind-blown debris from the Iqaluit dump or the 2015 dump fire may affect benthic environments of Frobisher Bay. These various stressors may interact with the seabed habitats of the bay both geologically and ecologically. Natural seabed geo-hazards in the bay may affect infrastructure development, which in turn have the potential to trigger submarine slope failure and sediment mass transport events (Hatcher & Forbes 2015).

Frobisher Bay is divided into inner and outer portions by the mid-bay islands. The inner bay is shallower, and more extremely macrotidal, and much more prone to geological hazards, with an extensive record of submarine slope failure. Furthermore, the inner bay has been the subject of ecological studies in the 1960's and 1970's and re-sampling these areas, and determining the spatial distribution of the habitats they represent will help determine the nature of long-term temporal change in these Arctic benthic communities. Finally, the inner bay is much more exposed to anthropogenic contamination with plastics and chemicals, including both floating plastics, higher density plastics in the seabed, and melted plastics from the Iqaluit dump fire. Chemical contaminants likely include hydrocarbons from shipping, organic pollutants from terrestrial runoff, sewage, and from the Iqaluit dump fire.

28.1.1 *Marine Geohazards*

Inner Frobisher Bay is an area in which marine geohazards and future infrastructure projects intersect. From extensive multibeam echosounding surveys carried out in the area aboard CCGS *Amundsen* and MV *Nuliajuk* over the past three years a particular type of marine geohazard, submarine slope failures, have been found in abundance. More than 250 of these submarine slope failure features have been found in the inner bay; they represent a potential challenge to future seabed development in the region. The aim of the geohazards component of this project is to better understand why these events occur, where they occur, and how they are triggered, in support of future infrastructure development in the area. Piston cores are crucial for determining the age of these submarine slope failure events. Furthmore, piston cores through submarine slope failures (as collected in 2015 and 2016) are best understood when compared with cores through undisturbed sediments (witness cores), which document the undisturbed background deglacial stratigraphy of the region,

Building off of cores collected from a slope failure complex off of Hill Island over the past two years, five piston cores were planned for collection aboard CCGS *Amundsen* with the priority being to characterize an undisturbed stratigraphic record for inner Frobisher Bay, and for the portions of the outer Bay close to the mid-bay islands. The trigger-weight-corer was deployed at all sites. Two of the piston coring sites in inner Frobisher Bay (Bell 11, Bell 12) were accompanied by a box core in order to ensure that the near surface seabed sediments that may be blown aside by the piston core were also collected for analysis.

28.1.2 *Marine Habitats, Marine Biodiversity and Temporal Change*

Box core and Agassiz trawl sampling in Frobisher Bay in 2017 support our efforts to map marine habitats throughout the bay, and to assess long-term temporal change in the bay. Fisheries Research Board of Canada scientists sampled benthic biota in the inner bay in the 1960's and 1970's (Wacasey et al. 1979, 1980, Cusson et al. 2007). Re-sampling of these historical sites, in the context of a wider habitat mapping program, will allow us to assess both spatial variation and temporal change in benthic species composition. We rely on the extensive multibeam sonar datasets in both the inner and outer bay, coupled with direct bottom sampling using box-cores and Agassiz trawls from CCGS *Amundsen*, and grab samples and drop-video samples from MV *Nuliajuk*, to ground-truth the multibeam. Initial sampling from *Amundsen* and *Nuliajuk* in 2015 and 2016 identified submerged moraines and other features in the inner bay that appear to host distinct habitat types from the muddier bottoms found in basins. Sampling from *Amundsen* in 2017 aimed to re-sample the historical sites, and to sample deeper water sites in the outer bay that are beyond the depth range reachable from the *Nuliajuk*. The sites in the outer bay were chosen to sample across gradients of depth and slope, as determined from the *Amundsen* multibeam bathymetry data. These are coupled with four CTD and rosette casts to characterize carbonate chemistry, dissolved CO_2, and dissolved methane (in conjuction with Dr. Kumiko Azetsu-Scott, Bedford Institute of Oceanography). In addition We carried out full biological characterization of the sponge gardens near Hill Island, in the Inner Bay, at the Basic Station A16.

28.1.3 *Scientific Objectives of the Project relating to 2017 Field Work*

The general scientific objectives of the Frobisher Bay project are:

1) To create a benthic habitat map for all of Frobisher Bay using multibeam sonar and sub-bottom profiling, ground-truthed with direct benthic sampling.
2) To assess inter-annual variation and long-term ecological change in inner Frobisher Bay benthic communities by re-sampling stations initially sampled by the Fisheries Research Board of Canada in the late 1960's and early1970's (Wacasey et al. 1979, 1980, Cusson et al. 2007), and resampled in 2016.
3) To describe deglacial stratigraphy of inner Frobisher Bay and the region around the mid-bay islands, in order to understand the stratigraphic context for abundant submarine landslides within the inner bay.
4) To apply the maps of hazards and sensitive habitats toward infrastructure development in the Frobisher Bay region.

The sampling objectives for the 2017 voyage aboard the *Amundsen* were:

1) To map the remainder of a deep hole in the NW portion of the outer bay that is too deep to be mapped using the less powerful sonar aboard MV Nuliajuk;
2) To re-sample two of the historical sites near Cairn Island, in the inner bay for long-term ecological change;
3) To sample areas of varying depth and slope in the outer bay for bottom type and faunal composition;
4) To collect piston cores and box cores from witness core sites within inner Frobisher Bay, and from deglacial sedimentary sites in the portion of outer Frobisher Bay close to the mid-bay islands.

28.2 Methodology

Methods employed during the Frobisher Bay portion of Leg 2b included seabed mapping with multibeam sonar and 3.5 kHz acoustic sub-bottom profiling, piston coring of targets chosen using past multibeam and sub-bottom profiles, box coring, and Agassiz trawling. Unlike the 2015 field season, no ROV dives were planned for Frobisher Bay in 2017. While we had intended to sample the outer Frobisher Bay deep water habitats with a drop video camera, we were unable to secure a camera in time for the cruise, hence we used a combination of box cores and Agassiz trawls to sample outer bay habitats. Figure 27.1 and Figure 27.2 show the locations of all box cores, Agassiz trawls, Piston cores, and multibeam data collected in inner and outer Frobisher Bay.

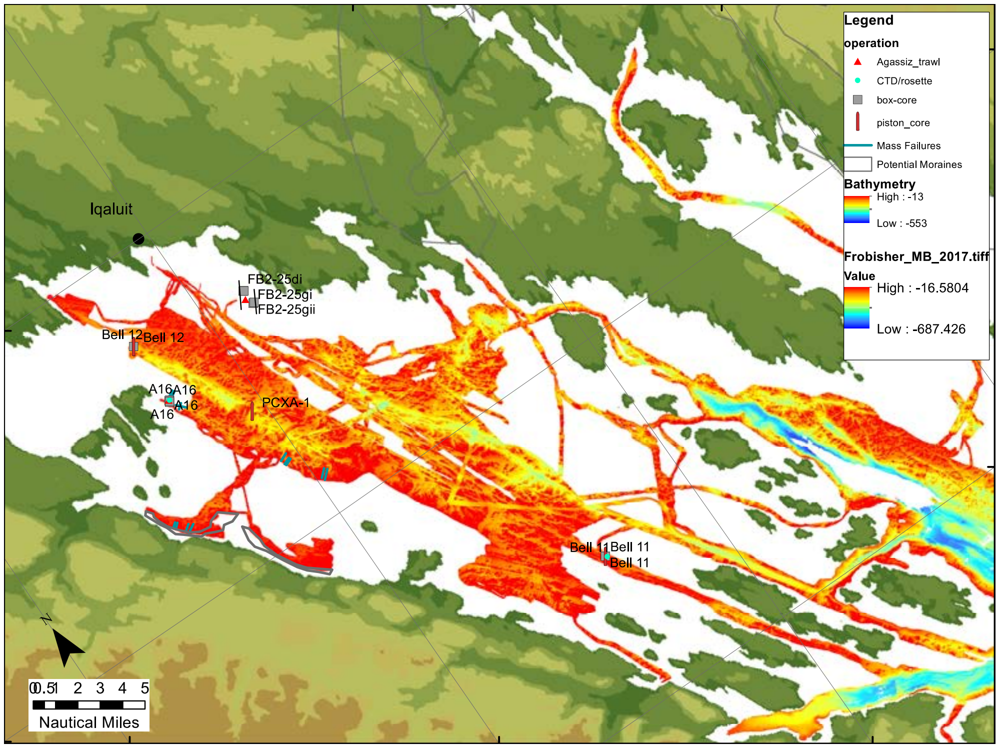

Figure 28.1 Sampling locations at inner Frobisher Bay onboard the NGCC Amundsen, July 14-16, 2017

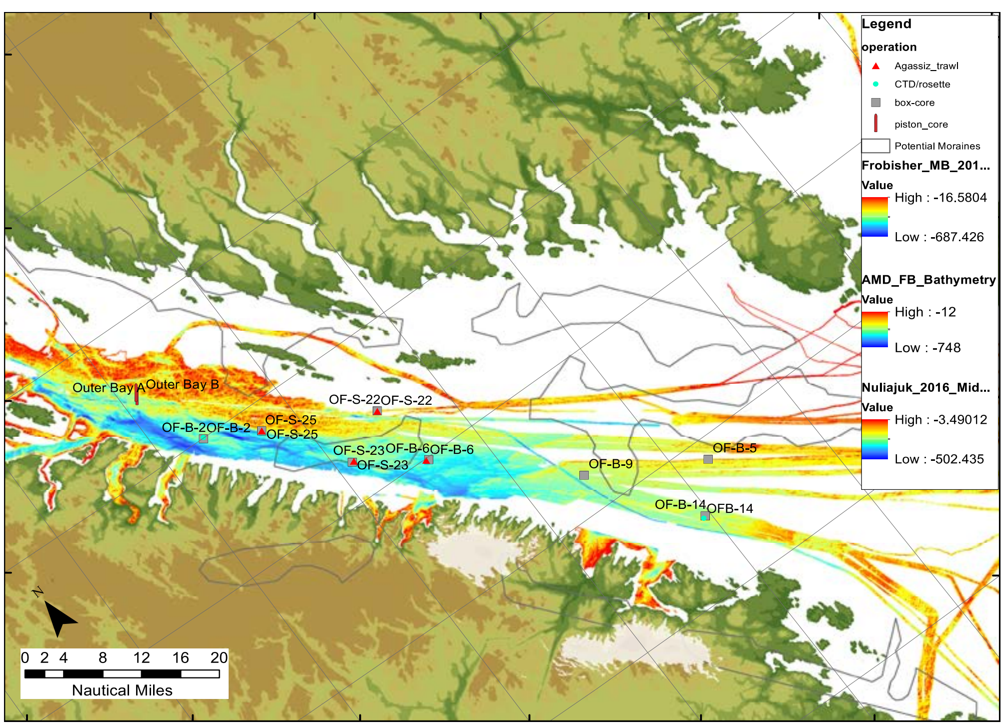

Figure 28.2 Sampling locations at Outer Frobisher Bay onboard the NGCC Amundsen, July 14-16, 2017

28.2.1 *CTD and Plankton Nets CTD Casts, or CTD and Rosette Casts.*

CTD and rosette casts were gathered in four locations forming a transect from the head of the bay to the centre of the outer bay, for characterising water temperature, salinity, density, and clarity. In addition, water samples from surface to bottom were collected to analyze for total alkalinity and dissolved inorganic carbon, dissolved carbon dioxide, and dissolved methane, allowing for calculations of calcium carbonate saturation profiles and methane concentrations (cf. Azetsu-Scott et al. 2010, Punshon et al. 2014; table 4). Samples were poisoned with $HgCl_2$ solution, and are stored in glass bottles within padded boxes in the aft refrigerated container. Samples will be analyzed at the Bedford Institute of Oceanography.

Tucker trawl and Monster Trawl plankton tows were completed at station A16, in inner Frobisher bay, following standard protocols.

28.2.2 *Box Cores*

Twenty box cores were collected and processed in Frobisher Bay. Twelve box cores in inner Frobisher Bay included triplicate box cores at 2 long-term ecology sites first sampled by Wacasey et al. (1979, 1980), four box cores at the Hill Island sponge gardens site, and two box cores associated with piston coring sites Bell 11 and Bell 12. The four box cores collected at the site of the 2015 Hill Island ROV dive were divided into two cores in sponge garden patches identified from ROV video, and two cores in bare patches without sediments. These 4 box cores were used to run incubations measuring oxygen consumption in sediments by infauna and sedimentary microflora (C. Grant, for M. Pierrejean, HiBio project). In outer Frobisher Bay a total of 8 box cores were collected to sample bottom types and faunas across gradients of depth and slope, based on multibeam bathymetry. A 3.5 kHz sub-bottom profile was recorded at the outer bay box-coring sites for which there was not too much ice to preclude data collection, and archived in .jpg and .jp2 format.

28.2.3 *Agassiz Trawls*

The Agassiz trawl aboard Amundsen was only deployed six times, once in the inner Bay at long-term ecology station FB2-2-5d, once near the Hill Island sponge gardens site, and at four of the 8 stations sampled in the outer bay. Ice cover in the remaining stations in the outer bay was too high for deployment for the Agassiz trawl.

28.2.4 *Piston Cores*

Piston cores for this leg were collected by the AGC Large piston corer, off of the foredeck, led by Dr. Anna Pienkowski (MacEwan University) and Dr. Jean-Carlos Montero Serrano (Université de Québec à Rimouski, UQAR). This system is equipped with a 9 cm diameter polycarbonate liner that is extracted from the piston corer and cut into 1.5 m sections for storage and transportation. Prior to refrigeration, these sections are capped and sealed with electrical tape to ensure that moisture is maintained within the sections. Samples from box cores were collected by pushing the same plastic core liner as is used in piston coring into the sediments to extract an intact stratigraphic sequence. These push cores were then treated with the same methods as piston cores following extraction. A 3.5 kHz sub-bottom profile was recorded at each piston coring site, and archived as .jpg and .jp2 files.

28.3 Preliminary Results

28.3.1 *Multibeam Sonar Acquisition*

Amundsen acquired multibeam sonar data during a 3-hour dedicated survey in the NW portion of outer Frobisher Bay, in waters that were too deep to be reached by the Nunavut FRV Nunavut (approximate bounding Coordinates: 63.261/-67.727; 63.185/-67.517; 63.184/-67.686; 63.252/-67.772). A narrow corridor of intermediate depth water at the north end of this polygon remains unsurveyed, but can probably be filled by the FRV Nuliajuk. The gap in multibeam coverage along the deep but uncharted SW margin of the outer bay remains unfilled.

28.3.2 *Box Coring and Agassiz Trawls*

Sediment samples from each box cores were frozen at -20°C for later processing. Fauna were picked from 0.5 mm sieved sediment at long-term ecology sites and the Hill Island sponge gardens, and were fixed in 4% formalin. Fauna from remaining sites was sieved at 1.0 mm, then transferred to 4% formalin.

Lithoclasts and carbonate bioclasts from outer bay sites were frozen for later analysis, and bryozoans were packaged dry for transport back to Memorial. Sediments and fauna from outer bay sites appeared to vary according to slope, as expected, with coarser sediments and more epifauna found at sites with higher slopes, as derived from the Amundsen multibeam bathymetry. Amundsen multibeam backscatter is not reliable enough to use as a descriptor of bottom type.

Lithoclasts at site B5, the site furthest to the northeast within outer Frobisher Bay, contained abundant carbonates, showing dramatic evidence of macroscopic bioerosion (i.e. by pholad bivalves or echinoids), and corrosion (Figure 27.4).

The sampling sites for 2017 sampling in the outer bay were selected along gradients of depth and slope, but also corresponded to some degree with potential moraine areas mapped by Canada-Nunavut Geoscience Office, based on extrapolations from moraines described above the water line (Figure 27.2). Coarse sediments occurred on shallower bottoms on high slope (e.g. OF-S-22, Figure 27.3), and also in deeper areas mapped as moraines (e.g. OF-S-23). The occurrence of extensive carbonate lithoclasts in sample OF-B-5 (Figure 27.4) is intriguing, given the abundant carbonates found in glacial deposits along the NE margin of Frobisher Bay, and the possible outcropping of Paleozoic carbonates within the outer portions of outer Frobisher Bay (Miller 1980, Mate et al. 2014). Also interesting, the apparently exposed bedrock in the central portion of outer Frobisher Bay interpreted from multibeam bathymetry (Mate et al. 2014, Todd et al. 2016) is apparently covered by a veneer of glacially-deposited coarse sediments and/or post-glacial muds, since all lithic assemblages collected were polymict, ranging from highly angular to well-rounded. It is not uncommon for the morphology of exposed bedrock on the seafloor to be evident in multibeam, but to be covered by a veneer of post-glacial sediment, which would be recovered by grab sampler. Better acoustic backscatter data (e.g. as available from FRV Nuliajuk) may help to resolve this uncertainty.

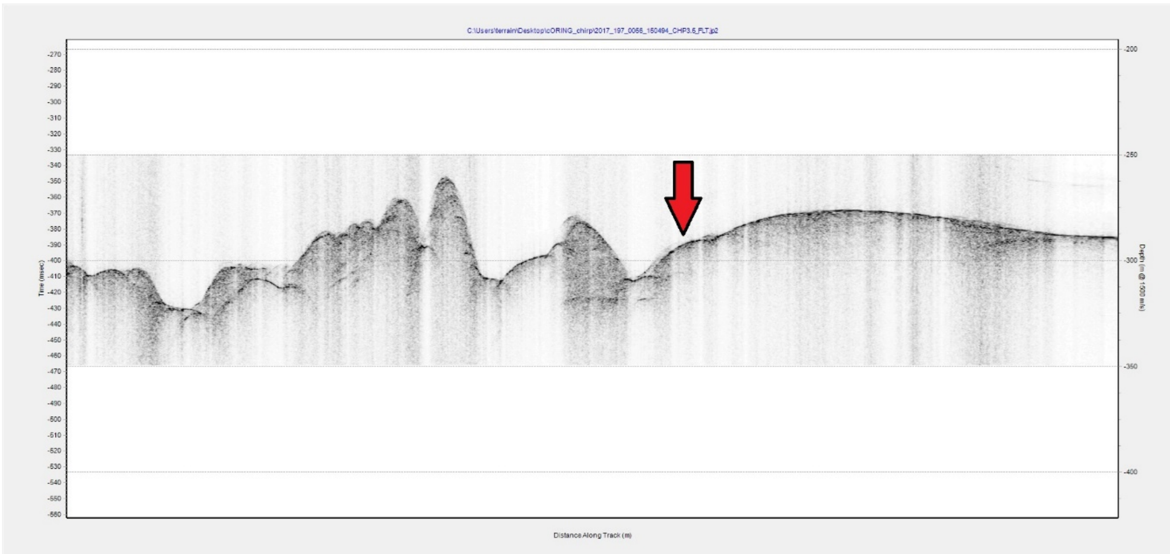

Figure 28.3 Sub-bottom profile at outer bay station OF-S-22, north side of outer bay, close to islands. Sub-bottom profile indicates moderately sloping hard bottom. Bottom type recovered was gravelly sand, with fauna dominated by Macoma calcarea, abundant ophiuroids, two types of crinoids, and Gorgonocephalus arcticus.

Figure 28.4 Lithoclasts and bioclasts from Outer Frobisher Bay box core OF-B-5. Box Core recovery (A). Note abundant polymict granules and pebbles (B), carbonate lithoclasts (C), and thick erect bryozoans (D)

28.3.3 *Piston Coring*

Five piston cores were collected in Frobisher Bay. All cores collected in 2017 could be considered witness cores, describing the deglacial chronology of the inner bay and the outer bay, thus to better understand the stratigraphic context for the submarine landslides extensively cored and dated in 2016. A list of piston cores can be found in Table 23.3. The very long (880 cm) core at site Outer Bay A contained gas-rich black sediments which may be void of stratigraphy. The upper caps of this core were perforated to allow for gas escape, and the core continued to give off sulphur gas after storage. This coring result was surprising because the sub-bottom profile at this location showed no evidence of pockmarks or gas-charging (Figure 27.5).The core collected at site Outer Bay B landed on a relatively large highly angular clast of igneous rock, and damaged the core cutter.

Piston cores Bell 11 and Bell 12 aimed to capture deglacial stratigraphy at the SE and NW ends of inner Frobisher Bay, respectively (Figure 27.6). The core at site Bell 11, in a channel close to the mid-bay islands, was strongly winnowed near the sediment-water interface, but consisted of muddy gravelly sand below 10 cm.

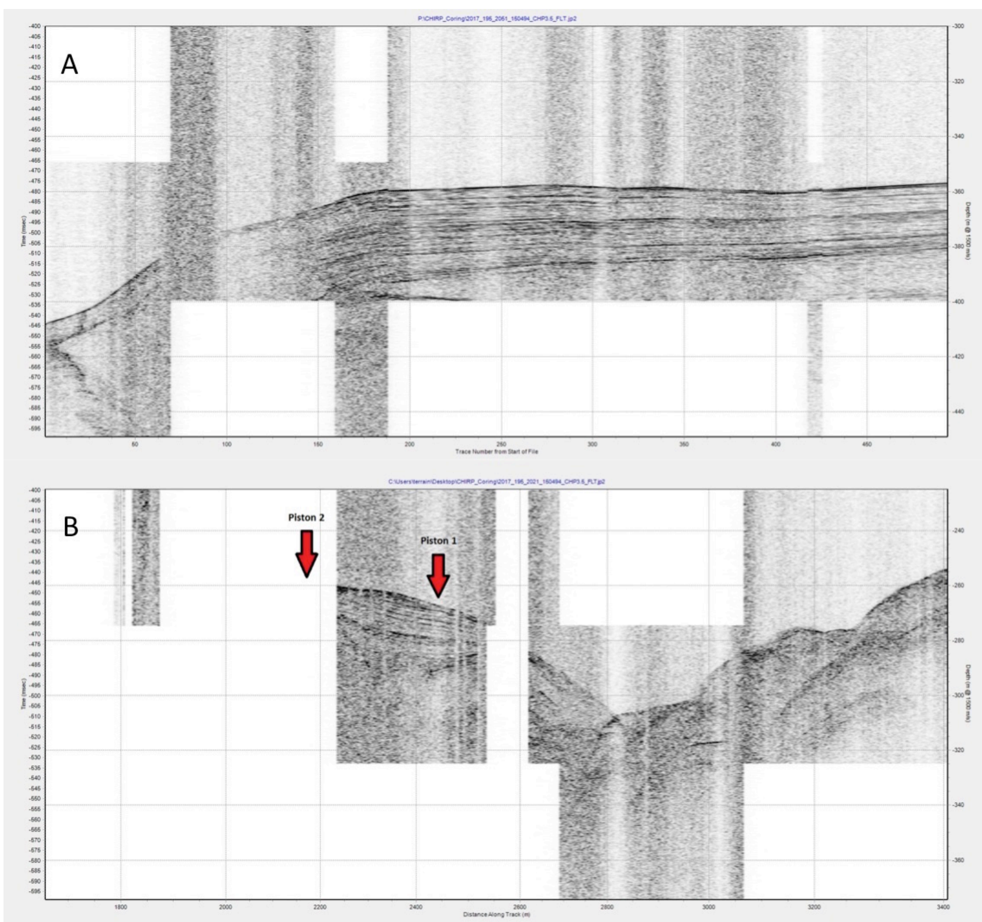

Figure 28.5 . Sub-bottom profiles at Piston Coring station Outer Bay A-B.

Piston 1 and Piston 2 in figure 4B refer to cores Outer Bay A and B, respectively. In upper image, note well-defined stratigraphy, but lack of gas charging in zoomed image of target Outer Bay A.

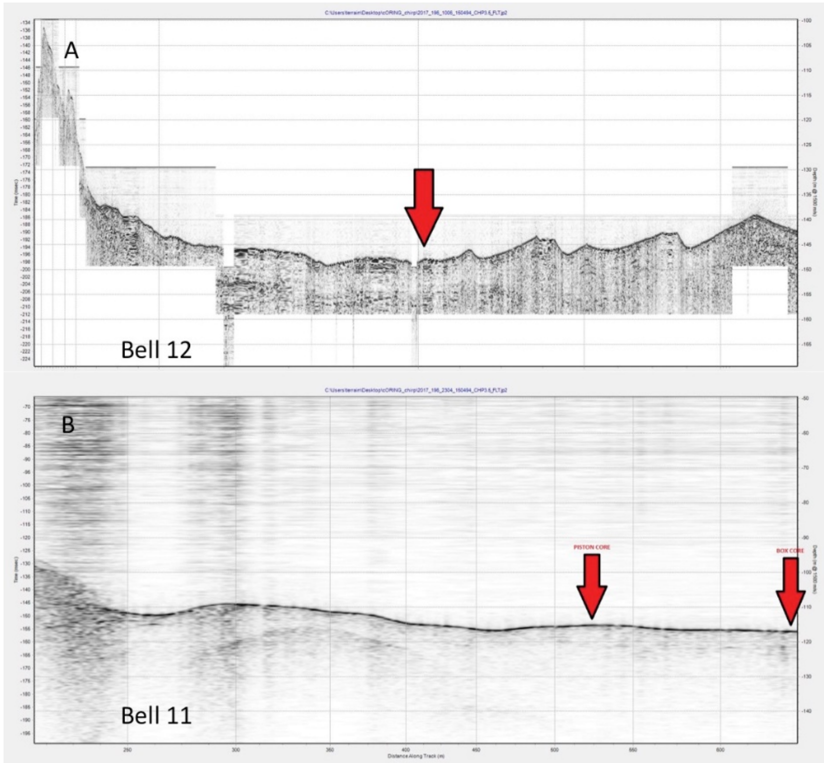

Figure 28.6 Sub-bottom profiles at Piston Coring stations Bell 12 and Bell 11, inner Frobisher Bay.

Note rougher bottom, but still well-defined stratigraphy in Bell 12. Bell 11 has strong upper reflector due to current winnowing

28.3.4 *Water Sampling*

CTD and rosette casts were collected at four stations along the bay, forming a head to mouth gradient through both inner and outer Frobisher Bay (Table 20.4, Figure 20.7). Below the surface freshwater layer evident in all stations, the deep stations in the outer bay show a pronounced temperature minimum in the 150-350 m depth range, which may restrict some of the regional sub-arctic fauna such as some cold-water corals. Aragonite and calcite saturation state calculations from two CTD casts in Frobisher Bay in 2016 suggest that inner Frobisher Bay waters shallower than 100 m are slightly saturated with respect to both carbonate species (Punshon, unpublished data, 2017, as reported in Zammit, 2017).

28.3.5 *Links to other ArcticNet projects.*

Extensive sampling for sponges (C. Dinn), for soft corals (B. Neves) and thyasirid bivalves (B. Neves, DFO for R. Dove, Memorial University) was undertaken in Frobisher Bay, in conjuction with the Hidden Biodiversity project (HiBio). Abundant soft corals growing on a rock recovered in box core at station OF-B-6 were sampled for morphology, stable isotopes, and lipids, in conjuction with samples of sedimentary organic matter for isotopic characterization (B. Neves, post-doctoral project; Figure 20.8). Large black sponges, Iophon picium, were also found in abundance at one station in the outer Bay (Figure 20.8). The sponges forming the highly abundant sponge gardens near Hill Island are apparently a combination of an undetermined species of Haliclona and a new species in the genus Iophon (C. Dinn., unpublished data, see figure 9). Sponge sampling in Frobisher Bay since 2015 has found up to 34 morphotypes of sponges, including at least two morphotypes that are apparently new species, based upon spicule morphology and DNA analysis (Figure 20.6). The new biogeographic records and new species descriptions of sponges from Frobisher Bay will form the major contribution of a paper and thesis chapter (C. Dinn, University of Alberta).

Similarly, the Full Station plankton and benthos sampling at station A16 (the Hill Island sponge gardens) was done in conjuction with the Hidden Biodversity project.

J-C Montero-Serrano (UQAR) took push-cores through all box-cores, in order to measure Holocene sedimentation rates in Frobisher Bay using 210Pb. These cores and descriptions of sedimentation rates and bulk detrital mineralogy will form part of his contrbution to the marine geology-focused ArcticNet project "Mapping of Arctic Canada's seafloor: contributions to Global Change Science, Sustainable Resource Development, Safe Navigation of the Northwest Passage, Geohazards, and Arctic Sovereignty".

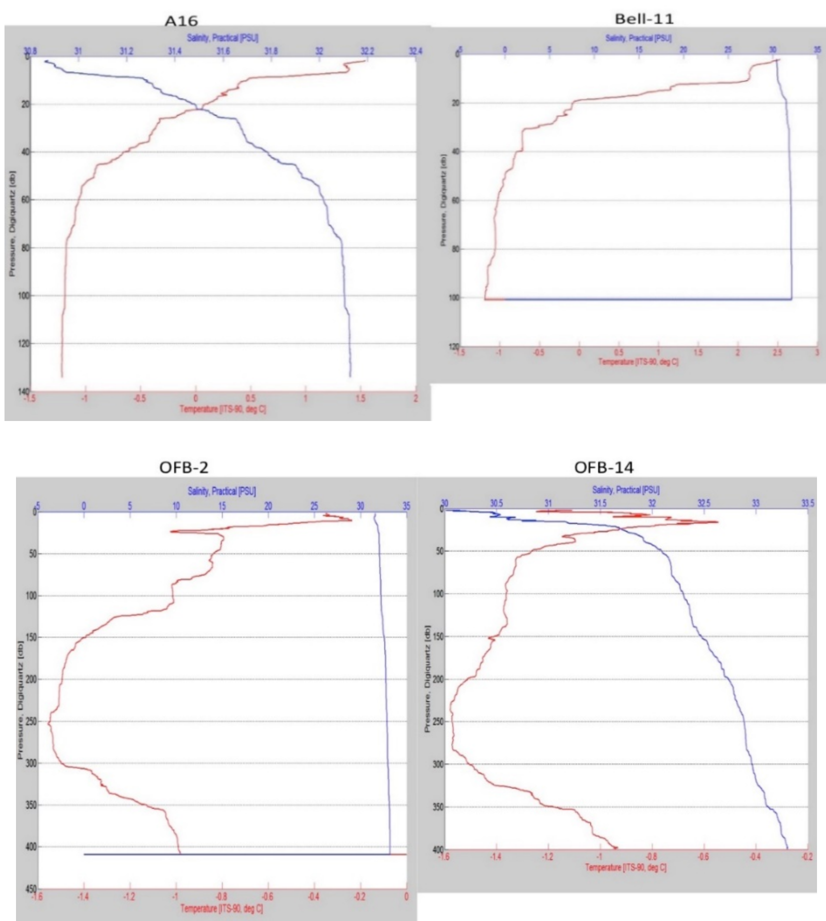

Figure 28.7 Temperature and salinity profiles from CTD/rosette casts in Frobisher Bay.

The y-axis, indicated in pressure, is broadly representative of water depth. Water samples were taken at standard depths in all casts for measuring carbonate chemistry, dissolved CO2, and dissolved methane, with the goal of calculating aragonite and calcite saturation.

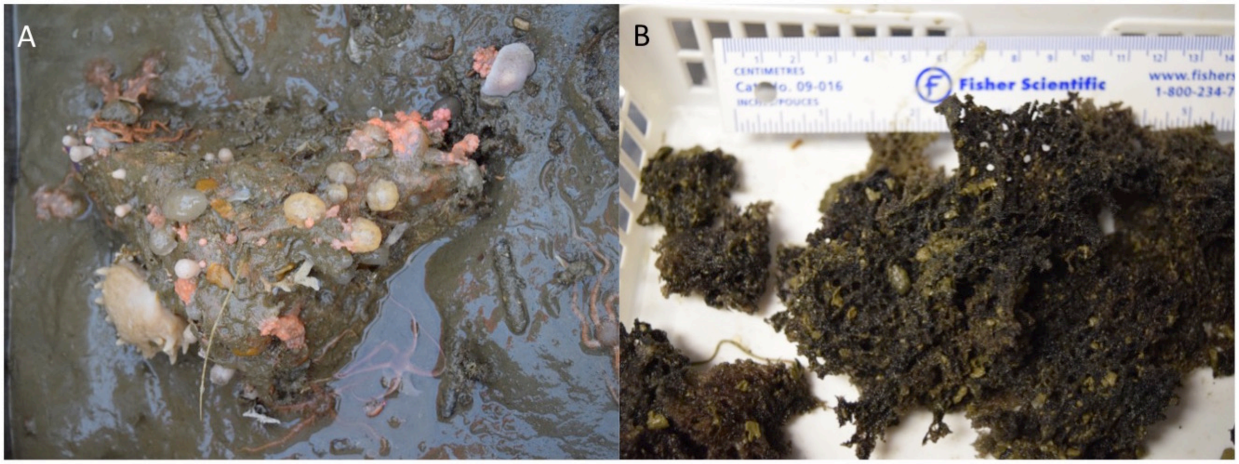

Figure 28.8 Soft corals and sponges recovered from outer Frobisher Bay box cores and Agassiz trawls.

A. Nephtheid soft corals on boulder, box core OF-B-9. B. Iophon picium Sponges from Agassiz trawl, OF-S-23.

Figure 28.9 Sponges collected in Frobisher Bay during 2017 Amundsen cruise

(A) Mycale lingua with Craniella sp. nov. attached (see E), (B) Cladoriza sp., (C) Thenea sp.,(D) Iophon sp. nov.,A new species based on spicule complement of fragments collected in 2015 (E) Craniella sp. nov. This Craniella was found in SE Baffin Shelf site in 2016 also attached to Mycale lingua and DNA suggests that it is a new species, (F) Iophon picium, (G) Polymastia grimaldii? (H) Unknown “finger sponge” – very abundant in ROV Video of Hill Island, likely Haliclona sp

Table 28.1 Box Core samples collected in Frobisher Bay, July 14-16, 2016.

Station #	date	time CST	Latitude	Longitude	water depth	slope	Region	depth of recovery	sediment characteristics	faunal characteristics	comments
OF-B-2	14-Jul-17	07:54	62 59.963	067 19.992	442	4	outer bay	full	sandy mud	ophiuroids, elongate conical tube worms	
OF-S-25	14-Jul-17	09:02	62 57.208	067 08.320	383	25	outer bay - S side	very little recovery	muddy cobble gravel	ophiuroids, Gorgonocephalus, crinoids	
OF-S-23	14-Jul-17	10:54	62 49.126	066 56.354	507	16		full	muddy	ophiuroids	
OF-B-6	14-Jul-17	12:46	62 44.74	066 42.35	495	1		full	olive-grey cohesive mud	abundant ophiuroids	bridge log says 315 m depth
Bell 12	15-Jul-17	06:52	63 41.225	068 37.485	146		Inner Frobisher Bay - head of bay	full			
A16	15-Jul-17	15:04	63 38.355	068 37.567	140		Hill Island sponges			sponge patch 1	for M. Pierrejean incubations
A16	15-Jul-17	15:41	63 38.353	068 37.648	137		Hill Island sponges			sponge patch 2 - reprise	for M. Pierrejean incubations
A16	15-Jul-17	16:06	63 38.289	068 37.672	109		bare patch			bare sediment 1	for M. Pierrejean incubations
A16	15-Jul-17	16:31	63 38.312	068 37.637	135		bare patch			bare sediment 2	for M. Pierrejean incubations
Bell 11	15-Jul-17	19:50	63 21.723	068 10.923	118		Inner Frobisher Bay - near mid-bay islands	1/2 recovery	brown cohesive muddy cobble gravel in top 10-12 cm, black cohesive ?sandy? mud below this	abundant sponges & barnacles on rocks	in channel swept by tidal currents
FB2-25di	15-Jul-17		63 40.487	068 25.380	31		long-term ecology	poor penetration - angled, perhaps washed on 1 side			excavated 1/2 box to 6 cm, top of dense black clay
FB2-25dii	15-Jul-17		63 40.477	068 25.305	29		long-term ecology	poor penetration - angl	cohesive grey-brown mud with abundant cobbles	abundant *Hiatella arctica*	excavated 1/2 box to 10 cm, top of dense black clay w/ no fauna in it.
FB2-25diii	15-Jul-17		63 40.463	068 25.324	31		long-term ecology	poor penetration - angled, perhaps washed on 1 side			excavated 1/2 box to 8 cm, top of dense black clay
FB2-25gi	15-Jul-17		63 39.784	068 25.250	82		long-term ecology	poor penetration - angled, perhaps washed on 1 side			excavated 1/2 box to 8 cm, top of dense black clay
FB2-25gii	15-Jul-17		63 39.802	068 25.226	84		long-term ecology	poor penetration - angled, perhaps washed on 1 side			excavated 1/2 box to 15 cm, top of dense black clay
FB2-25giii	15-Jul-17		63 39.802	068 25.121	94		long-term ecology	poor penetration - angled, perhaps washed on 1 side			excavated 1/2 box to 6 cm, top of dense black clay
OF-S-22	16-Jul-17	00:51	62 52.017	066 44.776	289	12	outer bay - N side, near Chase Is.	one third	gravelly sand	Macoma ?calcarea? Dominant	
OF-B-9	16-Jul-17	03:32	62 34.014	066 16.942	378	1	outer bay - S side		gravelly mud with polymict rounded to highly angular gravel	most fauna epifaunal on rocks or erect agglutinated or parchment tube- worms	
OF-B-14	16-Jul-17	06:52	62 23.183	066 01.312	411	0	outer bay - S side	1/8 full, sieved complet	grey-green very dense compact cohesive mud	1 priapulid worm, deep in sediment.	
OF-B-5	16-Jul-17	08:16	62 27.810	065 52.957	278	12	outer bay - N side	1/4 recovery	muddy gravel with polymict cobbles and boulders, abundant limestone clasts	abundant very small ophiuroids, Macoma ?calcarea?, epifauna on rocks includes Solus, colonial tunicate, several spp.of bryozoans	

Table 28.2 Agassiz trawl samples collected in Frobisher Bay, July 14-16, 2016

Station #	date	time started	time elapsed	tow speed	Latitude	Longitude	depth target	depth start	depth end	Region	recovery	portion analyzed	Bottom type comments	Faunal comments
OF-S-25	14-Jul-17	09:22	3 min	1.5 kt	62° 75.232	067° 08.360	383	402	281	Outer Frobisher		1/4 analyzed	muddy cobble gravel	ophiuroids, Gorgonocephalus, crinoids (2 types), small recovery.
OF-S-23	14-Jul-17	11:19	3 min	1.5 kt	62° 49.093	066° 55.944	479	470	475	Outer Frobisher	1/4 fish tub	all analyzed	olive-grey mud	ophiuroids, Gorgonocephalus, sponges, soft corals, moon snail, 1 small fish.
OF-B-6	14-Jul-17	13:27	3 min	1.5 kt	62° 44.848	066° 42.87	496	493	485	Outer Frobisher	1 full fish tub	1/4 analyzed	completely full of mud	abundant worm tubes
FB2-2-5g	15-Jul-17	03:31	03:28	2 kt	63° 40.125	068° 25.652				Long-term ecology	<1/4 tub	all analyzed	no sediment recovered	sponges, tunicates, & kelp
A16	15-Jul-17	14:27	03:00	?	63° 38.390	068° 37.642		141		Hill Island sponge garden				
OF-S-22	16-Jul-17	01:15	03:00	1.5 kt	62° 51.998	066° 44.871	253	252	252	N side Outer Frobisher	1/3 fish tub			Grogonocephalus, ophiuroids, 2 kinds of crinoids, Macoma calcarea

Table 28.3 Piston cores collected in Frobisher Bay during leg 2b, July 13-16, 2016

Core #	date	time CST	Latitude	Longitude	lat_dd	long_dd	depth	Region	apparent pen	N sections	total length	AB	BC	CD	DE	DF	FG	total_length_	core cutter	descriptive comments	technical comments	comments on sub-bottom profi	trigger weight core
Outer Bay A	14-Jul-17	18:25	63 07.615	067 26.212	63.1269167	-67.43687	331	Outer Frobisher Bay	900	6	881	150	156	150	158	151	116	881	no sample	gas-rich very black sediment, smells of sulphur. Section D-E has gap from 106 to 116 cm, probably filled with gas.	piston did not split but pins sheared. Tops of core section caps perforated to allow gas to escape.	no sign of gas in sub-bottom	empty
Outer Bay B	14-Jul-17	2111	63 07.965	067 25.932	63.13275	-67.43220	291	Outer Frobisher Bay	600	3	416	144	156	116				416	rock	6 cm gap at base of section A-B above rock & associated sediment.	damaged core cutter head with big rock; 6 cm gap at base of section A-B above rock & associated sediment.	looks well-stratified	empty
Bell 12	15-Jul-17	06:52	63 41.225	068 37.485	63.6870833	-68.62475	146	Inner Frobisher Bay	NR	4	474.5	150	155	150	19.5			474.5	compact san	water removed from top of section C-D	core cutter head slightly bent	sloping bottom - 3.5 kHz hard to read in screen shot, should be OK in jp2	empty
PCXA-1	15-Jul-17	09:39	63 35.877	068 31.421	63.59795	-68.52368	180	Inner Frobisher Bay	600	4	473.5	150	159	139.5	25			473.5	no sample		2.5 cm water removed from A-B & replaced with blue styrofoam after core settled & dewatered a bit. 10.5 cm removed from C-D at top of C-D, core-section shortened.	looks well-stratified	empty
Bell 11	15-Jul-17	19:50	63 21.723	068 10.923	63.36205	-68.18205	118	Inner Frobisher Bay - near mid-bay islands	NR	4	507	150	156	151	50			507	gravelly mud	surface of sediment is winnowed gravel with epifauna, then gravelly mud, with black organic-rich sediment starting about 10 cm		site based on hummocky multibeam; sub-bottom shows stratification: in tidal-current-swept channel btw shoals.	rock & gravelly mud in core cutter, but no TWC above

Table 28.4 Water samples collected for calcium carbonate saturation state in Frobisher Bay during leg 2b, July 14-16, 2017

Station #	date	Latitude	Longitude	lat_dd	long_dd	depth	Region	Sampling objectives	N bottles
OF-B-2	14-Jul-17	63 00.089	067 19.818	63.00148	-67.33030	422	Outer Frobisher	T,S,NO3,TA/DIC/pCO2/CH4	
A16	15-Jul-17	63 38.361	068 37.554	63.63935	-68.62590	143	Hill_island	T,S,NO3,TA/DIC/pCO2/CH4	13
Bell 11	15-Jul-17	63 21.653	068 10.785	63.36088	-68.17975	112	Mid-Bay-Islands	T,S,NO3,TA/DIC/pCO2/CH4	10
OFB-14	16-Jul-17	62 23.060	066 01.836	62.38433	-66.03060	412	Outer Frobisher	T,S,NO3,TA/DIC/pCO2/CH4	17

Conclusion

Sampling in Frobisher Bay during the 2016 Amundsen mission was limited to 2.5 days. During these two & 1/2 days, we completed: multibeam sonar mapping of a deep polygon in the outer bay that is below the reach of the Nunavut Government research vessel MV *Nuliajuk*, collection of 20 box cores, six Agassiz trawls, 4 CTD casts with associated water sampling at 4 stations, one set of plankton samples, and 5 piston cores with associated sub-bottom profiles and box-cores.

28.4 Comments and Recommendations

Amundsen sampling in Frobisher Bay for 2018 will likely need to focus exclusively on the outer bay, and on deep portions of the outer bay that are inaccessible to sampling by the Nunavut government fisheries research vessel MV *Nuliajuk*. 2018 sampling for completing the geological and biological habitat map of outer Frobisher Bay will be greatly aided by the possible development of a drop-video camera.

Acknowledgement

We thank Dr. Anna Pienowski (MacEwan University) and Dr. Jean-Carlos Montero-Serrano (Université de Québec à Rimouski) for leading piston coring operations in Frobisher Bay, Ms. Tonya Burgers (University of Manitoba) and Dr. Cara Manning (University of British Columbia) for collecting water samples in Frobisher Bay, and student hydrographer Annie-Pierre Trottier for collecting and processing multibeam and sub-bottom profile data throughout the bay and especially in our piston-coring and box-coring targets. We thank Chief Scientist Jean-Eric Tremblay, Captain Claude LaFrance, and the crew of CCGS *Amundsen* for their dedicated support of our research in Frobisher Bay.

Reference

Azetsu-Scott, K., A. Clarke, K. Falkner, J. Hamilton, E.P. Jones, C. Lee, B. Petrie, S. Prinsenberg, M. Starr, and P. Yeats. 2010. Calcium carbonate saturation states in the waters of the Canadian Arctic Archipelago and the Labrador Sea. Journal of Geophysical Research. 115: C11021.

Cusson, M., P. Archambault, and A. Aitken. 2007. Biodiversity of benthic assemblages on the Arctic continental shelf: historical data from Canada. Marine Ecology Progress Series. 331:291-304.

Hatcher, S., and D.L. Forbes, 2015.Exposure to coastal hazards in a rapidly expanding northern urban centre, Iqaluit, Nunavut. Arctic 68(4): 453-471.

Mate, D.J., Campbell, D.C., Barrie, V., Hughes Clarke, J.E., Muggah, J., Bell, T., and Forbes, D.L. 2014. Integrated seabed mapping of Frobisher Bay, Nunavut, to support infrastructure development, exploration, and natural hazard assessment. In Summary of Activities 2014, Canada-Nunavut Geoscience Office, p. 145-152.

Miller, GH, 1980. Late Foxe glaciation of southern Baffin Island, NWT, Canada. Geol. Soc. Am. Bulletin I 91: 399-405.

Todd, B,J., Shaw, J., Campbell, D.C., and Mate, D.J., 2016. Preliminary interpretation of the marine geology of Frobisher Bay, Baffin Island, Nunavut. In: Summary of Activities, 2016, Canada-Nunavut Geoscience Office, p. 61-66.

Wacasey, J.W., E.G. Atkinson, and L. Glasspoole. 1979. Zoobenthos Data from Upper Frobisher Bay, 1967-1973. Canadian Data Report of Fisheries and Aquatic Sciences. No. 164: 99p.

Wacasey, J.W., E.G. Atkinson, and L. Glasspoole. 1980. Zoobenthos Data from Inshore Stations of Upper Frobisher Bay 1969-1976. Canadian Data Report of Fisheries and Aquatic Sciences. No. 205: 42p.

Zammit, K., 2017. Gone but not forgotten: composition of cold-water carbonate bioclasts in Frobisher Bay, Nunavut. B.Sc. (Honours) thesis, Earth Sciences, Memorial University, ix+64 p.

29 The Marine Sedimentary Record of Paleoclimate, Paleoceanography, and Deglacial History in the Eastern Canadian Arctic Archipelago and Northern and Eastern Baffin Bay

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29.1 Introduction

The sampling undertaken during this expedition is framed within the IRIS 1 targeted research from the ArcticNet Phase 4 funded project Mapping of Arctic Canada's Seafloor: Contributions to Global Change Science, Sustainable Resource Development, Safe Navigation of the Northwest Passage, Geohazards and Arctic Sovereignty (project leader: Patrick Lajeunesse). Sampling activities also include collection of core material and pore water samples (by M. Zindorf) for Casey Hubert (U. Calgary) and Christian März (Leeds Uni.; c.maerz@leeds.ac.uk).

Benefitting from the presence of the of the CCGS *Amundsen* in Frobisher Bay, Disko Fan, Home Bay Fan, Trinity Fjord, Manson and Belcher glaciers, Prince Regent Inlet, Gulf of Boothia, Peel Sound, and Foxe Basin during Leg 2b, our team collected multiple sediment cores (box, gravity and piston) in these areas in order to:

1) Increase our understanding of paleoglaciology, deglacial dynamics, and Holocene sea ice history of the continental shelf and inter-island channels of the Canadian Arctic
2) Document the post-glacial melting history of the outlet glaciers draining the Devon and Ellesmere Island icecaps
3) Reconstruct changes in sediment provenance and transport related to climate variability
4) Establish a deglacial/Holocene high-resolution magnetostratigraphy for the Canadian Arctic Ocean
5) Document the dynamics of the Late-Wisconsinan deglacial ice shelf systems
6) Document the evolution of primary and secondary productivity of the Canadian arctic ecosystem in relation with climate conditions
7) Assess the post-depositional diagenetic evolution of shallow arctic marine sediments.

29.2 Methodology

The ISMER-UQAR and MacEwan teams were responsible, together with Evan Edinger from Memorial University and Cindy Grant from Université Laval, for box coring operations. The piston corer was deployed by ISMER-UQAR and MacEwan teams. The multibeam echosounder (Konsberg Simrad EM300) and 3.5-kHz chirp sub-bottom profiler (Knudsen 320R) were used, in collaboration with the Marine Geoscience Lab. (MGL) from the Université Laval (Annie-Pier Trottier and John Patrick McNeill), to ensure that the seabed was suitable for deployment of the corers, as well as to identify the thickest apparent deglacial/Holocene sequences with the absence of mass movements and/or sediment perturbations. Note that the MGL was responsible for mapping the seabed morphology and in acquiring sub-bottom stratigraphy during this leg. Additional gravity cores and box core push-cores were taken for geochemical and pore water analyses by Mark Zindorf (Newcastle University) for the Calgary/Leeds/Newcastle geochemistry team.

29.2.1 *Box Corer*

The box corer (Figure 28.1) collects up to 0.125 m3 of soft sediments at the seafloor and is suitable for any water depths (limited by winch cable length). It is used for minimum disturbance of the sediment/water interface. During the expedition, the box corer was deployed 51 times (Table 27.1 and Table 28.4). When the sediment volume was sufficient (which was the case for most deployments), three push cores (PVC tubes of 10 cm diameter and ~60 cm length) were taken from each box (Figure 28.2) core using a vacuum pump to reduce compaction. The sediment/water interface from each box-core location was subsampled into several Ziploc bags and plastic and glass vials for subsequent identification of microfossil (dinoflagellate cysts, non-pollen palynomorphs, benthic and planktonic foraminifera) as well as grain size, mineralogical, geochemical, magnetic and DNA analyses. Each push core and surface sediment sample was stored in a refrigerated container (4°C).

At several sites (Table 28.4) two further push cores (one 10 cm diameter, one 5 cm diameter), in addition to the three described above, were taken from the box corer. The 5 cm core was extruded and sliced in to 2 cm subsamples and frozen at -20°C for later microbial analysis (Figure 28.3). The additional 10 cm push core was sampled for interstitial waters at a 5 cm resolution using rhizons (0.1 µm pore-size). Pore-water samples were subdivided into archive and working volumes - the archive being left untreated; the working half being acidified with 2µ/ml HCl (conc). Both halves were stored at 4°C in a fridge. The 10 cm push core subsampled for pore water was subsequently sealed and stored in a refrigerated container (4°C) and available for further analyses.

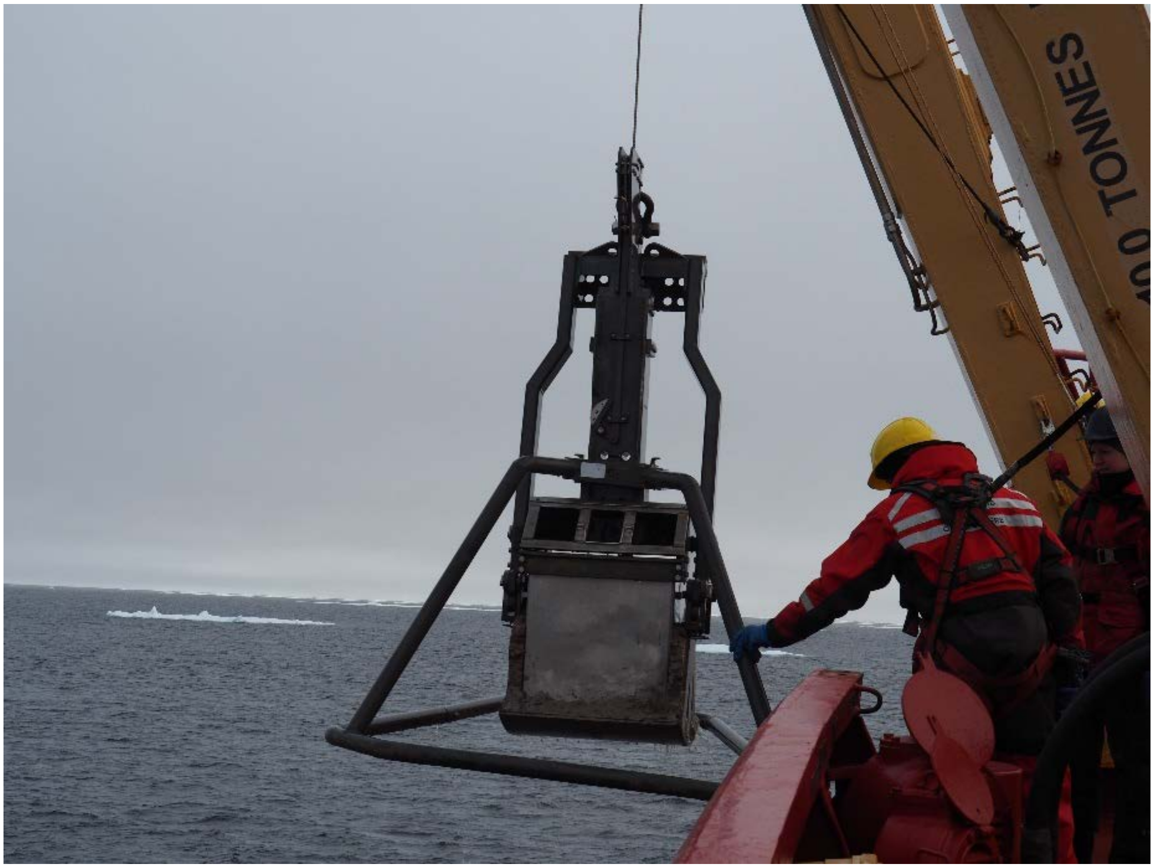

Figure 29.1 Recovery of full box core

Figure 29.2 Push cores in open box core, prior to extraction

Table 29.1 ISMER-UQAR box coring operations: location, depth, identification, and characteristics.

Core site are shown graphically in Figs. 7 & 8. PC = Piston Core; TWC = Trigger Weight Core; GC = Gravity Core; BC = Box Core (including sequentially lettered push cores from the box core); surface = surface samples from box core only.

Stn	Date (d/m/y)	Time (24hr)	Latitude (°N)	Longitude (°W)	Location	Depth (m)	ISMER-UQAR identifier AMD0217-	Push cores length (cm)			Comment(s)
								A	B	C	
OF-B2	14/07/2017	07:54	62°59.963	67°19.992	Forbisher Bay	442	01BC	40	38		
OF-S25	14/07/2017	09:12	62°57.208	67°08.306	Forbisher Bay	383	02BC				Only surface sediment + rocks fragments
OF-S23	14/07/2017	10:54	62°49.126	66°56.354	Forbisher Bay	501	03BC	42			
OF-B6	14/07/2017	12:46	62°44.74	66°42.35	Forbisher Bay	493	04BC				
FB-2-2-5d	15/07/2017	04:43	63°40.477	68°25.305	Forbisher Bay	29	06BC	29			
Bell-12	15/07/2017	08:11	63°41.263	68°37.455	Forbisher Bay	141	07BC	29			
A-16	15/07/2017	15:04	63°38.355	68°37.567	Forbisher Bay	140	08BC	25			
Bell-11	15/07/2017	20:43	63°21.591	68°10.924	Forbisher Bay	119	09BC	22			
OF-S22	16/07/2017	00:51	62°52.017	66°44.776	Forbisher Bay	289	10BC	24			
OF-B9	16/07/2017	03:32	62°34.014	66°16.942	Forbisher Bay	371	11BC	36	34.		
OF-B14	16/07/2017	06:52	62°23.183	66°01.312	Forbisher Bay	411	12BC	26			
OF-B5	16/07/2017	08:16	62°27.810	65°52.957	Forbisher Bay	278	13BC				Only surface sediment + rocks fragments
Disko Fan	19/07/2017	2:54	68°00.909	59°34.732	Disko Fan	947	14BC-1	39	35.		
Disko Fan	19/07/2017	3:37	68°01.373	59°34.807	Disko Fan	937	14BC-2	37			
Disko Fan	19/07/2017	4:28	67°59.545	59°33.953	Disko Fan	1012	15BC-3	36	37		
Disko Fan	19/07/2017	5:08	67°59.567	59°33.894	Disko Fan	1007	15BC-4	38			
Disko Fan coral	19/07/2017	11:38	67°57.890	59°29.106	Disko Fan	873	16BC-1	40	39.5		Keratosis sp. Forest (cold water
Disko Fan coral	19/07/2017	12:48	67°58.082	59°29.405	Disko Fan	874	16BC-2	32			close to coral forest
Stn. 8.1	20/07/2017	18:07	69°24.437	64°43.929	Home Bay through mouth fan	1054	17BC	50	46		
Stn. 176	21/07/2017	02:34	69°35852	65°24.226	Home Bay	267	18BC	15			Differents rocks fragments were colleted in the
Stn. BB2	22/07/2017	20:46	72°45.080	67°00.910	central Baffin Bay	2373	19BC	41	42	40	Soupy sediment in the core-top
Stn. 101	24/07/2017	16:22	76°21.473	77°30.960	Smith Sound	378	20BC	47	48		
Stn. 105	25/07/2017	03:14	76°19.061	75°45.484	Smith Sound	331	21BC				Only surface sediment + rocks fragments
Stn. 115	26/07/2017	15:46	76°19.915	71°15.284	Smith Sound	668	22BC	38	38		
Stn. 129	27/07/2017	17:09	78°19.360	74°05.546	Nares Strait	545	23BC				Only surface sediment + rocks fragments
Stn TS233	28/07/2017	14:31	77°45.313	76°41.163	Trinity fjor	396	24BC	36	33		Rocks fragments were colleted.
Stn 111	29/07/2017	14:30	76°18.486	73°12.428	Smith Sound	593	25BC	42	41		
Stn 108	29/07/2017	23:19	76°15.861	74°36.373	Smith Sound	448	26BC-1	29	32		A=3cm compression
Stn 108	29/07/2017	23:45	76°15.781	74°36.349	Smith Sound	449	26BC-2	42			
Belcher Glacier	30/07/2017	19:34	75°42.130	80°45.122	Belcher Glacier (Jones	623	27BC	44.5	44.5		
Stn. 323	31/07/2017	16:00	74°09.396	80°28.076	Lancaster Sound	787	28BC	44	47		B= extention by pumping of ~ 2
Stn. 301 - ROV	03/08/2017	19:45	74°16.654	83°19.131	Lancaster	715	29BC-1	46.5			
Stn. 301 - ROV	03/08/2017	21:25	74°16.646	83°20.112	Lancaster	740	29BC-3	48			
Stn. 304	04/08/2017	18:39	74°14.786	91°30.902	Lancaster	315	30BC	50			

Stn. 5.10	05/08/2017	23:26	74°29.303	99°04.587	Barrow Strait	223	31BC	35	36	35	Sediments from the piston cutter (5.10 PC) were recovered in a zipper bag.
Stn. 3.9	06/08/2017	09:07	73°39.276	96°09.686	Peel Sound	262	32BC	40	41. 5	40	A = ~2-3 cm compressio
Stn. QMG-M	08/08/2017	05:57	68°18.175	101°44.517	Queen Maud Gulf	114	33BC	40			
Stn. QMG-4	08/08/2017	22:23	68°29.057	103°25.831	Queen Maud Gulf	71	34BC	41			
Stn. QMG-3	09/08/2017	03:09	68°19.650	102°56.523	Queen Maud Gulf	45	35BC	41			
Stn. QMG-1	09/08/2017	14:28	68°29.553	99°53.882	Queen Maud Gulf	40	36BC	40.5	42		
Stn. QMG-2	09/08/2017	19:59	68°18.400	100°48.444	Queen Maud Gulf	45	37BC	44			
Stn. 312	10/08/2017	05:57	69°10.235	100°41.732	Victoria Strait	65	38BC	36.5			
Stn. 3.7	11/08/2017	08:36	72°05.348	96°03.920	Franklin Strait	414	39BC	45.5	46		
Stn. 3.4	11/08/2017	21:52	71°28.512	91°59.600	Prince Regent Inlet	270	40BC	48	46. 5		
Stn. 3.5	12/08/2017	08:15	70°26.197	91°14.179	Gulf of Boothia	224	41BC	35	36		
Stn. 5.11-W	12/08/2017	19:06	69°57.291	87°40.019	Western Fury & Hecla Strait	184	42BC	38.5	39		
Stn. 5.11	13/08/2017	00:18	69°52.961	86°05.079	Western Fury & Hecla Strait	291	43BC	39	39		
Stn. 333	13/08/2017	18:10	68°46.519	80°50.951	Foxe Basin	27	44BC				Only surface samples were taken. Coral samples were recovered in a zipper bag.
Stn. 3.10-2	14/08/2017	01:54	68°52.738	78°09.753	Foxe Basin	52	45BC	19	20		
Stn. 3.10	14/08/2017	12:07	67°47.844	80°50.816	Foxe Basin	96	46BC	13	14.		
Stn. 1.1	15/08/2017	10:10	65°09.308	81°21.235	Foxe Basin	418	-47BC	41	41.		

29.2.2 *Gravity and Piston Corer*

The gravity core (Figure 28.4) has a maximum recovery length of ~2.80 m (in a 3.05 m aluminum barrel) using a stainless-steel cutting head and penetrating the sediment under a 136 kg weight. A core catcher keeps the sediment in the corer when the latter is pulled upward. Winch speeds (lowering) ranged from 60 to 80 metres per minute depending on estimated substrate properties. During the expedition, the gravity core was deployed 9 times (Table 28.2 and Table 28.4). The gravity core is also used for the releasing of the piston corer, being referred to as the trigger weight core (TWC) and rigged with a shorter 2.15 m aluminum barrel (liner length = 1.90 m). During the expedition, the gravity core was used for both purposes. Gravity core deployment and recovery is markedly quicker than the combined piston and trigger-weight core (15-20 minutes versus ~90 minutes), thus the gravity core was deployed at several sites where thick sea ice would have posed a risk to the piston corer (hanging over the side of the ship for considerable time during deployment and recovery) and where time constraints necessitated shortened coring operations.

Table 29.2 ISMER-UQAR Gravity coring operations: location, depth, identification, and characteristics.

Core site are shown graphically in Figs. 8 & 9. PC = Piston Core; TWC = Trigger Weight Core; GC = Gravity Core; BC = Box Core (including sequentially lettered push cores from the box core); surface = surface samples from box core only.

Stn	Date (d/m/y)	Time (24hr)	Latitude (°N)	Longitud (°W)	Location	Dpt (m)	ISMER-UQAR identifier AMD0217	Length (cm)	Section length (cm)		Comment(s)
									A B	BC	
Stn. 180	18/07/2017	18:19	67°24.712	61°21.126	Off the coast of Baffin Island	713	01GC				No recovery; Sediment from the cutter was sampled into ziploc bag
Manson Glacier bay	30/07/2017	09:08	76°23.933	78°45.030	Manson Glacier bay	188	02GC	174.5	149	25.5	Last 20 cm consists of bioturbated organic-rich sediments.
Stn. 3.9	06/08/2017	08:44	73°39.282	96°09.712	Peel Sound	260	03GC	199.5	149.5	50	
Stn. 3.4	11/08/2017	21:34	72°28.527	91°59.640	Prince Regent Inlet	270	04GC	254	150	104	
Stn. 3.10-2	14/08/2017	02:10	68°52.765	78°09.861	Foxe Basin	52	05GC				Not penetration because rocks fragments in the surface. Only sediment from the cutter were recovered in a zipper bag

The piston corer (Figure 28.4) operates with a weight of 2000 kg with three 3.05 m steel core barrels connected with steel coupling sleeves attached with set screws, and a steel cutting head. When the companion trigger-weight core touches the seafloor, it causes the rise of the piston core’s trip arm and induces the piston corer to free fall. A core catcher helps keep the sediment in the corer when the latter is pulled upward. This coring instrument allows the collection of long cores up to a maximum of 9 m length due to the suction exerted by the piston in the core tube. The piston corer was deployed 8 times during the expedition, and thus a total of 8 piston cores and 8 trigger weight cores have been sampled. Once on board, all gravity and piston cores were cut into 1.5 m long sections and stored into a cold room (4°C). At 2 sites, a gravity core was taken for interstitial-water analysis. This core was sampled at 25 cm resolution using rhizons prior (Figure 28.5) to being cut into 1.5 m lengths. Interstitial-water samples were treated as described above.

Table 29.3 ISMER-UQAR Piston coring operations: location, depth, identification, and characteristics.

Core site are shown graphically in Figs. 8 & 9. PC = Piston Core; TWC = Trigger Weight Core; GC = Gravity Core; BC = Box Core (including sequentially lettered push cores from the box core); surface = surface samples from box core only

Stn.	Date (d/m/y)	Time (24hr)	Latitude (°N)	Longitud (°W)	Location	Depth (m)	ISMER-UQAR identifier AMD0217	Length (cm)	Section length (cm)					Comment(s)
									A B	BC	CD	DE	EF	
8.1	20/07/2017	19:37	69°24.669	64°43.900	Home Bay through mouth fan	1076	01PC	371	155	150	66			Sediment from the cutter as sampled into ziploc ag. AB base= ~ 2 cm nd BC/CD = ~5 cm ere sampled into ziplot ag.
8.1	20/07/2017	19:37	69°24.669	64°43.900	Home Bay through mouth fan	1076	01TWC	158	158					
129	27/07/2017	10:19	78°18.136	74°26.279	Nares Strait	521	129PC							Surface sediment were olleted in the core-top of he piston
Belcher lacier	30/07/2017	20:54	75°42.384	80°45.593	Belcher Glacier (Jones Sound)	626	02PC	726.5	186	156	150	119	90	Cutter: AB= 25 cm + ediment from the cutter ase was recovered in a ipper bag. EF= ~ 5 cm f sediments were isturbed by the piston at he top of the section
Belcher lacier	30/07/2017	20:54	75°42.384	80°45.593	Belcher Glacier (Jones Sound)	626	02TWC	53	53					
3.7	11/08/2017	07:01	72°05.690	96°02.517	Franklin Strait	404	03PC	211	150	39				Cutter AB= 22 cm
3.7	11/08/2017	07:01	72°05690'	96°02.517	Franklin Strait	404	03TWC	181.5	150	31.5				
3.5	12/08/2017	09:11	70°26.272	91°14.328	Gulf of Boothia	223	04PC	740	150	155.5	150	156.5	128	Cutter AB= 10 cm
3.5	12/08/2017	09:11	70°26.272	91°14.328	Gulf of Boothia	223	04TWC	186	36	150				
1.1	15/08/2017	11:14	65°09.319	81°21.305	Foxe	418	05PC	684	150.5	155	150.5	155	73	
1.1	15/08/2017	11:14	65°09.319	81°21.305	Foxe	418	05TWC	126	126					
1.1	15/08/2017	13:17	65°11.708	81°23.093	Foxe Basin	409	06PC	511	150	152	151	58		Sediments from the utter were recovered in a ipper bag. DE= posible emobilization of the urface by plastic liner ebris. Sediments from he catcher were ecovered in a zipper bag nd short liner.
1.1	15/08/2017	13:17	65°11.708	81°23.093	Foxe Basin	409	06TWC	58	58				i	Sediments from the utter were recovered in a ner.

Note that box-cores collected in conjunction with a piston corer allow recovery of the undisturbed sediment-water interface, which is usually perturbed when the piston corer enters the sediments. Ideally, push cores from box-cores can be correlated visually, chronstratigraphically, or geochemically with piston, trigger, and gravity cores from the same site.

Figure 29.3 Extruding small push core for geochemical analyses

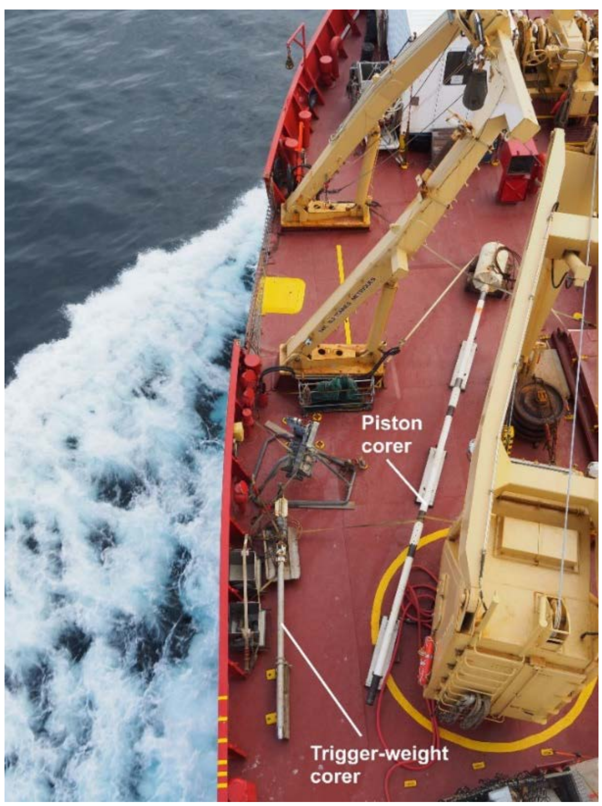

Figure 29.4 Gravity corer (rigged with short barrel as a trigger weight) and piston corer on the fore-deck of the CCGS *Amundsen* awaiting connection and deployment.

Figure 29.5 Push (up) and gravity (down) cores drilles and undergoing subsampling for pore water using rhizons. Push core is approximately 50 cm long

Table 29.4 MacEwan University coring operations: location, depth, identification, and characteristics.

PC = Piston Core; TWC = Trigger Weight Core; GC = Gravity Core; BC = Box Core (including sequentially lettered push cores from the box core); surface = surface samples from box core only

Arctic- Net Stn. No.	Date (d/m/y)	Time	Latitude (°N)	Longitude (°W)	Location	Water Depth (m)	Type	Core Length (cm)	MacEwan Core ID 2017AMD-2B
OF-B2	14/07/17	07:54	62° 59.963’	67° 19.992’	Frobisher Bay	442	BC	-	0001BC surface
OF-23 (OF-B2)	14/07/17	10:54	62° 49.126’	66° 56.354’	Frobisher Bay	507	BC	-	0002BC surface
OF-B6	14/07/17	12:46	62° 44.740’	66° 42.350’	Frobisher Bay	493	BC	-	0003BC surface
FB2-1	15/07/17	02:06	63° 39.784’	68° 25.250’	Frobisher Bay	82	BC	-	0004BC surface
BELL12	15/07/17	08:11	63° 41.263’	68° 37.455’	Frobisher Bay	141	BC	-	0005BC surface
A16	15/07/17	15:04	63° 38.355’	68° 37.567’	Frobisher Bay	140	BC	-	0006BC surface
BELL11	15/07/17	20:43	63° 21.591’	68° 10.924’	Frobisher Bay	118	BC	-	0007BC surface
OF-S22	16/07/17	00:51	62° 52.017’	66° 44.776’	Frobisher Bay	289	BC	-	0008BC surface
OF-B9	16/0717	03:32	62° 34.014’	66° 16.942’	Frobisher Bay	375	BC	-	0009BC surface
OF-B14	16/07/17	06:52	62° 23.183’	66° 01.312’	Frobisher Bay	411	BC	-	0010BC surface
OF-B5	16/07/17	08:16	62° 27.810’	65° 52.957’	Frobisher Bay	278	BC	-	0011BC surface
PATCH	19/07/17	02:54	68° 00.909’	59° 34.732’	Baffin Bay	947	BC	-	0012BC surface
DISKO FAN BC I	19/07/17	04:28	67° 59.545’	59° 33.953’	Baffin Bay	1012	BC	-	0013BC surface
DISKO FAN BC II	19/07/17	05:08	67° 59.567’	59° 33.874’	Baffin Bay	1007	BC	-	0014BC surface
DISKO FAN BC III	19/07/17	11:32	67° 57.890’	59° 29.106’	Baffin Bay	873	BC	-	0015BC surface
DISKO FAN BC IV	19/07/17	12:48	67° 58.082’	59° 29.405’	Baffin Bay	874	BC	-	0016BC surface
8.1	20/07/17	18.07	69° 24.437’	64° 43.929’	Baffin Bay	1054	BC	-	0017BC surface
176	21/07/17	02:34	69° 35.852’	65° 24.226’	Baffin Bay	267	BC	-	0018BC surface
BB2	22/07/17	20:46	72° 45.080’	67° 00.910’	Baffin Bay	2373	BC	39.0	0019BC A
101	24/07/17	16:22	76° 21.473’	77° 30.960’	Baffin Bay	378	BC	49.5	0020BC A
105	25/07/17	03:14	76° 19.061’	75° 45.484’	Baffin Bay	331	BC	-	0021BC surface
115	26/07/17	15:46	76° 19.915’	71° 15.284’	Baffin Bay	668	BC	37.5	0022BC A
129	27/07/17	10:21	76° 19.881’	76° 38.853’	Nares Strait	521	PC	646.5	0023PC
							TWC	85.0	0023TWC
TRINITY	28/07/17	14:31	77° 45.313’	76° 41.163’	Trinity Bay	396	BC	-	0024BC surface
111	29/07/17	14:30	76° 18.486’	93° 12.428’	Baffin Bay	593	BC	-	0025BC surface
108	29/07/17	23:19	76° 15.861’	74° 36.373’	Baffin Bay	448	BC	-	0026BC surface
108	29/07/17	23:45	76° 15.781’	74° 15.781’	Baffin Bay	449	BC	45	0026BC A
Belcher Glacier	30/07/17	19:34	75° 42.130’	80° 45.122’	Belcher Glacier	623	BC	-	0027BC surface
323	31/07/17	16:00	74° 09.396’	80° 28.076’	Lancaster Sound	792	BC	44.0	0028BC A
301	03/08/17	19:45	74° 16.654’	83° 19.131’	Lancaster Sound	715	BC	-	0029BC surface

304	04/08/17	18:39	74° 14.786’	91° 30.902’	Barrow Strait	315	BC	-	0030BC surface
5.10	05/08/17	22:29	74° 29.728’	99° 04.687’	Barrow Strait	215	PC	219.0	0031PC
							TWC	empty	0031TWC
5.10	05/08/17	23:26	74° 29.363’	99° 04.587’	Barrow Strait	223	BC	31.0	0032BC A
								38.5	0032BC B
								37.0	0032BC C
								~30	0032BC small push*
3.9	06/08/17	09:07	73° 39.276’	96° 09.686’	Peele Sound	262	BC	39.0	0033BC
QMGM	08/08/17	05:57	68° 18.175’	101° 44.517’	Queen Maud Gulf	114	BC	40.0	0034BC A
QMG-4	08/08/17	22:23	68° 29.057’	103° 25.840’	Queen Maud Gulf	71	BC	-	0035BC surface
QMG-3	09/08/17	03:09	68° 14.655’	102° 56.497’	Queen Maud Gulf	46	BC	40.0	0036BC A
								40.0	0036BC B
								40.0	0036BC C*
								40.0	0036BC small push*
QMG-3	09/08/17	04:03	68° 19.678’	102° 56.373’	Queen Maud Gulf	52	GC	215.0	0037GC*
QMG-1	09/08/17	14:28	68° 29.551’	99° 53.882’	Queen Maud Gulf	40	BC	-	0038BC surface
QMG-2	09/08/17	19:59	68° 18.400’	100° 48.444’	Queen Maud Gulf	95	BC	-	0039BC surface
312	10/08/17	05:57	69° 10.235’	100° 41.732’	Franklin Strait	65	BC	37.5	0040BC A
3.7	11/08/17	08:36	72° 05.348’	96° 03.920’	Peele Sound	474	BC	45.5	0041BC A
3.4	11/08/17	21:52	71° 28.512’	91° 59.604’	Gulf of Boothia	270	BC	45	0042BC F
								46	0042BC H*
									0042BC small push*
3.4	11/08/17	22:15	71° 28.518’	91° 59.742’	Gulf of Boothia	270	GC	213.0	0043GC*
3.5	12/08/17	08:15	70° 26.197’	91° 14.179’	Gulf of Boothia	224	BC	36.5	0044BC A
5.11W	12/08/17	18:46	69° 57.295’	87° 40.360’	Fury & Hecla Strait	183	GC	225	0045GC
5.11W	12/08/17	19:06	69° 57.291,	87° 40.019’	Fury & Hecla Strait	184	BC	38.0	0046BC A
								39.5	0046BC B
5.11	12/08/17	23:39	69° 52.870’	86° 04.409’	Fury & Hecla	298	GC	249.0	0047GC
5.11	13/08/17	00:18	69° 52.961’	86° 05.079’	Fury & Hecla	298	BC	35.5	0048BC F
								39.0	0048BC I
3.10-2	13/08/17	01:54	68° 52.738’	78°09.753’	Foxe Basin	52	BC	19.0	0049BC A
1.1-1	15/08/07	10:10	65° 09.308’	81° 21.235’	Foxe Basin	418	BC	40.5	0050BC A
								40.0	0050BC B*
								40.0	0050BC small push*

29.2.3 *Core identification and labelling*

The ISMER-UQAR and MacEwan sediment samples were labelled using the following similar numbering systems. Disparities between ISMER-UQAR and MacEwan station numbers reflect the fact that while both teams took box push cores from the same sites, gravity, piston and trigger-weight cores were assigned to different teams. Gravity cores taken for Hubert/März/Zindorf were labelled as part of the MacEwan system.

<u>ISMER-UQAR system: AMD0217-01PC-AB</u>
AMD = Amundsen
02 = Leg # 02
17 = Year 2017
01 = Station # 1
PC = Corer type (e.g., PC= piston core, BC = box core, GC= gravity core)
AB = Core section if applicable

<u>MacEwan system: 2017AMD-2B-0001PC-AB</u>
2017 = Year 2017
AMD = Amundsen
2B = Leg #2b
001 = Station # 1
PC = Corer type (e.g., PC= piston core, BC = box core, GC= gravity core)
5/40
AB = Core section if applicable

For both systems, piston, trigger, and gravity core 1.5 m subsections are labelled as per Figure 28.6 with A being the base and section AB being the lowest section, followed by BC, CD etc. sequentially. Where multiple push cores were taken from a box core, they were labelled by the addition of a sequential alphabetical identifier, e.g. 003BC A, 003BC B, 003BC C etc.

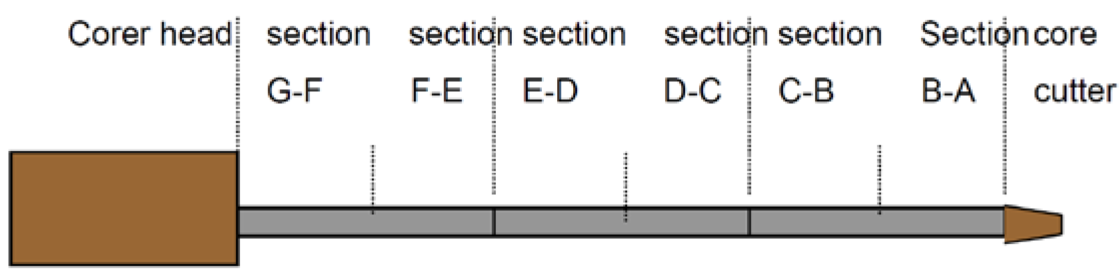

Figure 29.6 labelling system for sections of piston and gravity cores

Core samples for both ISMER-UQAR and MacEwan teams will be retained in refrigerated storage on the CCGS *Amundsen* during Legs 3 & 4 to be removed on demobilisation during October in Québec. Cores will then be shipped, and stored, and analysed in detail at Rimouski and Edmonton.

29.3 Preliminary Results

Considering the challenge to work in the Arctic Ocean due to rough sea conditions (notably at the Belcher Glacier and Barrow Strait sites) and sea ice extent (particularly Peel Sound and Fury

& Hecla Strait), the mission was still successful with the collection of multiple sediments samples (Figs. 7 & 8; Appendix A Tables 1.1, 1.2, 1.3 & 2), considerably expanding sediment core coverage through the eastern Canadian Arctic and Northwest Passage.

A total of 51 box cores, 9 gravity, and 8 piston cores were recovered at different locations along the Frobisher Bay, Disko Fan, Home Bay Fan, Trinity Fjord, Manson and Belcher glaciers, Prince Regent Inlet, Queen Maud Gulf, Gulf of Boothia, Peel Sound, and Foxe Basin. This high number of samples provides an excellent surface coverage of the entire study area which will allow us to have more confidence in our downcore interpretations. Some coring locations were abandoned due to the substrate being too coarse for coring (identified prior to long coring in the box core) while others resulted in core cutter damage due to large caliber clasts in lower deglacial facies (Figure 28.7).

Figure 29.7 Damaged piston core cutter being removed from the lowermost core barrel. Note splayed and deformed cutting edge

For the ISMER-UQAR team, these samples will be analyzed in detail in the laboratory to achieve the objectives of this mission. Briefly, sediment samples will be studied for their mineralogical (bulk and clay fraction), geochemical (elemental and isotopic), microfossil (dinoflagellate cysts, non-pollen palynomorphs, benthic and planktonic foraminifera), palynological (dinoflagellate cysts), magnetic, and siliciclastic grain-size signatures. Such studies will provide a baseline to better interpret, in terms of sediment dynamics and climate change, the sedimentological signatures preserved in the Canadian Arctic sedimentary records, which may then help to place current eastern Arctic climate change.

Samples for MacEwan University will be analysed as part of ongoing studies in to regional deglaciation, deglacial ice shelf development and collapse, deglacial-postglacial sea ice evolution, ocean circulation, and foraminiferal distribution. Laboratory analyses will include lithostratigraphy, mineralogy micropaleontology (benthic and planktic foraminifera, organic walled-microfossils), biogeochemistry (stable isotopes, sea ice biomarkers, total organic carbon), cryptotephra, and radiocarbon chronostratigraphy (foraminifera, molluscs, compound-specific) investigations.

Sediment samples for diagenetic overprint for the Calgary/Leeds/Newcastle group will first be analyzed for bulk inorganic geochemistry (by XRF or ICP-MS). Depending on the results, Fe speciation, P speciation, S isotopes and trace element geochemistry (ICP-MS) will be applied. Pore-water samples will be analysed for dissolved sulphur, cations, anions and trace elements (ICP-MS or ICP-OES) and, depending on outcome, for S isotopes.

Preliminary results are limited to direct observations of core penetration and sediments visible through the clear core-liner walls and exposed in box cores and in core cutters/catchers. In the Disko Fan, Home Bay Fan, Trinity Fjord, Manson and Belcher glaciers, most of the surficial seabed sediments are predominantly composed of olive-grey silty clay with relatively abundant benthic fauna. In contrast sediments from the Frobisher Bay, Prince Regent Inlet, Gulf of Boothia, Peel Sound, and Foxe Basin areas consists of a relatively thin layer (~10 cm) of reddish brown silty clay (oxic layer) overlying a diamicton with abundant pebbles and cobbles. Thick sequences of apparently massive grey muds were encountered at both Fury & Hecla sites, the gravity corer not recovering the diamicton expected to occur deeper in the sedimentary sequence. In norther Foxe Basin only a shelly gravel was recovered by the box corer, requiring that gravity coring be cancelled due to risk of corer damage on such a hard substrate. In southern Foxe Basin, thick sequences of organic anoxic black-mottled grey muds were encountered above diamicton. Pore-water extraction was generally successful with yields of 2 to 8 ml water during the first hour of sampling depending on sediment compaction and water content.

The time period covered by each core record depends on the sediment accumulation rate at each location. For longer records, this is expected to be highly variable as depositional processes change from the Late Pleistocene through the Holocene (high sedimentation rate ice-proximal glacimarine environments through to low sedimentation Late Holocene Arctic marine settings). For the ISMER-UQAR team, chronology will be mainly determined by following the paleomagnetic approach proposed by Barletta et al. (2008, 2010) and Lisé-Pronovost et al. (2009). This chronostratigraphic analysis will be performed in close collaboration with ArcticNet Network Investigator Guillaume St-Onge. This paleomagnetic age model will be improved by a combination of AMS 14C ages on mollusc shells and/or benthic foraminifers (when present) and ^{210}Pb-^{137}Cs measurements on the companion box-cores. As part of ongoing efforts to improve the applicability of AMS ^{14}C chronologies for the high Arctic – a chronostratigraphic approach on which most terrestrial island Quaternary histories are based – the MacEwan team will use foraminiferal (ideally monospecific planktic and benthic) ^{14}C dates coupled with the selective use of compound-specific bulk organic ^{14}C dating and, where applicable, ^{210}Pb-^{137}Cs measurements. To explore further constraining currently poorly-quantified early to mid Holocene marine reservoir age correction factors (used in calibrating ^{14}C ages to calendar-equivalent calibrated ages) cryptotephras will be investigated and identified and compared to the ^{14}C chronology.

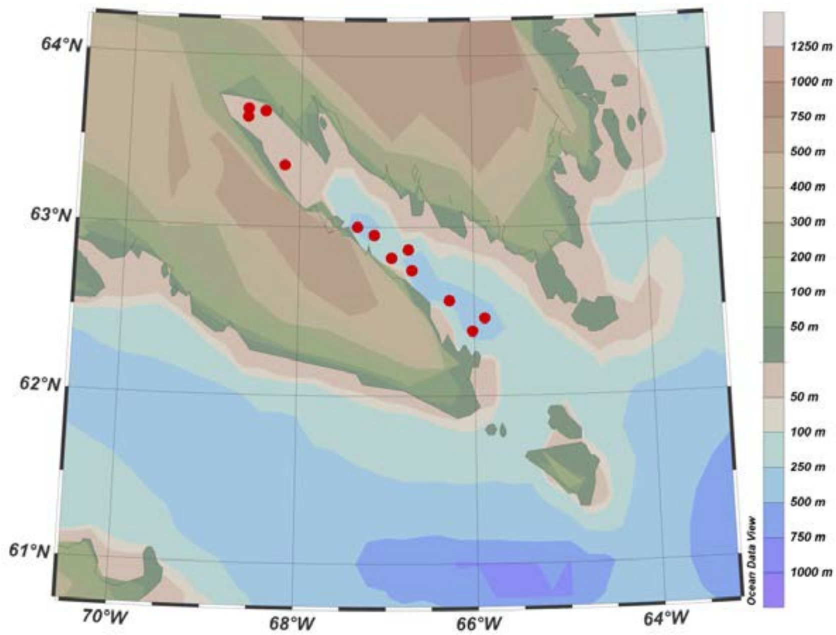

Figure 29.8 Location of the box core samples collected in Frobisher Bay during Leg 2b

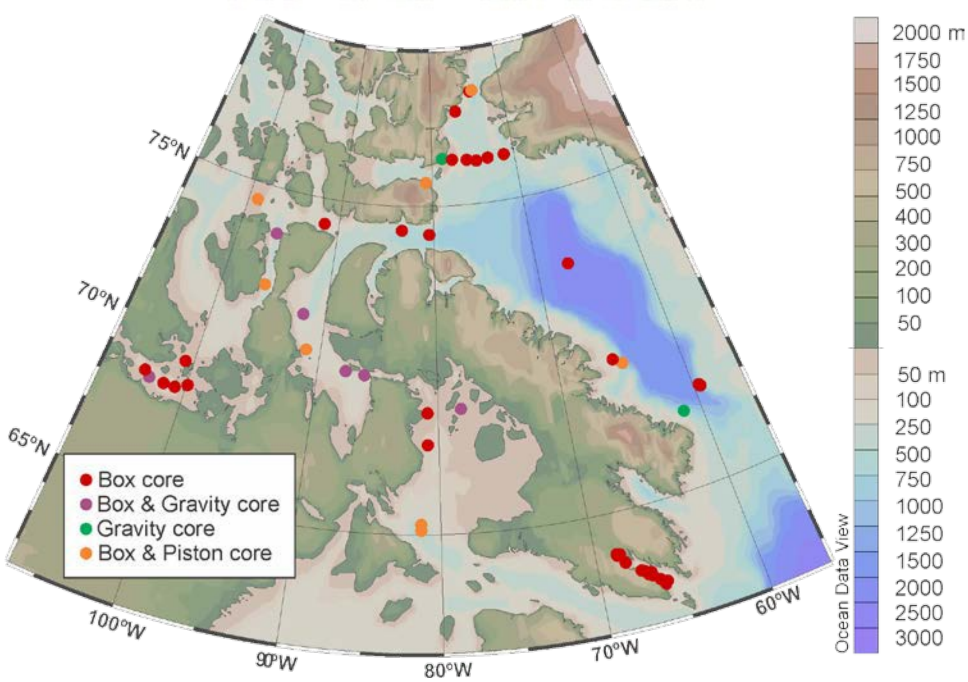

Figure 29.9 Sample location during Leg 2b of the 2017 Amundsen expedition

Finally, from a student and HQP-training perspective, the expedition was a unique opportunity for Simon Faye (PhD student at ISMER-UQAR), Sarah Letaeif (Master student at ISMER-UQAR), Anne Corminboeuf (bachelor student at UQAR and Université Laval), Rabecca Thiessen (bachelor student at MacEwan University), Alexandre Caouette (bachelor student at MacEwan University), and Mark Zindorff (PhD at Newcastle University) to receive hands-on training in Arctic ship-based coring and sampling operations.

29.4 Comments and Recommendations

Overall, we were satisfied with the vessel access and ship time request process. Nevertheless, there remains a perception that the geological aspects of ArcticNet are of lower priority compared to other activities such as CTD/Rosette sampling, resulting in emphases being placed on returning to the same stations every year. There is a sense that there is little flexibility for proposing geologically important and interesting stations outside of the ship's "normal" cruise track during the planning stages of the cruise. This is also seen in the apparent ease of adding ad-hoc nutrient stations during the mission (especially the first part of Leg 2b) when it was perceived that proposals for opportunistic (and quick gravity) coring would not be met with similar enthusiasm. Perhaps it reflects more our natural emphasis on our own research foci in the geosciences rather than the actual complex reality of an interdisciplinary research cruise and the compromises required to make that work.

The hard work put in by the ArcticNet expedition planning team is recognised and very much appreciated and the complexities of Arctic research planning are fully acknowledged. However, as an end user, we had several concerns. After a fruitful mission planning meeting in Québec it came as a surprise that berth space issues had not been adequately resolved – something that resulted in a major headache for both the planning team and research groups. As a consequence of berths being oversubscribed, our team lost the opportunity to conduct helicopter and shore-based surveys and had to drastically cut the size of the coring team for the first part of Leg 2b to three people. The latter issue comes with major health and safety consequences with a bare-bones team of three being hugely overworked. A crew of five piston-coring personnel, including two people qualified to core lead and work at the A-frame on harnesses at any one time should be considered a safe and effective minimum requirement. Further, major issues around berth allocation must be resolved by the end of the mission planning meeting to avoid the subsequent problems that were apparent this year. Lastly, we understand that with Keith Levesque's departure from ArcticNet, the planning team were working their hardest to sort out the complex logistics for the expedition. However, given that many expedition members were travelling not just locally from Québec, but at considerable expense from across Canada and internationally we found the information on charter flights (in particular the dates) was given at very short notice making booking economical flights difficult. The short notice given in the expedition planning was also apparent when assembling equipment and consumables for piston coring. The relationship between the Geological Survey of Canada and ArcticNet was always rather ambiguous (service provider, research partner, both?) such that when the GSC were no longer involved in this year's expedition, major issues arose surrounding the provision of qualified coring personnel and consumables such as core liner tubes and end caps. Receiving information that core liner tubes and end caps would not be available through ArcticNet a month before the expedition was due to depart Québec when the minimum order time for such materials typically exceeds two to three months caused considerable consternation. This was particularly true for the smaller MacEwan University and Memorial University teams that did not have core liners in store or could afford (or needed) the large number of core liners required to make a minimum order from the manufacturer in the US. It was only after several stressful weeks and through exploiting (abusing?) good personal relationships with individuals at the GSC, Laval, and Rimouski that sufficient liners were procured to make coring possible for these teams. If the GSC are not to be involved in future cruises, we recommend that research teams are aware that they will be required to provide their own coring consumables by the mission planning meeting in February/March (at a minimum). Perhaps there could be an option for ArcticNet, in discussion with user research teams, to purchase core liners and caps (3 metre core liners exceed $100 a piece and require a very large minimum order) and charge research teams for their use on a per-item basis.

Despite the above constructive criticism, we consider this year's expedition to have been very successful and are highly satisfied with our experiences conducting research on the Amundsen. The crew and officers were fantastic – exceptionally able, helpful, and personable. Science personnel from other teams aboard were great, volunteering to assist during coring activities and valuing both formal and informal collaborations. Morale on the ship was high and it was a joy to see so many students having such a great opportunity to undertake Arctic research. The chief scientists did an excellent job in balancing sometimes competing research interests with weather, sea ice, and precious time constraints. Martine Lizotte did a great job for her first time as chief scientist during the second half of Leg 2b and was particularly accommodating when it came to requests for adding additional gravity core samples to the cruise plan. We look forward with pleasure to continued involvement with ArcticNet and future opportunities for Arctic geological science and student training aboard the CCGS *Amundsen*.

Acknowledgement

We gratefully thank the chief scientists Jean-Éric Tremblay and Martine Lizotte, the Captain Claude Lafrance, the officers and crew of the CCGS *Amundsen* for their support, their help, and friendship throughout this leg of the 2017 ArcticNet cruise. We also acknowledge the support of the mapping group (Annie-Pier Trottier and John Patrick McNeill) who greatly facilitated the site surveys and Angus Robertson at GSC-Atlantic who provided expert advice during sea trials and helped supply consumables for piston coring.

30 Hidden Biodiversity and Vulnerability of Hard-Bottom and Biogenic Habitats and Surrounding Environments in the Canadian Arctic – Leg 2b

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30.1 Introduction

The ROV-based research program on hard-bottom and vulnerable benthic environments aboard the CCGS *Amundsen* during its 2017 mission is sponsored jointly by ArcticNet Project, Hidden Biodiversity and by Fisheries and Oceans Canada. The major goals of the DFO-funded program to study coral and sponge habitats in the Canadian Arctic and the ArcticNet HiBio (Hidden biodiversity and vulnerability of hard-bottom and surrounding environments in the Canadian Arctic) project are to discover previously unknown coral and sponge biodiversity, other invertebrate and fish biodiversity, and previously under-sampled hard-bottom and biogenic habitat types in the Canadian Arctic. Focal regions are the Eastern Canadian Arctic including the northern Labrador Sea and Baffin Bay, and the eastern portions of the Canadian Arctic Archipelago.Particular emphasis is placed on steep and deep hard-bottom habitats that cannot be sampled effectively using traditional oceanographic sampling methods such as box-cores.

In 2017, an additional component was to compare measurements of ecosystem function in soft-bottom biogenic habitats structured by corals and/or sponges with those in adjacent habitats without the corals or sponges. Finally, a major focus for the 2017 field campaign was to have been the well-documented hydrocarbon seep at Scott Inlet. Related research in Leg 4b will deploy moorings with current meters, sediment traps, and hydrophones to measure currents, survey plankton and particulate organic matter (POM), and record marine mammal activity in cold-water coral dominated habitats off the northeast edge of the Labrador shelf, and to survey benthos in an adjacent area under consideration for a new deep-water marine protected area.

The Super Mohawk (SuMo) ROV aboard CCGS *Amundsen* forms an integral part of the ArcticNet Hidden Biodiversity, and DFO funded programs. Associated research used instrumental data and water sampling from the CTD & rosette, invertebrate and ichthyoplankton sampling using the tucker and monster nets, and benthic sampling using the box corer and Agassiz trawl to sample the same environments through the water column, while seafloor mapping with multibeam sonar and sub-bottom profiler characterizes the seafloor underlying these benthic environments. Our integrated geological, biological, and oceanographic sampling addresses these understudied environments in a holistic fashion.

Most sites were chosen based on previously identified coral and/or sponge diversity and abundance hotspots from scientific trawl survey or experimental fisheries bycatch data. These included the various sites around Hatton Basin, Jones Sound, Lancaster Sound, and Admiralty Inlet. Exceptions were the site of a persistent surface oil slick and suspected hydrocarbon seep at Scott Inlet, the steep rock walls in Pond Inlet, and the bamboo coral forest at Disko Fan (Neves et al. 2014). Finally, one of the goals of the project is to identify and characterize corals and sponges in areas of the Arctic that have not previously been impacted by commercial fishing activities.

Other activities in 2017 included a survey of sponges discovered in box cores, Agassiz trawls, and beam trawls, and studies of the stable isotopic composition, lipid content and composition of soft corals sampled throughout leg 2b, coupled with sampling of the stable isotopic composition of sedimentary organic matter. Additionally, thyasirid bivalves occurring in marine sediments were surveyed at all box core sites throughout the cruise leg.

The general scientific objectives are:

1) Assess coral and sponge biodiversity within hard bottom and biogenic habitats of the Eastern Arctic.
2) Assess fish diversity and abundance associated with coral and sponge habitats within Jones Sound, Lancaster Sound, Pond Inlet, Admiralty Inlet, and at the Disko Fan (SE Baffin Bay) narwhal-coral closure.
3) Assess the hypothesized connection between hydrocarbon seeps, authigenic carbonates, and habitat for hydrocarbon-tolerant microbes, corals, sponges, bivalves, and other fauna at a well-documented hydrocarbon seep.
4) Characterize the microbial and macrofaunal biota of a northern cold seep and adjacent areas, and to collect thyasirid bivalves for assessment of their symbiotic microflora wherever these bivalves were encountered.
5) Determine how soft-bottom coral and sponge habitats contribute to regional infaunal sedimentary diversity and function.
6) Measure aragonite and calcite saturation profiles in Frobisher Bay, Baffin Bay and the Eastern Canadian Arctic Archipelago, with the goal of understanding how aragonite and calcite saturation might affect the composition of VME communities.
7) Measure stable isotope composition of particulate organic matter and soft corals, to assess the potential importance of deposit feeding as a source of nutrition in soft corals.
8) Characterize water column microbial diversity in sites with abundant cold-water corals and sponges.

30.2 Methodology

A total of eight locations in the northern Labrador Sea and southeastern Baffin Bay were chosen for possible surveys using the SuMo ROV during the Amundsen 2017 expedition, with three locations as targets in the initial cruise plan, and five alternate locations due to the risk of ice cover preventing access to some target locations. The three initial target locations were: Scott Inlet Hydrocarbon Seep (Scott), Disko Fan bamboo coral forest (Disko), and Lancaster Sound, the site of a proposed National Marine Conservation Area, and where abundant sea pen meadows of the Arctic sea pen Umbellula encrinus have been observed as part of time-lapse camera observation of Greenland Sharks;

The five alternate locations werev (see Figure 29.1):

1) The outer side of the NE Hatton Basin sill, Northern Labrador Sea known habitat for the large gorgonian corals Primnoa resedaeformis and Paragorgia arborea;
2) Jones Sound, where abundant sea pen meadows of the Arctic sea pen Umbellula encrinus have been observed as bycatch in experimental fisheries;
3) Pond Inlet, where steep rock walls exposed to sedimentation from Bylot Island glaciers provide a representation of the deep coral and sponge fauna in glacierized fjords exposed to the Atlantic water mass;
4) Navy Board Inlet, site of a large bedrock massif in shallow waters bathed by Pacific-derived water;
5) Admiralty Inlet, where multibeam sonar has detected large hard-bottom features associated with potential moraines and mega-scale glacial lineations (MSGL), with steep rocky habitats, and where experimental fisheries have documented a diverse assemblage of corals and sponges.

At each station, the intended sampling methodology consisted of: multibeam sonar and 3.5 kHz sub-bottom profile survey, one ROV dive, water column profile sampling with CTD and rosette, and box core and/or Agassiz trawl. The Agassiz trawl was cancelled in locations that appeared to contain too many boulders, and might therefore risk damaging the trawl. In locations for studies of sedimentary ecosystem function, box-cores were collected in quadruplicate, two in the coral or sponge habitat, and two in areas without the corals or sponges, as determined on the basis of ROV video surveys.

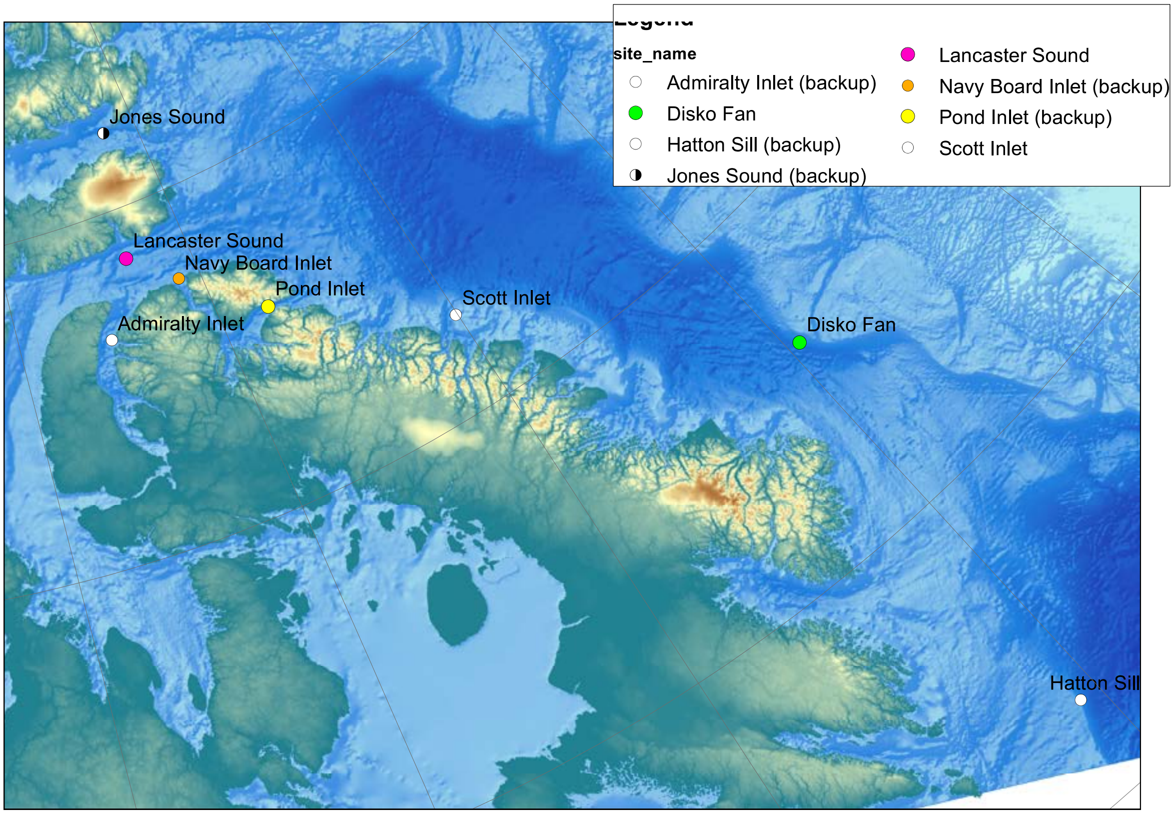


Figure 30.1 ROV dive locations planned or visited during the 2017 CCGS *Amundsen* expedition

Five sites were in the original dive plan. Three additional alternate sites were added during the cruise to accommodate loss of other dive sites to ice conditions or weather: Pond Inlet (PI), Navy Board Inlet (NBI), and Admiralty Inlet (AI). The planned order was to have been Disko Fan, Scott Inlet (2 dives), Lancaster Sound. The achieved order was Disko Fan, Jones Sound (visited, but dive cancelled on site due to rising winds), Pond Inlet, Navy Board Inlet (dive aborted due to winds), Lancaster Sound. The Pond Inlet site was added because the ship needed to transit to Pond Inlet to disembark a scientist who needed to leave the voyage early for family reasons.

30.2.1 *Equipment*

The SuMo ROV has a high definition (HD) camera (1Cam Alpha, Sub C Imaging, 24.1 megapixels) and two green lasers 6 cm apart for size indication. We used the FH video recording mode (second best resolution), since using the best resolution would reduce the camera storage capacity. A sampling skid (Figure 29.2), essentially a sliding tray into which samples can be stowed opportunistically throughout the length of the dive, was installed at the beginning of the Amundsen 2016 Leg 2a. This sampling skid was invaluable during the 2017 field season, as it enabled opportunistic sampling of fauna along ROV transects during dives.

An elevator built in 2015 to be used with this ROV was planned to be deployed at two of the three sites: Scott Inlet hydrocarbon seep (site 2), and Disko Fan (site 1). The elevator consisted of a platform holding seven polycarbonate boxes of mixed size at its base, and five floats at the top of the platform (Figure 29.2). Unfortunately, high ice cover prevented the use of the elevator in Disko Fan, and high ice cover led to cancelling of operations at Scott Inlet altogether. The elevator was not used during the 2017 field season.

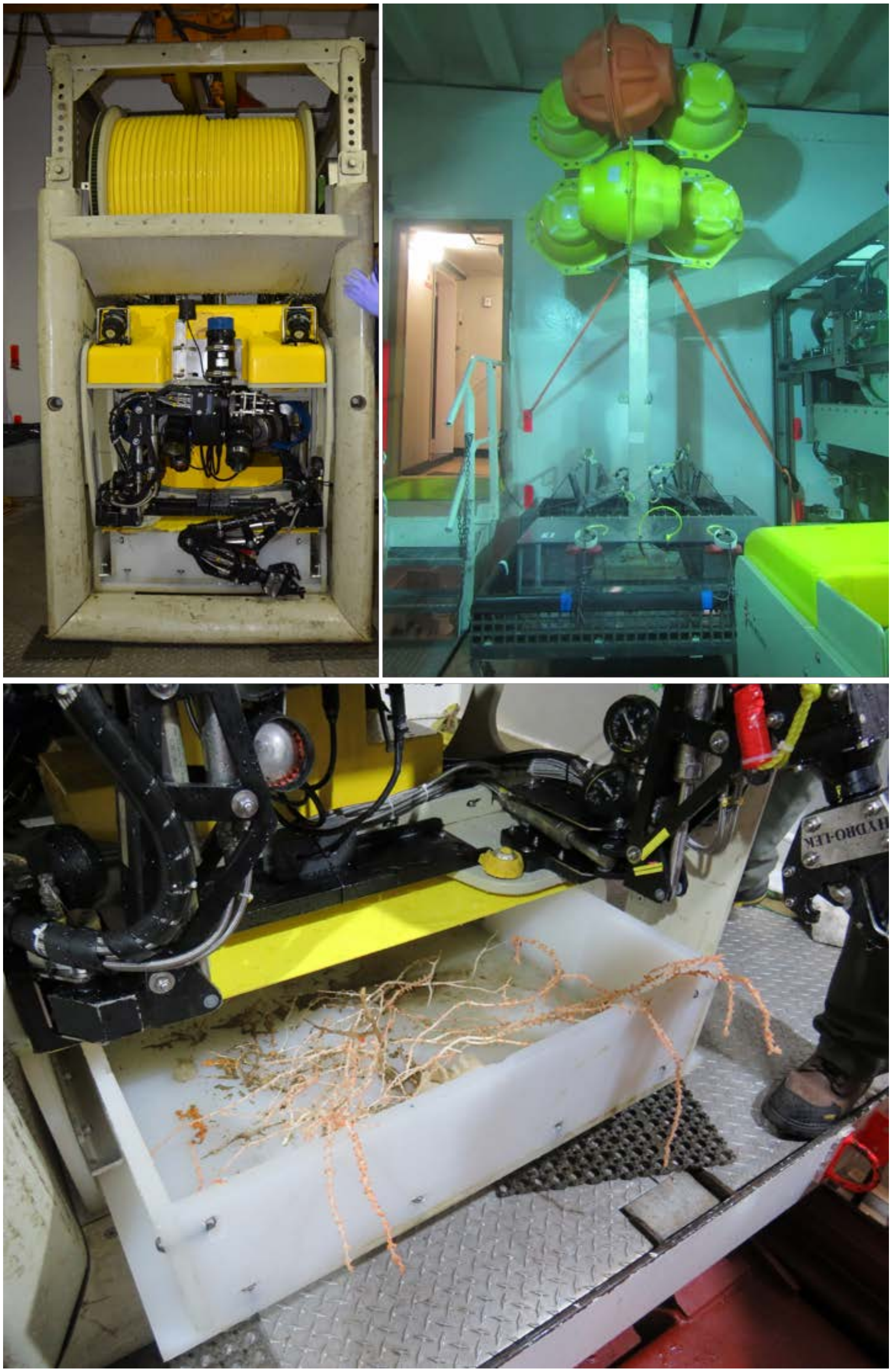


Figure 30.2 A) Super Mohawk (SuMo) ROV, B) elevator, and C) sampling skid with Keratoisis sp. Samples

30.3 Preliminary Results

Table 20.1 summarizes the sites where ROV surveys took place.

Table 30.1 Details on sites surveyed with the SuMO ROV during the 2017 CCGS *Amundsen* expedition

Dive	Date	Site	Latitude (N)	Longitude (W)	Depth (m)	Bottom time
58	19-07-2017	Disko Fan	67°58.17’	059°30.26’	930	1:43 - tech
XX	30-07-2017	Jones Sound				No dive: wind
59	1-08-2017	Pond Inlet	72°49.643′	077°36.596′	845	6:30. complete
60	2-08-2017	Navy Board Inlet	73 43.54	081 05.57	280	0:35 - wind
61	3-08-2017	Lancaster Sound	74 16.66	083 21.88	726	4:58. Tech.

30.3.1 *Dive 58: Disko Fan (67° 58.17012 N/ 59° 30.26268’W). July 19th 2017*

At this site, one ROV dive had three objectives: to recover a recruitment/bioerosion experiment deployed at this site in 2016 and deploy another similar experiment for collection at another point in the future, yet unknown; to collect a large sample of dead coral fragments from the path of a 1999 trawl survey to assess natural coral recruitment and coral forest recovery from trawl disturbance, and to carry out a video survey to increasing depth to assess the lower depth limit of the coral forest. Unfortunately, because 3-4/10 ice cover precluded the use of the elevator, the experimental rack had to be recovered directly by the ROV. Furthermore, three technical issues with the ROV deployment dramatically shortened the dive, meaning that only the first objective, that of recovering the experiment, was accomplished.

Three technical issues impeded use of the ROV at this site. First, the ROV moon pool was full of ice shaved off into the moon pool while CCGS *Amundsen* had been breaking ice in the two days prior to this ROV dive. Although the ship’s engine room had left a warm water vent running into the moon pool overnight, the moon pool was still full of shaved ice in the morning, which had to be cleared mechanically, delaying the start of the dive by about 3 hours. Second, the ROV had a light failure upon launch into the moon pool, the repair of which further delayed the dive by another 3 hours. When the dive was finally begun, only 4 hours of the initial 12-hour operating period remained. The goal at this point had been to recover the experiment, bring it to the surface for recovery by zodiac, and continue the dive for the other two objectives. Unfortunately, the ROV manipulator arm froze shortly after picking up the recruitment/bioerosion experiment, necessitating an immediate two-part recovery of the ROV. The experimental rack was recovered, but the other dive objectives were not met. Furthermore, because the rack was recovered without the aid of the elevator, several of the substrates attached to the rack were dislodged during ascent through the water column.

<u>Box cores and incubations.</u>

At this site, six box-cores were deployed, in order to set up incubations to assess sedimentary ecosystem function. Checking the coordinates of the first four box core deployments found that the two cores aimed at coral habitats were incorrectly placed; these were repeated during the time period between the ROV light failure and the ROV deployment. Results of the incubations are described in a separate cruise report (C. Grant, HiBio/Arc3Bio).

The carbonate experimental frame was found approximately 25 minutes after the ROV landed on bottom (Figure 29.4). The recruitment/bioerosion experiment had a 50% recovery rate for the pieces of rock, coral, or shell deployed. Recovery of the upward-facing pieces (68%) was greater than recovery of the downward-facing (38%) pieces. Final frame contained 13 plates on top, and 8 plates on bottom, making a total of 21 plates out of 36 (Figure 29.4). Although the rack was composed of 3-1-6 stainless steel, it suffered some rust. Crevice corrosion was also observed at one of the welds within the rack. Furthermore, and with greater impact upon the recovery rate of the experimental blocks. crevice corrosion occurred in the stainless steel below the marine epoxy glue holding the substrates to the rack. The pieces of rock or Primnoa coral that were lost from the rack apparently dislodged at the point of the stainless steel crevice corrosion, with no influence from rust. Most of these pieces on the upward-facing side of the rack were present when the rack was located, but were dislodged during the ascent. Several of the downward-facing pieces, particularly the heavier pieces of rock or Primnoa skeleton, were observed on the sediment surface below the rack at the time of collection.

Macroscopic recruitment observed on the substrates was uniformly low, with more anemones and other soft-bodied recruits attached directly to the frame holding the substrates than to the experimental substrates themselves. Hydroids were found attached to the rope, but not to the plates or frame (Figure 29.5). No macroscopic bioerosion was visible. Substrate pieces recovered were photographed and frozen for microscopic examination and precise measurement of weight loss on return to Memorial University. Rusting of the rack may have influenced the results of the experiment, as several of the experimental substrates had rust-staining on them, especially the marble and the Umbellula skeleton pieces, suggesting oxy-hydroxide precipitation. While it is possible that the oxy-hydroxides resulted from oxidation of iron in the hemipelagic sediments, it is more likely that they formed as a result of rusting of the rack itself. Interestingly, the highly convoluted, fragile aragonitic skeletons of Flabellum alabastrum recovered appeared to have experienced no colonization fragmentation, rust staining, loss of detail, or other macroscopic evidence of degradation.

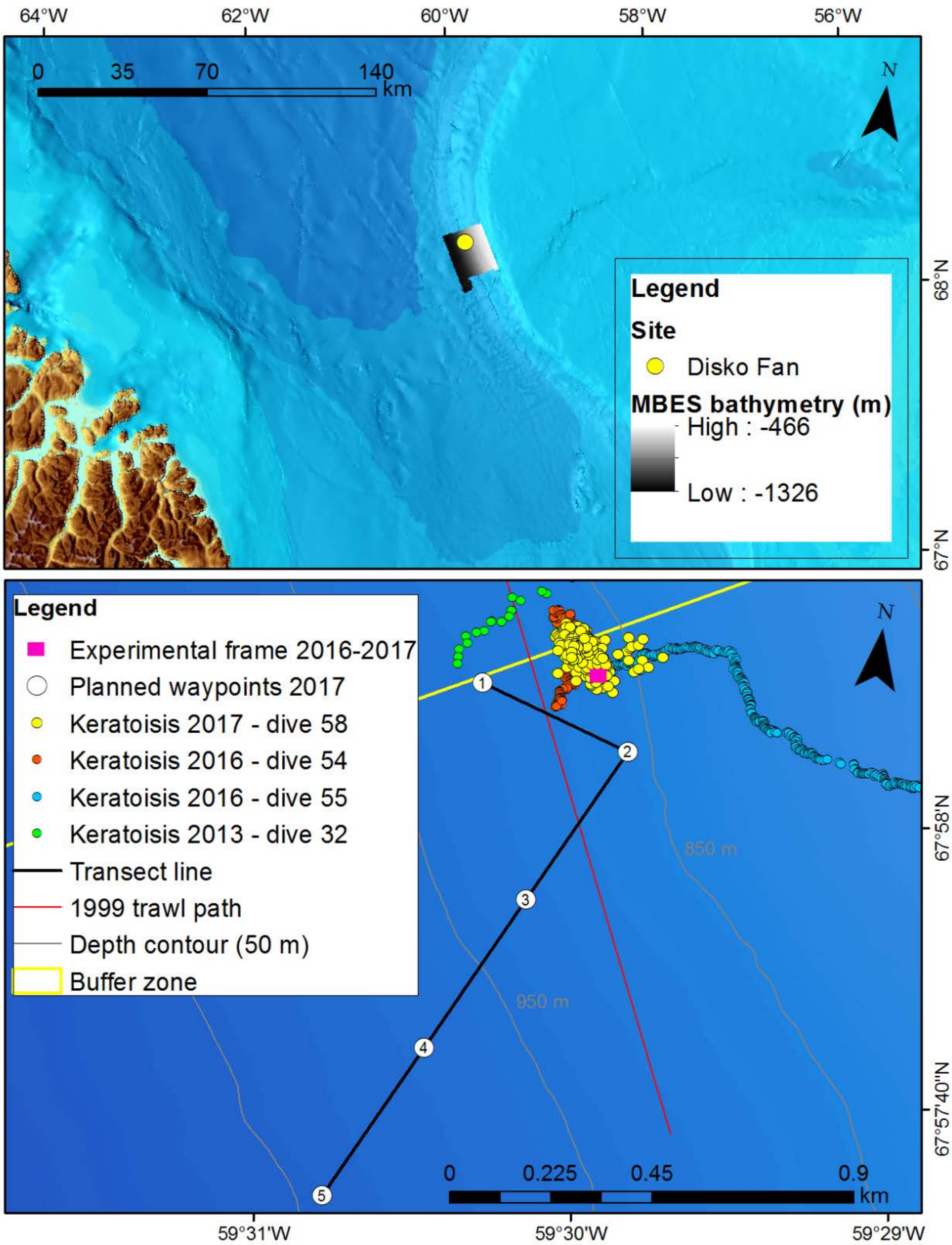


Figure 30.3 Disko Fan ROV dive 58 (site 1): A) general location, B) details of planned and accomplished transects, and the location of the settlement/bioerosion experiment.

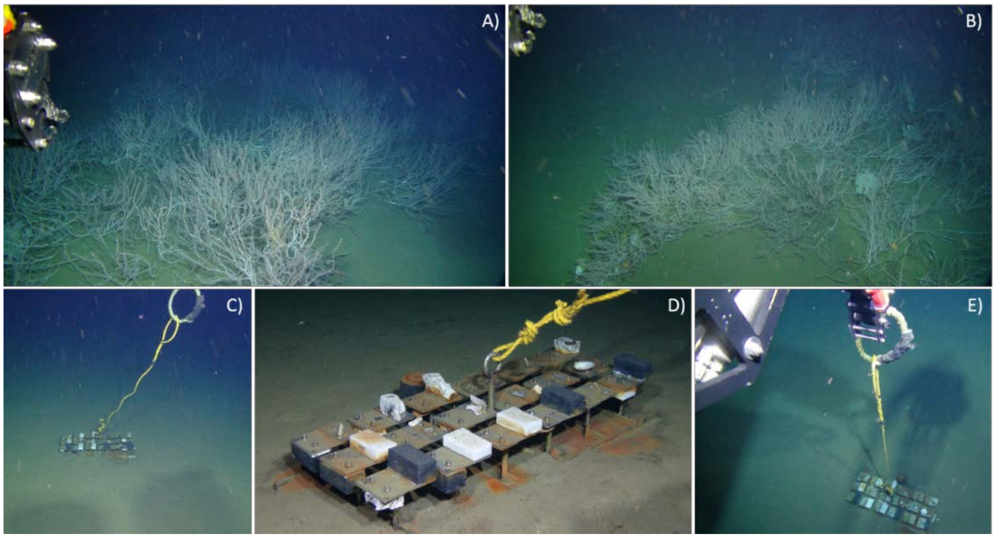


Figure 30.4 Dive 58 at Disko Fan. A) and B) Keratoisis sp. patches, C) experimental frame at sight, D) close-up of experimental frame, E) frame recovery.

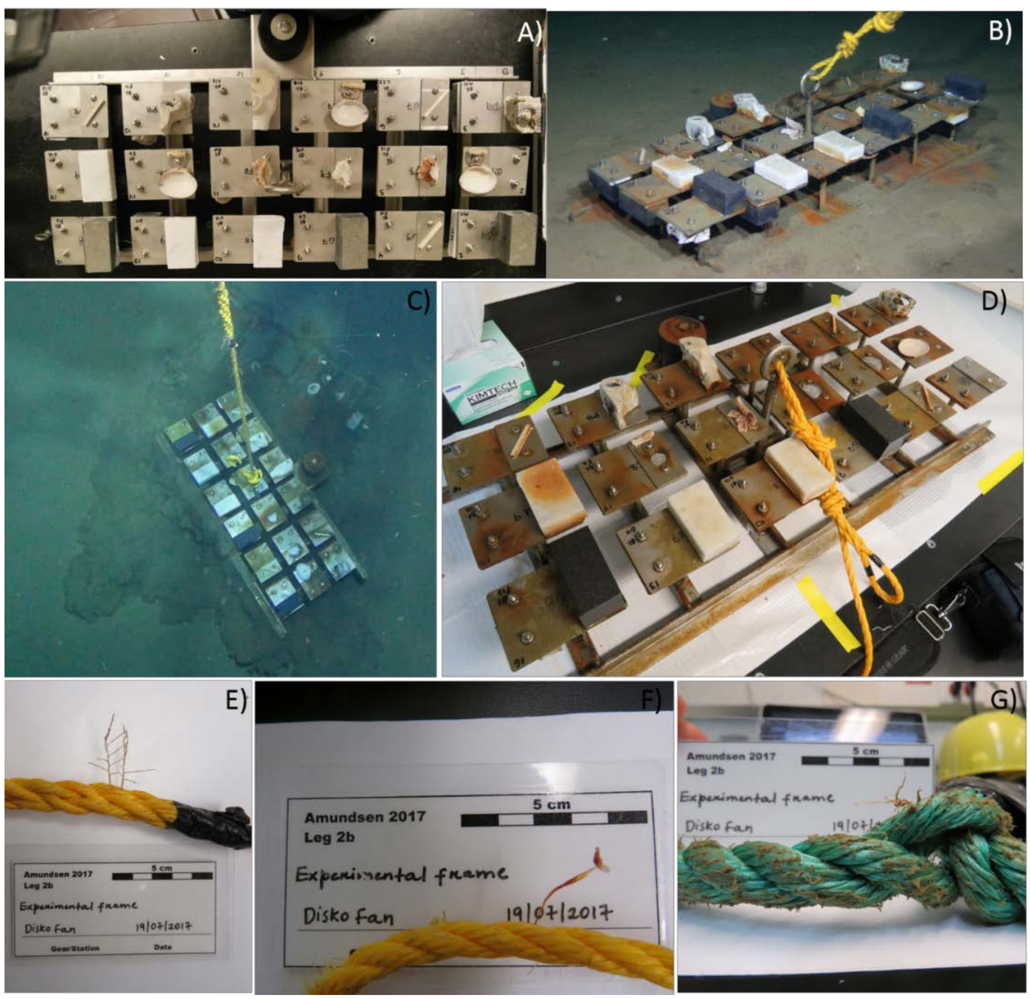


Figure 30.5 Carbonate experiment deployed at Disko Fan: A) experimental frame before deployment in 2016, B) frame in situ in 2017, C) frame being lifted, showing fallen pieces on the seafloor, D) recovered frame, E-G) specimens settled on ropes. Red arrows point to missing plates.

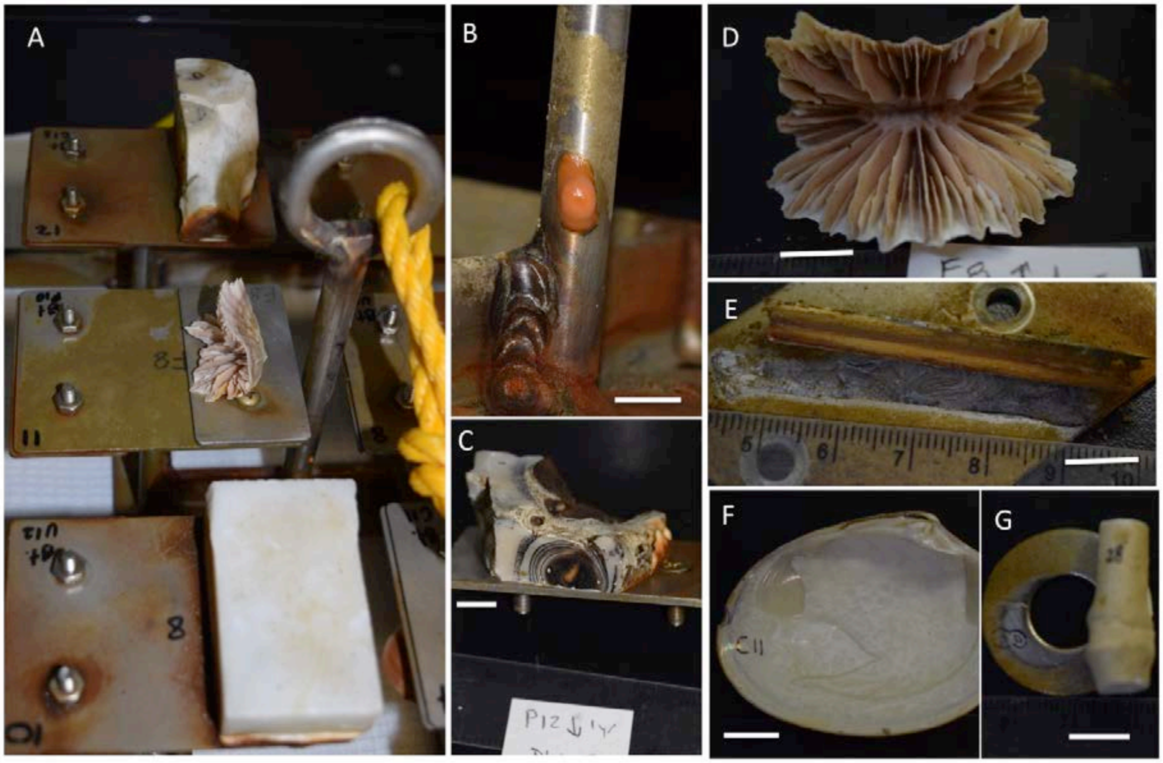


Figure 30.6 Photos of recovered experimental frames and bioclasts. A. Subset of three substrates on rack upon recovery. Note rust near hardware and staing of Primnoa (at rear). B. Anemone settled on rack. C. Primnoa skeleton. D. Flabellum skeleton. E. Section of Umbellula skeleton. Note crevice corrosion on steel plate below dislodged and Fe-stained skeleton. F. Callista bivalve shell. G. Keratoisis segment. Scale bars (B-G) 1 cm.

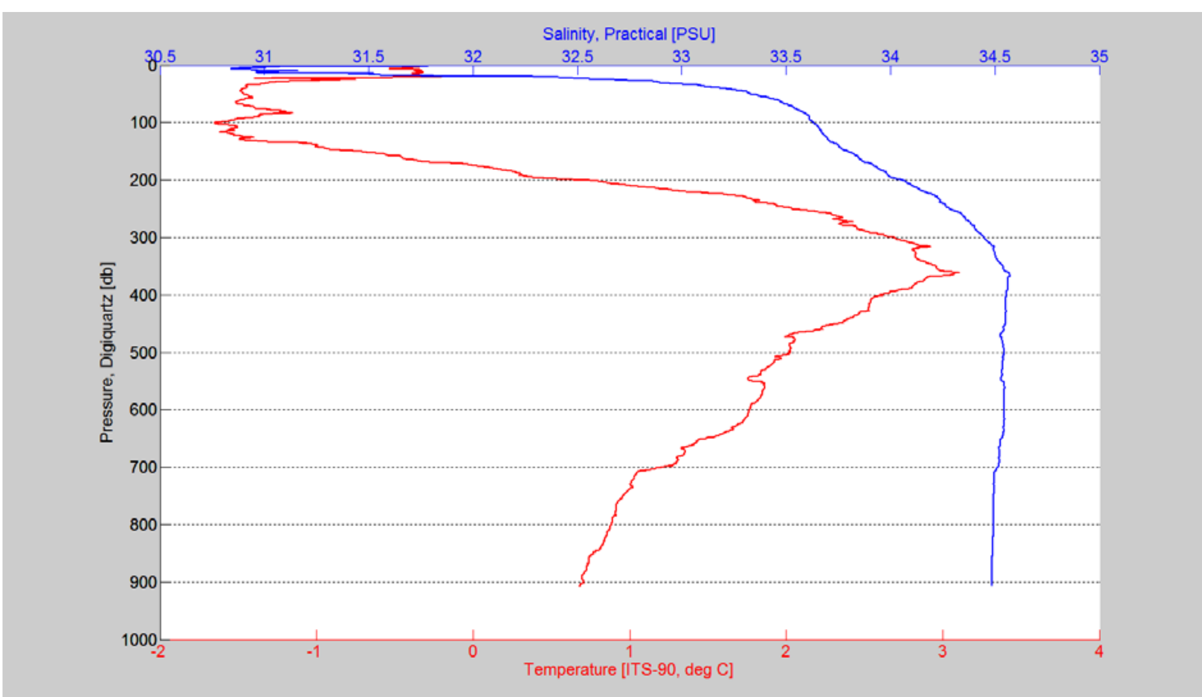


Figure 30.7 Temperature and salinity plot for rosette station 1702020 (Disko Fan)

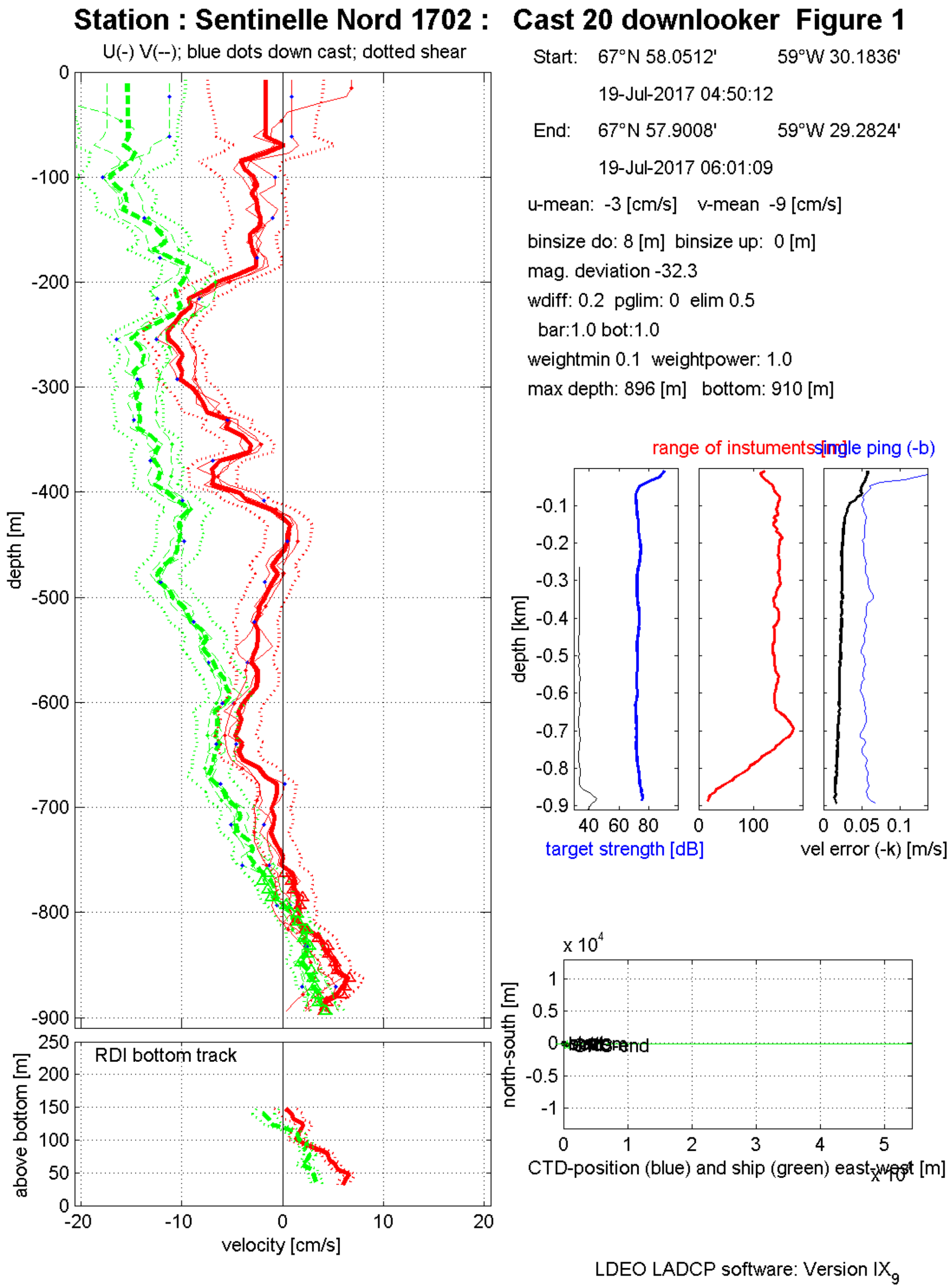


Figure 30.8 Bottom currents, Disko Fan

Figure 30.9 Box-core deployed at Disko Fan “patch”, showing fragments of Keratoisis sp. recovered. The combined weight of the Keratoisis pieces recovered in this box-core was 180 g

30.3.2 *Dive XX. Jones Sound (76º04.99’N/ 81º56.49W’, 790 m). 30 July 2017.*

The ROV dive at Jones Sound was one of two alternate dive sites originally proposed in our ArcticNet sampling request and Dive Plan. Jones Sound has been the site of an experimental fishery for Greenland Halibut since 2014, which has revealed a high abundance of corals and sponges, especially the arctic sea pen Umbellula encrinus, including large and apparently very long-lived individuals (Neves et al. 2014, Arctic Change).

The primary purpose of the ROV dive in Jones Sound was to be to characterize the diversity, abundance, and size-frequency distribution of corals, sponges, other invertebrates, and fishes in the mid-depth waters of Jones Sound, including the steep slopes near the eastern entrance to Jones Sound. The particular dive site chosen is based upon coral and sponge bycatch data from the experimental fisheries in Jones Sound. Jones Sound includes a polynya on the western end, near Hell Gate, where strong tidal currents keep the gate ice freemost of the year, and another polynya closer to the dive site, in LadyAnn Strait. These polynyas, combined with the through-flow of waters from the Beaufort Sea to Baffin Bay, may lead to highly productive conditions. Alternatively, the high abundance and large size of corals observed in Jones Sound may result from lack of disturbance, as this area has not experienced industrial fisheries apart from whaling and sealing.

We arrived at this dive site on the afternoon of Sunday, July 30, 2017 having delayed our arrival by a few hours to allow for mapping, sub-bottom profiling and gravity coring at Manson Bay, rather than require us to double back to this site after having completed the ROV dive. We proceeded with 1 hour of multibeam sonar site mapping and sub-bottom profiling, while we assessed the winds, which had been forecast for 15-20 kt. During the multibeam mapping, the winds continued to rise to above 25 kt., the threshold for safe ROV diving with the SuMo ROV. The dive was cancelled during the multibeam mapping of the site. After the mapping was completed, we proceeded with an ROV cast to gather data on water column characteristics in this site, before proceeding to Belcher Bay for piston coring near the Belcher Glacier.

30.3.3 *Pond Inlet. (72°49.643'N/ 077°36.596'W, 845 m). 2 Aug. 2017*

The primary purpose of this dive was to investigate the fauna of steep rock walls in a glacierized fjord setting, that is, a fjord that is experiencing rapid sedimentation from active glaciers in its catchment area. Pond Inlet lies in the deep rocky channel between the NE end of Baffin Island and Bylot Island, both of which have active glaciers delivering sediment to the inlet. Sedimentation rates outside of Pond Inlet in about 1100 m water depth are 1.5 m/ ky, extremely rapid for Baffin Bay or the Labrador Sea. Strong currents likely winnow some of this sediment. The high rate of sedimentation experienced at this site implies that most bedrock surfaces will have a veneer of fine sediment, unless they are vertical or overhung, or unless the sediments are winnowed by currents. Although somewhat strong currents were observed during the descent at the beginning of the dive, the LADCP on the CTD/rosette indicated a maximum current speed of about 20 cm/s, with a near-bottom current speed <10 cm/s (figure 10). Bottom temperature was about 1ºC (Figure 20.11).

The dive at this site was originally planned to ascend the steep rock walls from approximately 1000 m to 350 m. Unfortunately, the location of the original transect was covered with medium-sized floes of multi-year ice. Although the ship tried to break these floes up while we were waiting for the helicopter to return to the ship, before starting the dive, in the end the persistent ice over the originally planned transect required us to move the transect west by about 500 m to an area with less ice. The new launch target was in 850 m water depth, and ascending to the same depth, about 350 m (see Figure 20.12).

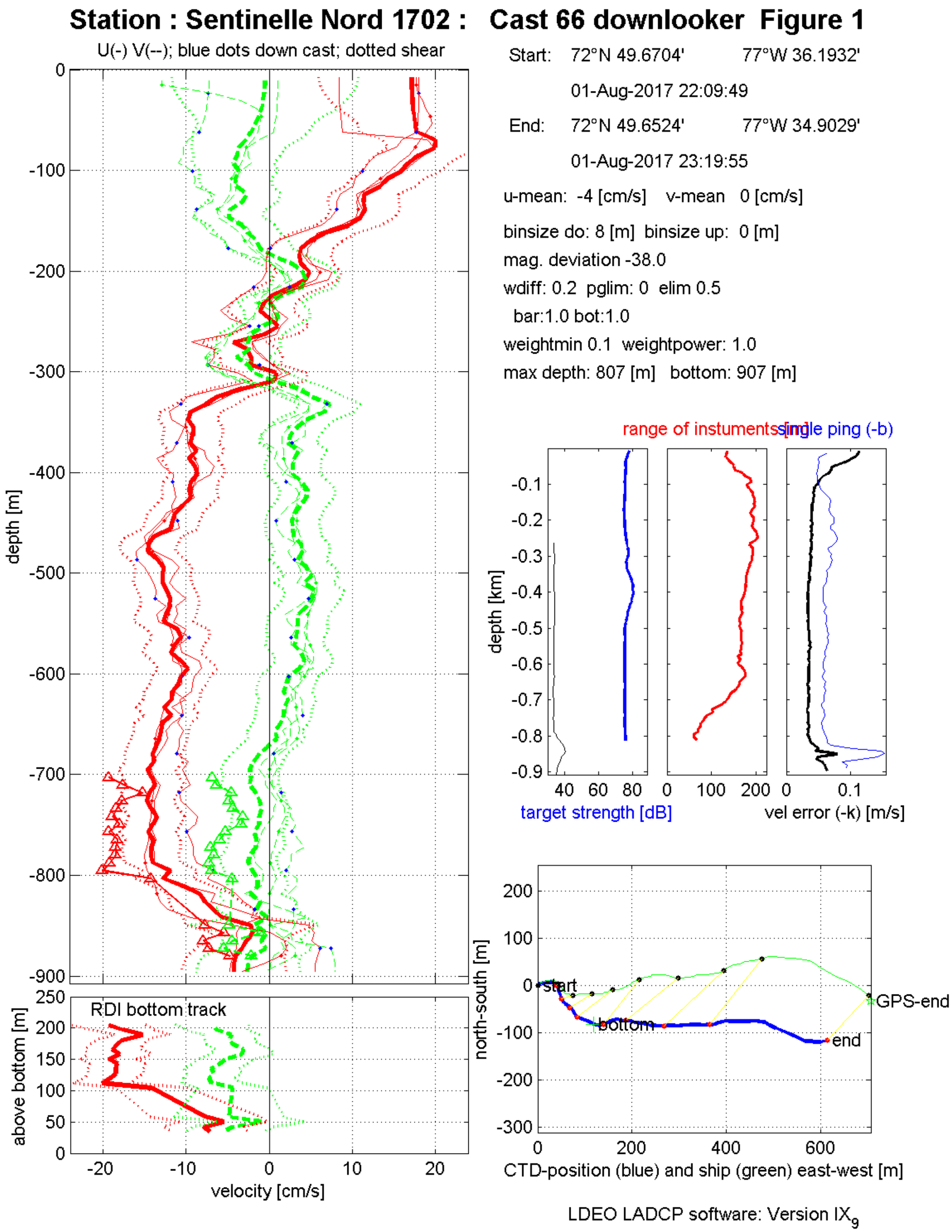


Figure 30.10 Bottom currents, Pond Inlet ROV dive site

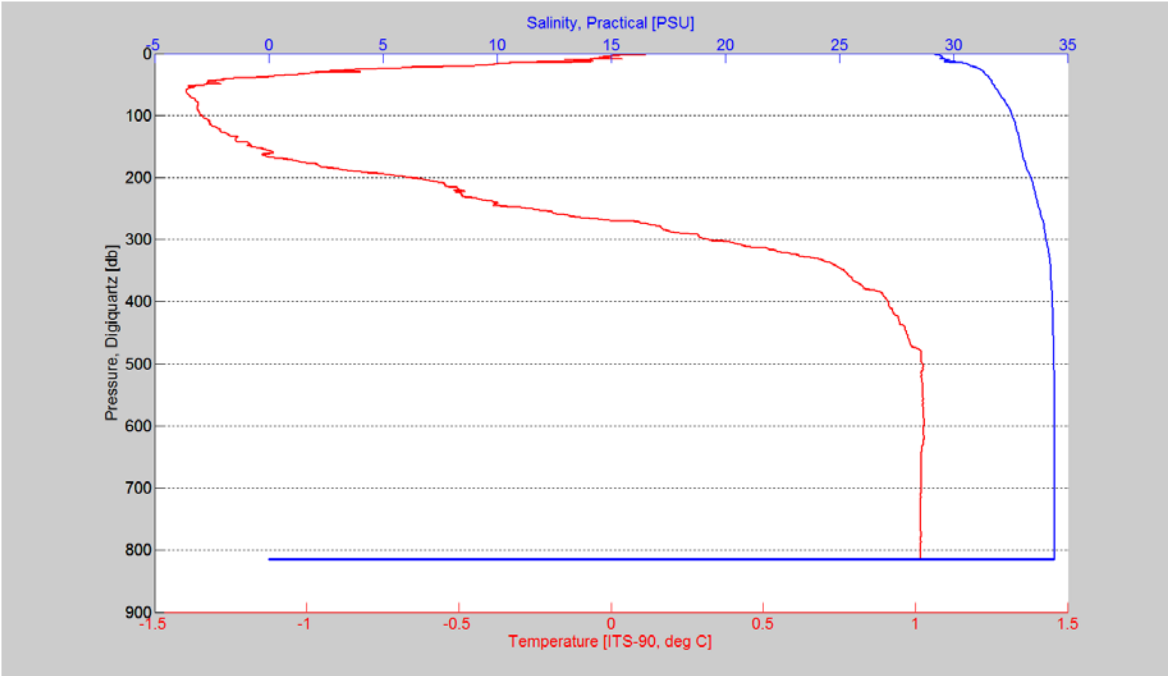
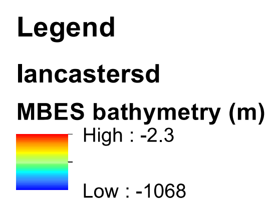


Figure 30.11 Temperature and salinity profile from ROV dive station in Pond Inlet

This dive went very well from both technical and scientific standpoints. Dive duration was 6.5 hours from launch to end of data collection – about 5 hours of dive for video transect and sample collection. Twelve samples were collected successfully, 7 sponges and 5 corals. The sponges were collected to identify unknown sponges that had not previously been encountered in the Arctic, and as voucher specimens for some types of sponges that had previously been seen, but never collected. In addition to these sponges, a number of sponges were observed whose morphotypes are so distinctive in video that it was not necessary to collect them for genetic or morphological verification. There were some problems with loss of video, but not crippling, and most of these could be attributed to strain on the umbilical cable, or rarely, to strain on the tether cable, or to the ship getting out ahead of us. Overall, ROV performance was quite good.



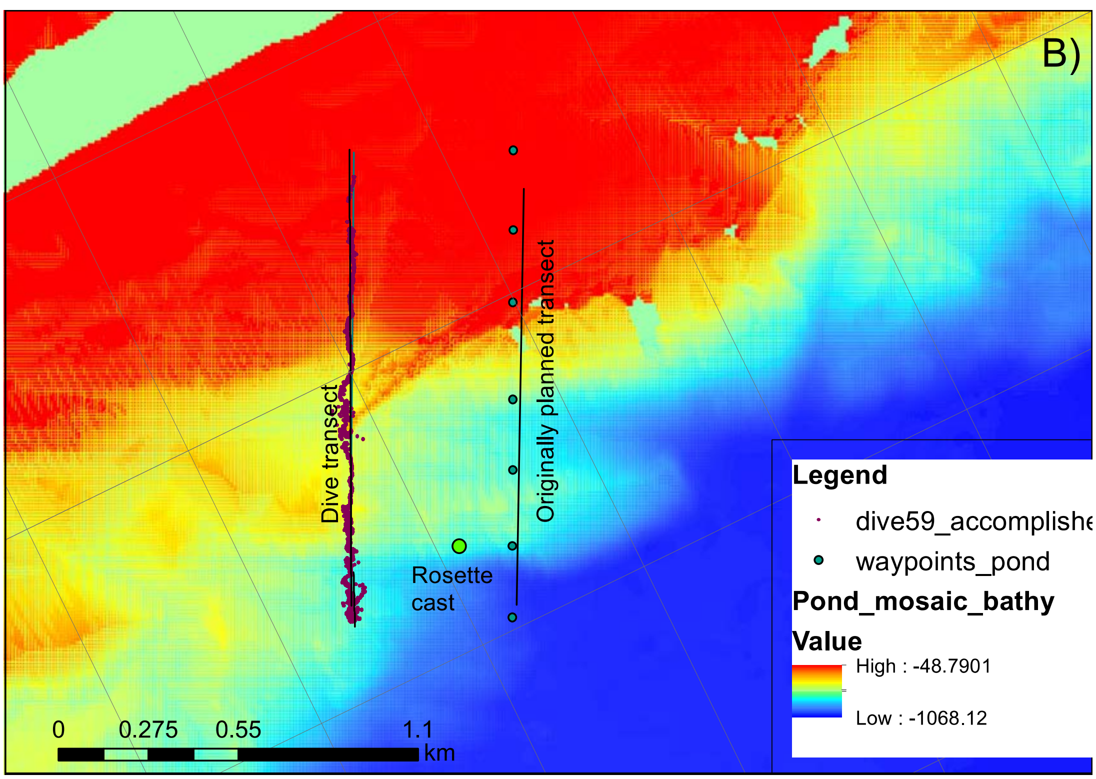


Figure 30.12 . Map of ROV dive at Pond Inlet. A. Setting. B. Dive transect

The dive started about 850 m depth. We knew there would be a rapid sedimentation rate at this location, due to proximity to Bylot Island glaciers. The GSC piston core HU2013029-067PC in this region shows 7 m sediment accumulation in 3,000 yrs – 1.5 m/ky – 1076 m. The high sedimentation rates meant that the rock walls were either covered in sediment – if they were inclined but not vertical, or if they were vertical or overhung, they were quite heavily encrusted with fauna. This rock wall environment should be quite representative of steep and deep rock walls in glacierized fjords throughout the Eastern Arctic, as described by the Dale et al. 1989 paper from the SAFE project. The dominant macrofauna were anemones, with at least 3 varieties of anemones observed. Anemones apparently became a lot more abundant in shallower water closer to the shoreline, as the boulder-cobble gravel facies became more common (Figure 20.13). The coral fauna consisted of nephtheid soft corals only. No Umbellula were observed – perhaps because the bottom was too rocky, even in the areas that were not bedrock walls. No skeletal corals (gorgonians or scleractinians) were observed, perhaps because the water was too cold, or too undersaturated with respect to CaCO3, or else due to lack of larval dispersal sources). Soft corals in general included rock-dwelling soft corals settled directly on cobbles and boulders – almost never on bedrock – and some sediment-dwelling soft corals, too. The fish fauna included abundant Greenland Halibut, eelpout, grayling, long-nose skate, snailfish, and at least 2 large unknown fishes.

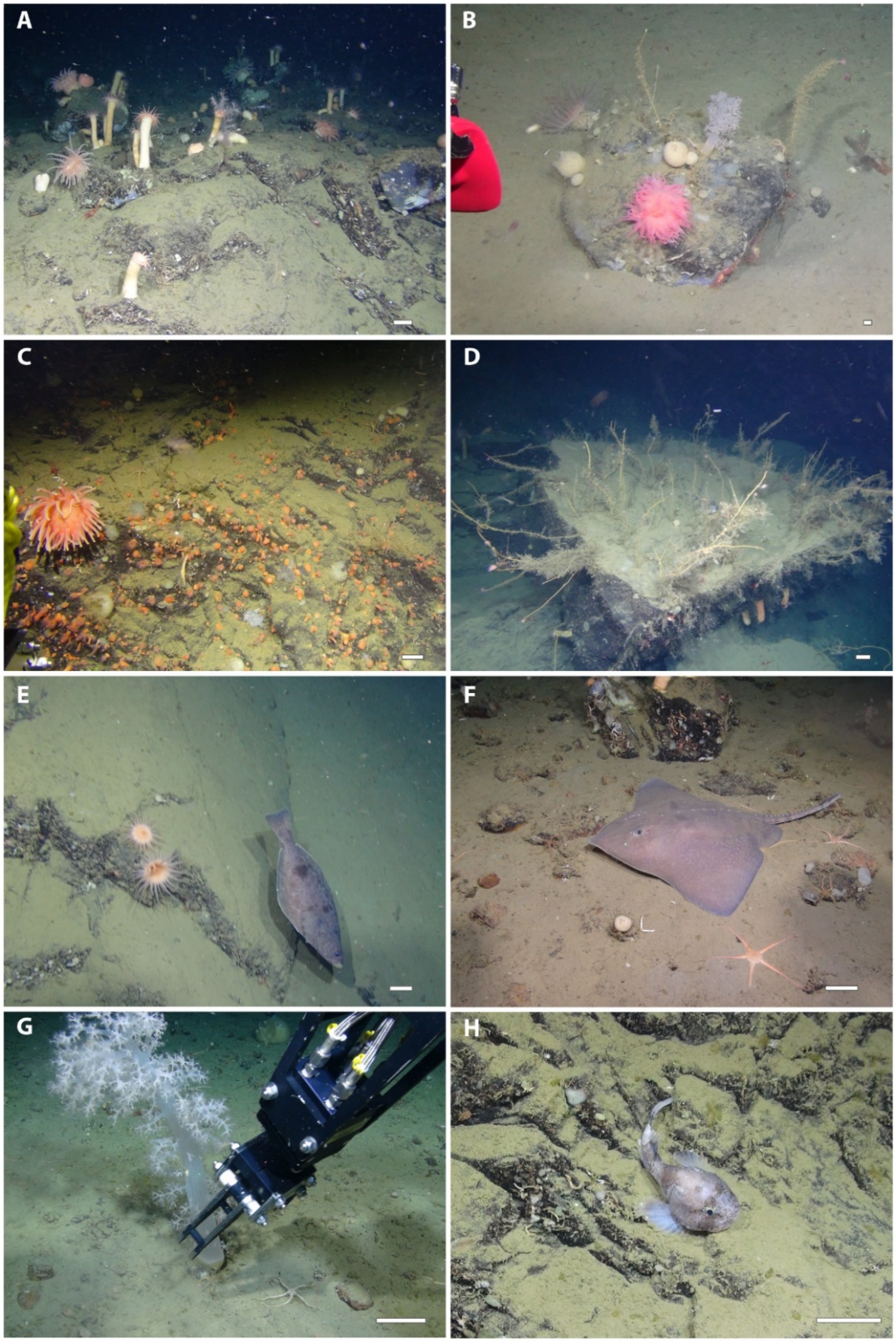


Figure 30.13 Selected Fauna observed during Pond Inlet ROV dive.

(A) Anemones growing on bedrock outcrop, (B) Anemones, soft coral, suspected hydroids, and sponges colonizing a rock in the fine sediment, (C)Small anemones/ sea cucumbers on rock face, (D)Large hydroids, (E) Greenland Halibut on rock wall, (F) Skate, (G) Sampling a soft coral, (H) Sculpin (?)

By contrast, the sponge fauna was quite diverse (Figure 29.14). Among carnivorous sponges, Cladorhiza were rare, but Chondrocladia, was abundant, and in patches. The Cladorhiza sponge sample that was collected appeared to be feeding on Themisto abyssorum amphipods, which were attached to sponge even after ascent. Upon review of the high definition video, Stylocordyla borealis was seen amongst the carnivorous sponges. There were a few Asconema and Mycale lingua, abundant Polymastia in some places, and a wide diversity of erect and encrusting sponges we did not know yet. The bedrock walls were home to many encrusting sponges (not sampled) and several Hexactinellid species. Large fan-shaped Axinellid sponges were also found growing on the rock walls.We collected a whole Chondrocladia, and found 2 small soft corals growing on its base, just above the root – indicating that the (dead) stems are habitat for other epifauna too, as observed in gorgonian corals. The Chondrocladia sample also a scale worm, possibly living inside it.

In total, 8 separate sponge samples were collected from this dive (Table 29.2).

Table 30.2 Sponges collected in Pond Inlet during leg 2b of the 2017 CCGS *Amundsen* cruise. Specimens were collected using the SuMO ROV.

Samples	Description	Depth	Latitude (N)	Longitude (W)
041 (R59-1)	*Cladorhiza sp.*	874.8m	72° 49.6689’	77° 36.5413’
042 (R59-2)	Potential *Axinella sp*	855.5m	72° 49.7344’	77° 36.4314’
043 (R59-3)	Glass sponge with protruding spicules	808.2m	72° 49.7508’	77° 36.4122’
044 (R59-3-1)	Multi-papillated demosponge attached to R59-3	808.2m	72° 49.7508’	77° 36.4122’
045 (R59-3-2)	Likely second piece of R59-3-1	808.2m	72° 49.7508’	77° 36.4122’
046 (R59-5)	Large Hexactinellid with wide osculum	777m	72° 49.7632’	77° 36.389’
047 (R59-6)	Small piece of bushy sponge	767.4m	72° 49.934’	77° 36.1211’
048 (R59-8)	White ball sponge	456.4m	72°.50.1634’	77° 35.7056’
049 (R59-11)	*Chondrocladia*	415.7m	72° 50.2039’	77° 35.6477’

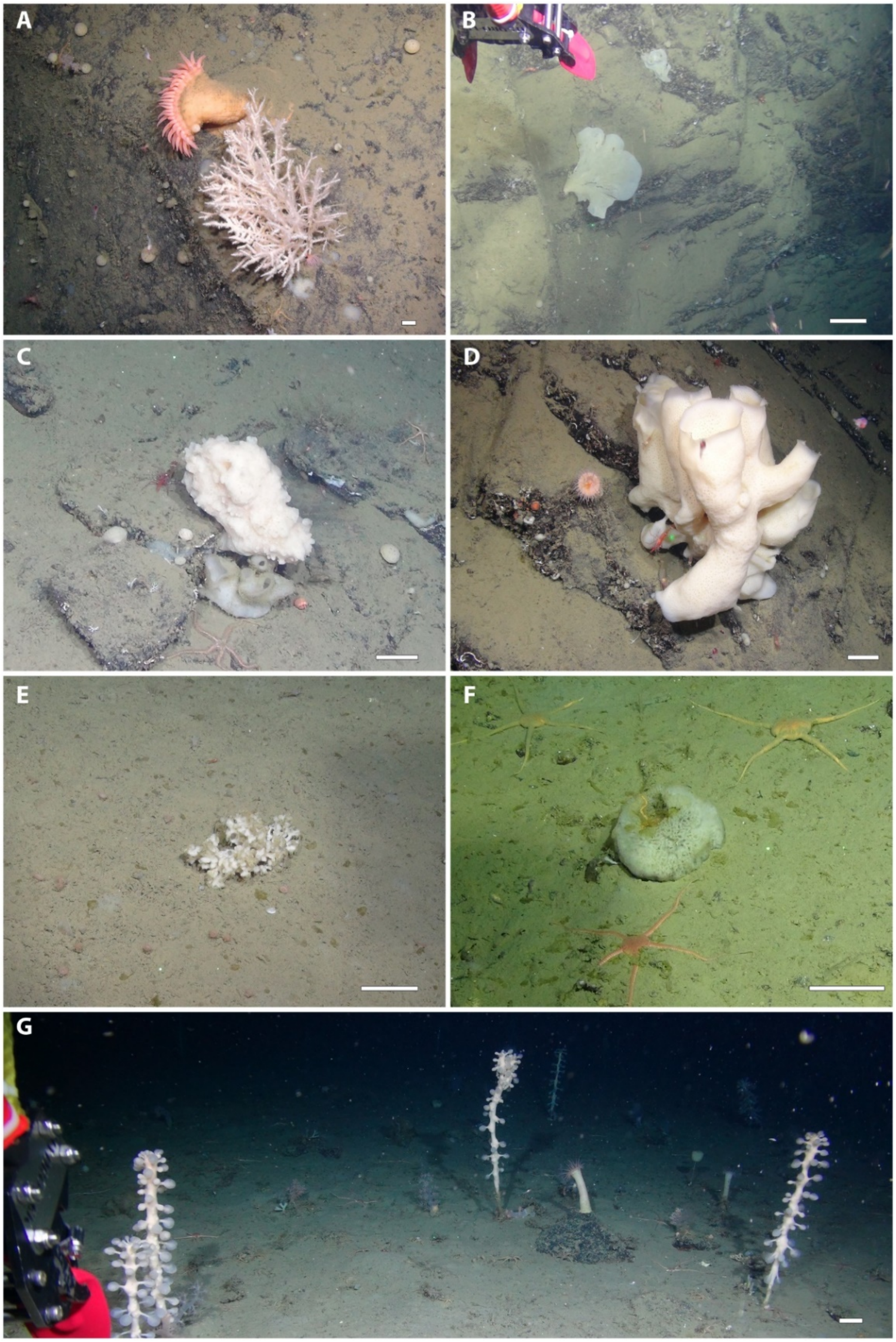


Figure 30.14 Sponges collected in Pond Inlet during 2017 Amundsen cruise.

(A)Cladorhiza sp., (B)Axinella sp., (C)Multilobate sponge with Hexactinellid underneath, (D)Unknown Hexactinellid, (E)Bush-like sponge, (F)Ball Sponge, (G)Field of Chondrocladia sp. sponge in lower left of image was collected. Scale bars 6cm

30.3.4 *Dive 60. Navy Board Inlet. (73.729N/-81.122W, 280 m). 3. Aug. 2017*

The primary purpose of the ROV dive in Navy Board Inlet was to document the diversity of large structure-forming invertebrates, especially sponges, on the steep bedrock wall environments of the Inlet. The planed dive would be an ascent up a 50-60 degree slope on the north side of the bedrock massif, facing Lancaster Sound. ROV dive A43 at the southern end of the same bedrock massif, facing Eclipse Sound, found a mixture of cobble-boulder gravel and low slope bedrock environments, with a variety of epifauna. The dive in 2015 was aborted after about 2 hours due to electrical problems with the ROV. The depth of the target at Navy Board Inlet is quite shallow, compared to the other sites investigated with the HiBio project, so would likely be in Pacific water mass depths, rather than Atlantic. The rate of movement along this transect would be slow, to allow for extensive collection of the sponge fauna and other organisms on the steep bedrock walls. The planned transect was about 600 m long, ascending from about 280 m to 130 m depth.

Dive 60 was launched about 8 AM. The ROV was launched at about 300 m depth, in slightly deeper water away from cliff. Between the initial bridge check at 6:30 AM and the actual launch, the wind increased from 15 to 20 kt, with gusts reaching 26-27 kt. During the dive launch, the ship was unable to hold station against the wind, with the ROV still in its cage. The ROV was lowered to about 200 m. After about 30 minutes in the water, with the ship having difficulty holding station, the ROV pilots and the captain agreed that continuing this dive, against a rock wall, it would have been too hazardous to continue. The decision to abort dive was made after 35 min.; total dive duration was 50 min. The ROV was recovered without having left the cage, but without damage. Total duration of HiBio operations at this site 3 hours, including CTD/rosette cast. The Captain noted that this dive could have proceeded without problems if the ship's Dynamic Positionaing (DP) system was functional.

The CTD and rosette cast here was to measure nutrients, to survey bacterial and eukaryotic plankton diversity, normal water column properties in addition to carbonate chemistry, dissolved CO2, dissolved CH4, and the stable isotopic compositon of particulate organic matter.

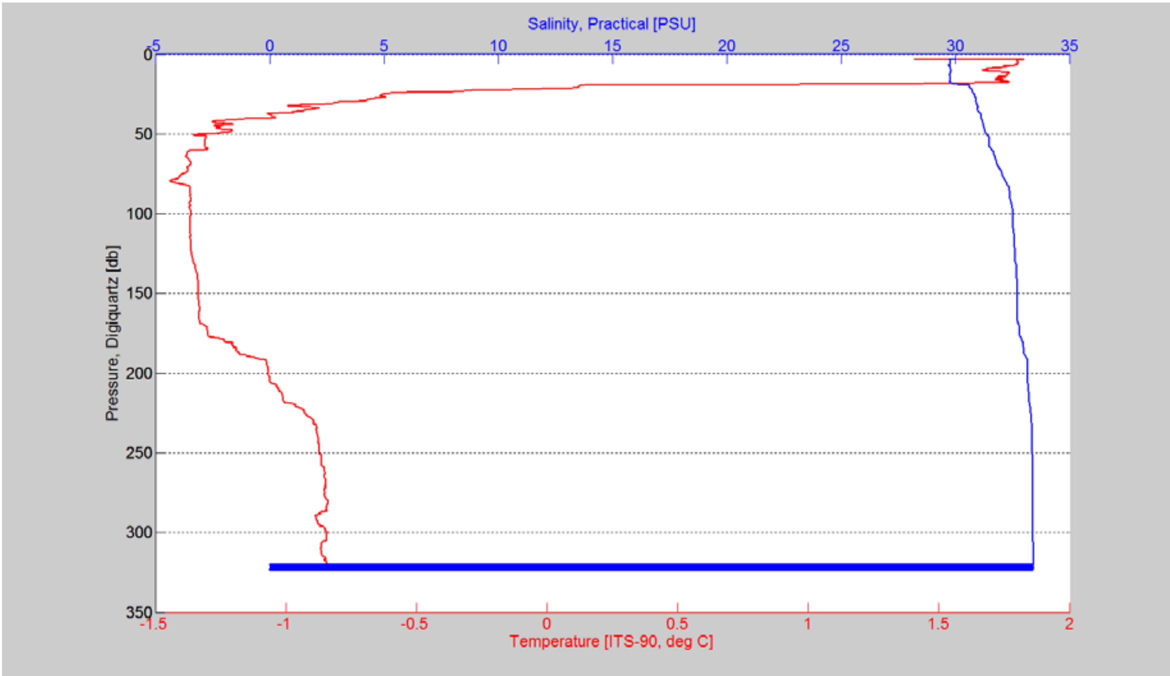


Figure 30.15 . Temperature and salinity profile from ROV dive station in Navy Board Inlet. The ROV dive was aborted after < 1 hr due to winds

30.3.5 *Dive A61. Lancaster Sound. (7°16.6'N/ 083°18.74'W). 740 m. 4 Aug. 2017.*

The purpose of the ROV dive in Lancaster Sound was to investigate biogenic habitats of the tall Arctic sea pen Umbellula encrinus. These sea pens are known from trawl bycatch samples and records in several areas of the Arctic, where they appear to occur at low densities. An incidental video record from a fisheries time-lapse camera deployment in Lancaster Sound in 2015 indicated high abundances of Umbellula at about 700 m in central Lancaster Sound, and DFO trawl survey bycatch indicated common occurrences of Umbellula in deeper water (>1000 m) on the broad fan at the eastern end of Lancaster Sound, facing Baffin Bay, as well as Jones Sound Admiralty Inlet, Qikiqtarjuaq, and other sites in Baffin Bay. The species is also known from waters off Greenland, Iceland, Norway, and the Barents Sea. Most trawl survey records of Umbellula from Canadian waters record isolated individuals or small numbers. Bycatch records from the Barents Sea include numbers as high as 5000 individuals in a 15-minute survey trawl.

The other purpose of the ROV dive in Lancaster Sound was to choose locations with Umbellula, and others without Umbellula, for comparing ecosystem function measurements in relation to the density of the sea pens. These measurements depend on incubations run on push cores from box-cores collected after the ROV dive.

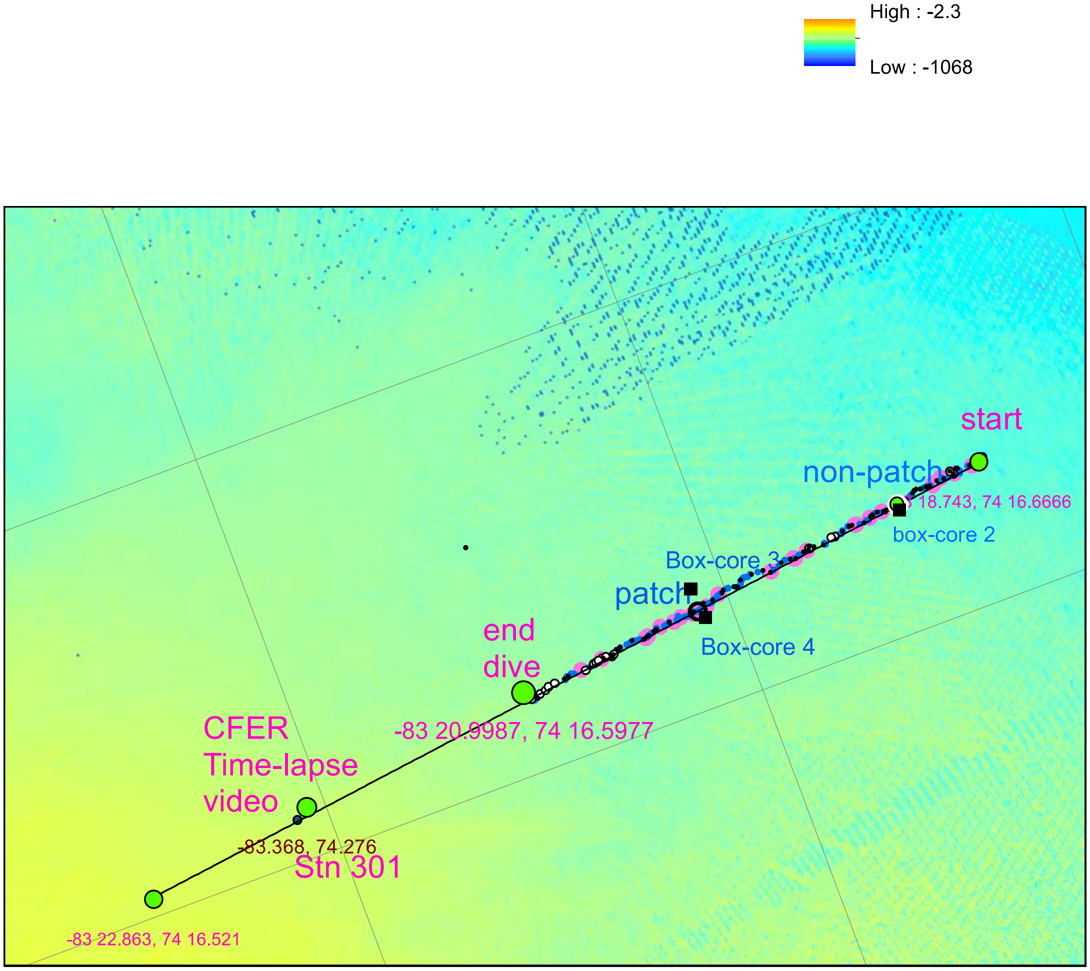


Figure 30.16 Map of Lancaster Sound ROV dive showing transect completed and locations of box-cores for ecosystem function measurements

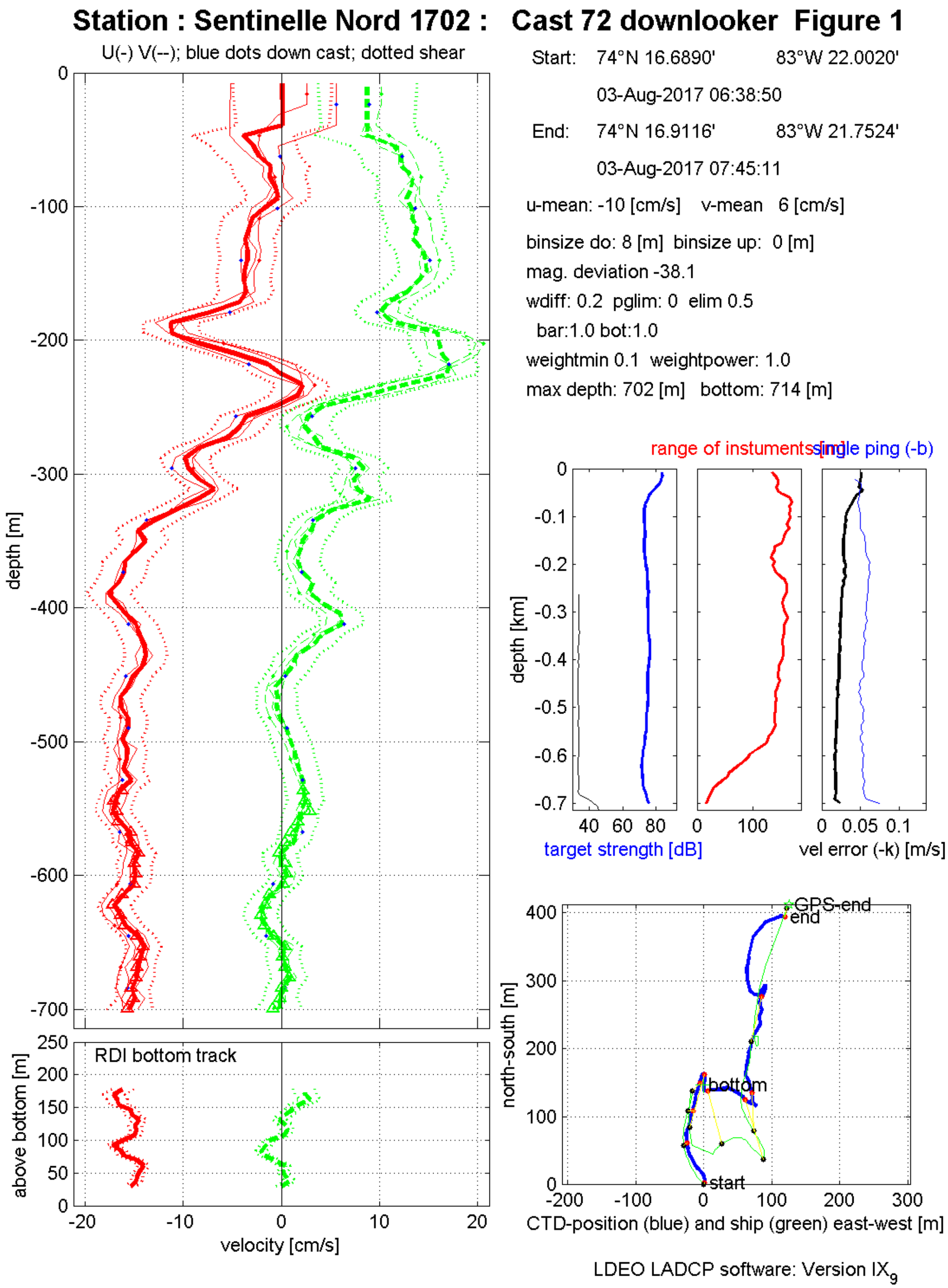


Figure 30.17 Current speed profiles at the Lancaster Sound ROV dive site, CTD cast 72

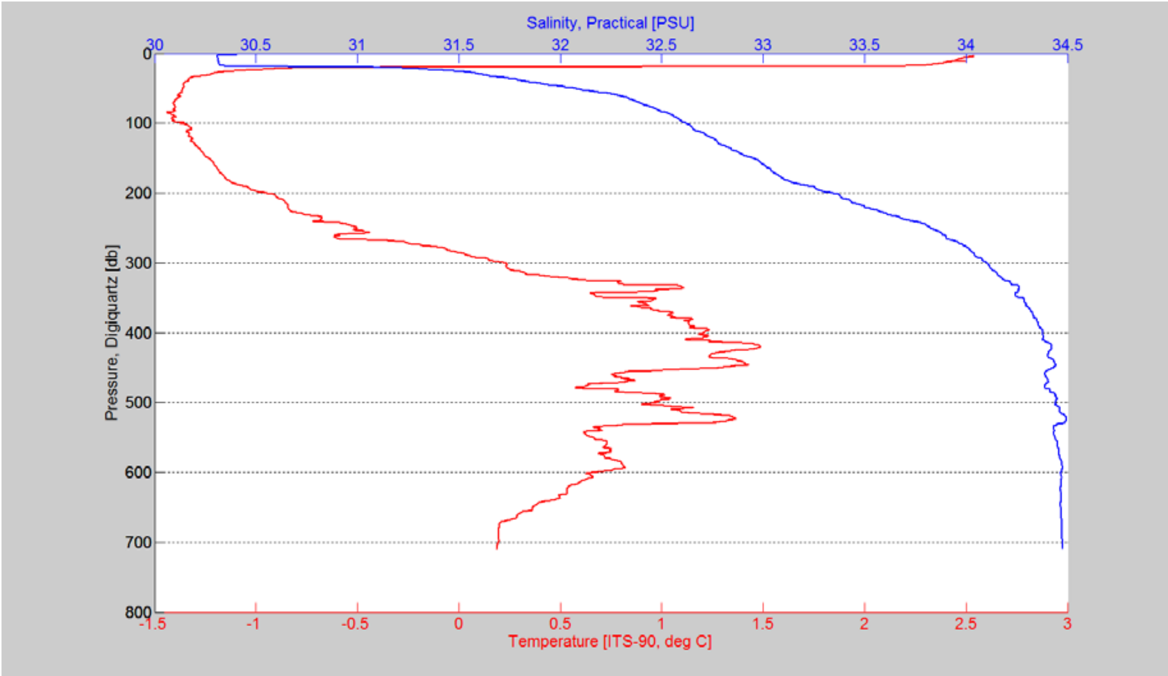


Figure 30.18 Temperature and salinity profiles at the Lancaster Sound ROV dive site, CTD cast 72

Technical issues caused a truncation of the dive after about 4 hours. During the end of the ROV video transect, the umbilical cable from the ship to the ROV cage was apparently bent a the point of the roller guides at the base of the moon pool, stressing the fibre-optic cables inside the umbilical, leading to short power interruptions and loss of video. This loss of telemetry was partly resolved when the dive switched from transect mode to collection mode, then the ship was no longer moving. Although moderately strong currents were noted moving N to S during the dive, currents did not interfere with dive outcome.

At this site, the ROV recorded transect data for approximately 1 km, over a level muddy sand bottom with abundant Umbellula sea pens, common Chondrocladia carnivorous sponges, small Virgularia sea pens, and common other sessile, sedentary and mobile epifauna and infauna including several types of cerianthids, several types of anemones, large Gorgonocephalus, and two common ophiuroid species, small holothurians and sea stars (Figure 20.19).The most common fish were eelpouts (Lycodes sp.), although several other types of fish were observed. Depth change over the 1 km transect was less than 10 m.

During the ROV transect, we logged every individual of Umbellula observed, so using these data we were able to map the areas of more frequent or less frequent occurrence. This map of Umbellula occurrence was used to guide box-coring for seapen-rich and seapen-poor habitats. Although the incubation experiment is designed to compare ecosystem function within biogenic habitats vs. adjacent non-biogenic habitats, the nature of the Umbellula distribution here appears to be largely homogeneous, with some degree of variation in density of the sea pens, rather than discrete areas with and without sea pens. The area that was box-cored for the “non-patch” environment thus measures ecosystem function in an area with fewer sea pens, rather than an area with none. The incubation experiment should be interpreted as measures of ecosystem function along a gradient in sea pen density, rather than a strict comparison of sites with vs. without large biogenic structure.

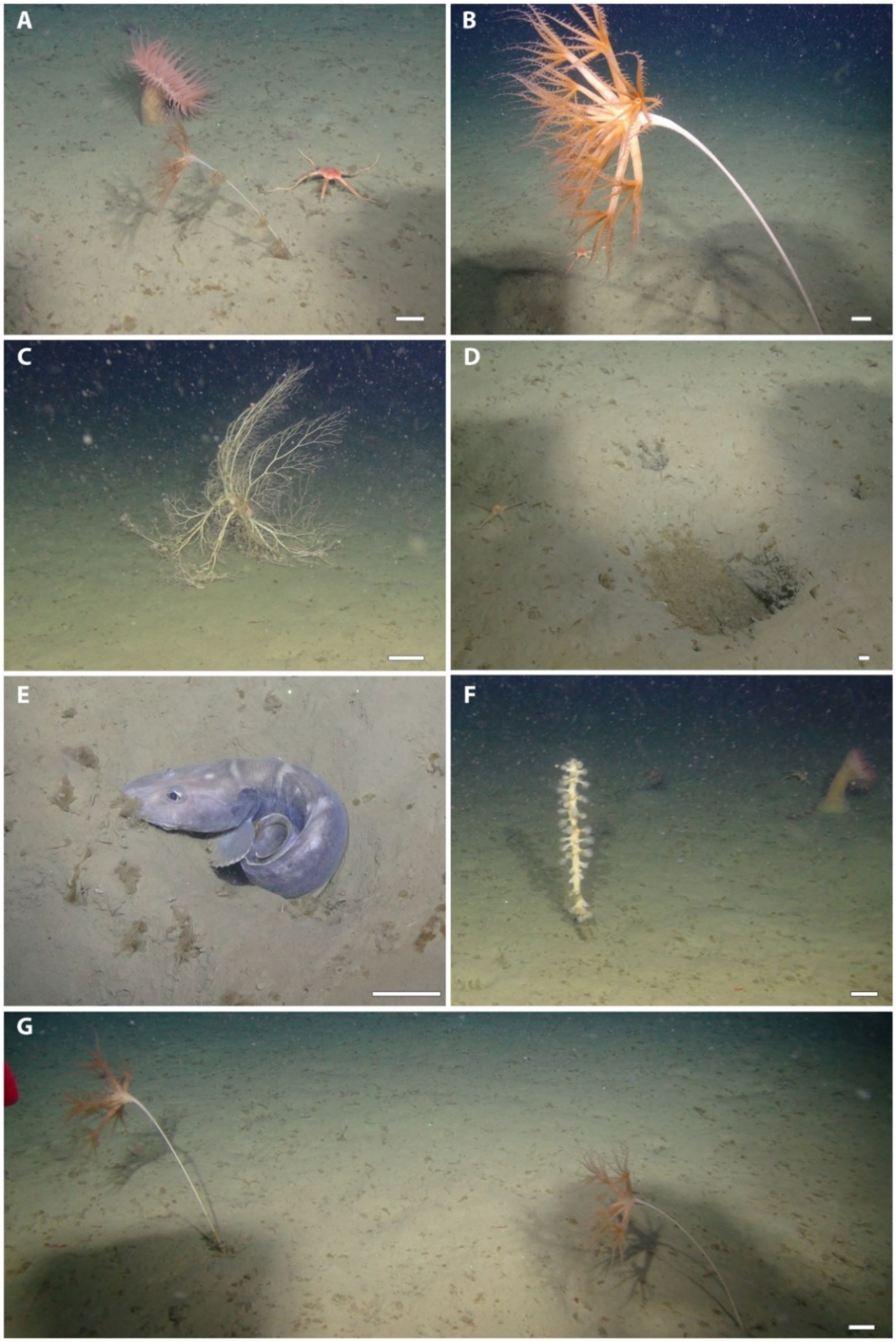


Figure 30.19 Fauna observed during Lancaster Sound ROV dive.

(A) Anemone, Umbellula, and brittle star (B) Umbellula polyps, (C)Gorgonocephalus, (D)Hole in sediment, potential burrow, (E) Fish, probably Lycodes, (F) Chondrocladia and anemone, (G) multiple small Umbellula.

Box-coring was aided by the use of the ROV elevator beacon, so that the position of the box-core when it contacted the bottom could be recorded precisely. The placement of the two "non-patch" box-cores was much more precise than the placement of the two "patch" box-cores. In this case, the placement of the "non-patch" cores was more critical, as they aimed for a 50-m portion of the ROV video transect in which no Umbellula were observed. Near the start of this 50-m portion of the transect, a dislodged sea pen had been seen next to a 2-3 m long pit in the seafloor (figure --). The origin of this pit in unknown, but it may result from feeding by marine mammals. Other pits, smaller and rounder, were also observed in several places along the sea floor, and could be the result of feeding activities by skates.

Immediately following the dive, the second settlement and carbonate accretion/bioerosion experiment was deployed, at the "start of dive" waypoint. The precise placement of this experiment was also tracked using the ROV elevator beacon, for ease of recovery (at an unknown time in the future). The experiment was equipped with four zinc anodes to control rust, and all large, non-fragile experimental pieces were secured to the 316 stainless steel frame using cable ties, except for Flabellum and Callista + Keratoisis. It is not known when we will be able to return to this site with an ROV to collect this experiment.

The Agassiz trawl at this site recovered 7 Umbellula, 6 small Virgularia sea pens, two small nephtheid soft corals (probably Gersemia sp.,) with sediment-filled sacs instead of holdfasts attached to pebbles, and 1 Chondrocladia sponge, in addition to other common epifauna and infauna.

30.3.6 *Other Operations*

At the ROV sites that had not already been thoroughly mapped, we collected multibeam and sub-bottom profile data, in addition to bottom water sampling, and box coring if the site was not a rocky bottom, and Agassiz trawling in some stations, summing to most of a Basic Station. The water sampling was aimed at answering three major questions: what is the abundance, and stable isotopic composition, of particulate organic matter in near-bottom water that could be available to feed corals and sponges and other benthos; what is the composition of the microbial biota in the water column, and what is the calcium carbonate saturation profile at each location (section 6). Box-coring, Agassiz-trawling, and incubation experiments were done by the benthos team from Université Laval (see report by Cindy Grant).

The volume of water and number of depths sampled required for all the different water sampling goals of HiBio and other teams necessitated two CTD/rosette casts at some locations. Additional water sampling included sampling of dissolved CO2 and dissolved methane. See report by microbial ecologist Dr. Mary Thaler for summary of the microbial diversity measurements.

30.3.7 *CTD-Rosette Sampling*

Water samples for the Hidden Biodiversity team were collected from the CTD-rosette for the purposes of measuring total alkalinity (TA), dissolved organic carbon (DIC), dissolved carbon dioxide (pCO2), and dissolved methane (CH4), and for measuring the amount and stable isotopic composition of near-bottom particulate organic matter at stations sampled by ROV. The primary purpose of the TA, DIC and pCO2 sampling is to understand the influence that carbonate chemistry, particularly calcite and aragonite saturation, might have on biogenic habitat-structuring organisms, especially corals. A second goal was to assess natural sources of methane to the water column in seep site and other areas. Instrumental data also characterize each site. To assess POM, we collected and filtered 20 litres of water at each ROV dive site to measure the mass and stable isotopic composition of suspended particulate matter.

Table 30.3 Information on CTD-rosette sampling at Frobisher Bay and HiBio sites during the 2017 Amundsen expedition.

Station #	Region	date	cast	Latitude	Longitude	depth	N bottles
OF-B-2	Outer Frobisher	14-Jul-17	12	63 00.089	067 19.818	422	19
A16	Inner Frobisher	15-Jul-17	14	63 38.361	068 37.554	143	13
Bell 11	Inner Frobisher	15-Jul-17	15	63 21.653	068 10.785	112	10
OFB-14	Outer Frobisher	16-Jul-17	16	62 23.060	066 01.836	412	17
Stn 180	SW Baffin	18-Jul-17	19	67 25.564	061 23.308	710	14
Disko_ROV	SE Baffin	19-Jul-17	20	67 58.020	059 30.10	911	17
Jones_Sound	Jones Sound	30-Jul-17	63	76 04.994	081 56.485	770	19
ROV Pond_Inlet	NW Baffin	01-Aug-17	66	72 49.663	077 35.876	807	20
ROV NBI	NW Baffin	02-Aug-17	67	73 43.544	081 05.568	369	16
Stn 301	Lancaster Sound	03-Aug-17	72	74 16.660	083 21.884	721	19

30.3.8 *Coral recruitment and carbonate taphonomy experiments*

Vulnerable marine ecosystems are vulnerable to disturbance from human activities due to a number of properties, including physical fragility, great longevity, and, potentially, low recruitment. Additionally, because coral-based VMEs make carbonate skeletons, the skeletons of the live animals, but especially the geological deposits of the dead animals, are potentially vulnerable to the impacts of ocean acidification (Guinotte et al. 2006). While we know that many deep-sea corals are able to compensate for impacts of ocean acidification on their skeleton formation by controlling the pH of the calcifying fluids, this control has a metabolic cost (McCulloch et al. 2012), and does not protect the skeletons of these corals form post-mortem degradation. These experiments are designed to measure both recruitment to hard surfaces, and the physical, chemical, and biological degradation of a variety of types of carbonate skeletons in waters that are near or below saturation with respect to either calcite or aragonite. The materials deployed on these experiments include two types of rock: gabbro ("black granite") and marble, four types of carbonate coral skeletons representing two gorgonians (magnesian calcite), one scleractinian (aragonite), and one pennatulacean species (magnesian calcite with high collagen content), and agagonitic shells of the bivalve Callista sp., which have been used previously in similar experiments in warm temperate and cold-temperate carbonate settings (Wisshak et al. 2011).

The experiment recovered from Disko Fan was described with the results of that dive. A second experiment was to have been deployed near the hydrocarbon seep at Scott Inlet, but that dive was cancelled. Since the Disko Fan dive described recruitment in a muddy setting, we deployed the second carbonate recruitment and taphonomy experiment at the site of the Lancaster Sound dive, in the Umbellula sea pen meadow habitat. Although this is a soft-bottom habitat, dominated by infauna, substrate limitation has often been suspected as a cause for lack of epifauna in these environments. Furthermore, the Lancaster Sound site represents waters that are undersaturated with respect to calcium carbonate (Azetsu-Scott et al. 2010), making an appropriate comparison vs. the Disko Fan experiment. It is not known when it will be possible to recover this experiment. The results from the experiment deployed at Disko Fan suggest that one year is too short a deployment to experience significant recruitment, or significant skeletal degradation. We anticipate a deployment of at least 3 years.

Figure 30.20 Experimental frame showing plates with corals and rocks and deployment in Lancaster Sound using acoustic release and tracking beacon

Conclusion

These preliminary results indicate that the dives were successful, based on objectives specified in our original dive plan:

1) Invertebrates and fish diversity. Quantitative data on invertebrate and fish diversity in three quite different types of biogenic habitat were gathered.
2) Ecosystem function measurements in biogenic habitats were measured in three different types of biogenic habitats and their nearby equivalents without the biogenic structure.
3) Settlement and bioerosion experiment was recovered, but showed very little evidence of settlement of biotic or abiotic alteration of carbonate skeletons.
4) Many of the large habitat-forming corals and sponges described from the ROV video would have been largely invisible to traditional sampling methods.

30.4 Comments and Recommendations

Although ROV performance was considerably improved over the 2015 and 2016 field seasons, the SuMo ROV continues to face technical issues that limit its use for scientific data collection. Nonetheless, with persistence and a better understanding of some of the sources of the technical challenges, the ROV was able to yield useful scientific data, and to carry out complex underwater tasks, making it possible to carry out research that would be impossible without the ROV. Unfortunately, the ROV program comes with an additional cost involved, since CSSF pilots need to accompany the ROV. Furthermore, delays in the research plan due to ice conditions and weather meant that most of the ROV-based research was concentrated in a few days at the end of the cruise, with no latitude for alternative plans due to weather or ROV malfunction.

Technical recommendations. One dive was cancelled because the wind speeds were at the upper limit of the ROV operations tolerance, and the ship was unable to hold station without the benefit of a dynamic positioning (DP) system. As the captain noted after that aborted dive, if the Amundsen's DP system were functional, the dive could have proceeded without incident. Secondly, the ongoing issues with loss of telemetry may be related to the multi-mode fibre-optic cable in the ROV umbilical cable. This cable uses technology that was current when the ROV was purchased in 2003, but is now outdated, and leaves the ROV prone to electrical problems associated with bending of the umbilical cable.

Logistical Recommendation

A greater efficiency in the use the ROV pilots time aboard the ship would come from increasing the use of the ROV, and in particular, having a greater number of sites visited per year. If there were 10-12 sites planned in a particular field season, losing one of two of these to weather or technical issues would have a much lesser impact on the outcomes of the research program. This sort of concentration of ROV dives could be achieved by having ROV-based research activities concentrated into alternate years. It would still be recommended to avoid ROV dives on consecutive days, unless there are 4 pilots/technicians on board to carry out necessary repairs overnight.

Acknowledgement

We would like to thank the CCGS *Amundsen* captain Claude LaFrance, the ship crew, the scientific crew, the ROV operators Vincent Auger and Peter Lockhart (CSSF), and the chief scientist Dr. Jean-Éric Tremblay for the great work making this expedition possible. We thank PhD student Tonya Burgers and PDF Dr. Cara Manning for collecting water samples in the Frobisher Bay and HiBio stations, and the rosette team (Colline Gombault, Claudie Marec, & Chris Beasley) for instrumental data. We thank the benthos team, Cindy Grant and Valerie de Carufel, for managing the box-core and Agassiz trawl sampling, and giving us access to coral, sponge, and sediment samples from both box-cores and Agassiz trawls. We thank the plankton team (Gerald Darnis, Thibaud Dezutter, Mathieu Leblanc, Vicky Peck) for access to plankton samples, and Sarah Bernstein (Environment & Climate Change Canada) for access to the vacuum pump for filtering bottom water samples.

Reference

Conlan, K., Aitken, A., Hendrycks, E., McClelland, C. & Melling, H. (2008). Distribution patterns of Canadian Beaufort shelf macrobenthos. Journal of Marine Systems, 74, 864–886.

Jauer, C.D., and Budkewitsch, P. 2010. Old marine seismic and new satellite radar data: Petroleum exploration of north west Labrador Sea, Canada. Marine and Petroleum Geology. 27: 1379-1394.

Batstone, R. T., Laurich, J. R., Salvo, F. & Dufour, S. C. (2014). Divergent chemosymbiosis-related characters in Thyasira cf. gouldi (Bivalvia: Thyasiridae). PLoS ONE, 9, e92856.

Budkewitsch, P, Pavlic, G, Oakey, G, Jauer, C, and Decker, V. 2013. Geological Survey of Canada, Open File 7068, doi:10.4095/292280.

Dando, P.R., Southward, A.J. & Southward, E.C. (2004). Rates of sediment sulphide oxidation by the bivalve mollusc Thyasira sarsi. Marine Ecology Progress Series, 280, 181-187.

Dufour, S. C. & Felbeck, H. (2003). Sulphide mining by the superextensile foot of symbiotic thyasirid bivalves. Nature, 426, 65–67.

Neves, B. M., E. Edinger, C. Hillaire-Marcel, E. Saucier, S. C. France, M. A. Treble & V. E. Wareham, 2014. Deep-water bamboo coral forests in a muddy Arctic environment. Marine Biodiversity 45: 867-871.

Oliver, P. G., Ockelmann, K. W., & Killeen, I. J. (2002). The Thyasiridae (Mollusca: Bivalvia) of the British continental schelf and north sea oilfields: an identification manual. Cardiff: National Museums & Galleries of Wales.

Piepenburg, D., Archambault, P., Ambrose Jr., W.G., Blanchard A.L., et al. (2010) Towards a pan-Arctic inventory of the species diversity of the macro- and megabenthic fauna of the Arctic shelf seas. Marine Biodiversity, 41, 51-70.

Punshon, S., Azetsu-Scott, K., and Lee, C. M. 2014. On the distribution of dissolved methane in Davis Strait, North Atlantic Ocean. Marine Chemistry. 161: 20-25.

Roy, V., Iken, K. & Archambault, P. (2015). Regional variability of megabenthic community structure across the Canadian Arctic. Arctic, 68, 180-192.

Taylor, J.D., Williams, S.T. & Glover, E.A. (2007). Evolutionary relationships of the bivalve family Thyasiridae (Mollusca: Bivalvia), monophyly and superfamily status. Journal of the Marine Biological Association of the United Kingdom, 87, 565-574.

Leg	Station ID	Station Type	Local Date	Ship Time	UTC to local	Latitude (N)	Longitude (W)
Leg 1							
1	NFLD	Ice	08/Jun/2017	12:32	UTC-4	50°08.190'	055°16.440'
Leg 2							
2a	732	Short Basic	07/Jul/2017	18:35	UTC-4	55°23.256'	077°59.780'
2a	736	Short Basic	08/Jul/2017	17:10	UTC-4	58°25.439'	078°18.720'
2a	720	Short Basic	09/Jul/2017	11:33	UTC-4	60°39.158'	078°34.168'
2a	694	Short Basic	10/Jul/2017	03:12	UTC-4	62°30.450'	078°30.037'
2a	688	Short Basic	10/Jul/2017	16:29	UTC-4	62°21.744'	074°40.329'
2a	684	Short Basic	11/Jul/2017	04:45	UTC-4	61°47.302'	071°54.932'
2a	682	Short Basic	11/Jul/2017	14:38	UTC-4	61°02.600'	069°43.028'
2b	676	Short Basic	12/Jul/2017	00:10	UTC-4	60°07.572'	069°03.852'
2b	670	Short Basic	13/Jul/2017	12:04	UTC-4	59°00.266'	067°55.730'
2b	OF-B2	Benthic Cam	14/Jul/2017	06:27	UTC-4	63°00.089'	067°19.818'
2b	OF-B6	Benthic Cam	14/Jul/2017	12:38	UTC-4	62°44.740'	066°42.390'
2b	Outer Bay A	Coring	14/Jul/2017	18:18	UTC-4	63°07.577'	067°26.206'
2b	FB2-2-2-5g	Benthic	15/Jul/2017	02:04	UTC-4	63°39.801'	068°25.290'
2b	FB2-2-2-5d	Benthic	15/Jul/2017	04:05	UTC-4	63°40.487'	068°25.380'
2b	Bell 12	Coring	15/Jul/2017	06:37	UTC-4	63°41.234'	068°37.459'
2b	PCX A1	Coring	15/Jul/2017	09:35	UTC-4	63°35.891'	068°31.405'
2b	A16	Basic	15/Jul/2017	10:37	UTC-4	63°38.345'	068°37.656'
2b	Bell 11	Coring	15/Jul/2017	18:21	UTC-4	63°21.653'	068°10.785'
2b	OF-S22	Benthic Cam	16/Jul/2017	00:46	UTC-4	62°52.024'	066°44.707'
2b	OF-B9	Benthic Cam	16/Jul/2017	03:25	UTC-4	62°34.051'	066°16.909'
2b	OF-B14	Benthic Cam	16/Jul/2017	05:32	UTC-4	62°23.060'	066°01.836'
2b	BB1	Nutrient	18/Jul/2017	01:49	UTC-4	66°51.673'	059°03.477'
2b	180	Basic	18/Jul/2017	12:29	UTC-4	67°24.679'	061°27.137'
2b	Discofan	ROV	19/Jul/2017	00:44	UTC-4	67°58.051'	059°30.160'
2b	Patch	Coring	19/Jul/2017	02:41	UTC-4	68°00.954'	059°34.813'
2b	Bare	Coring	19/Jul/2017	04:14	UTC-4	67°59.520'	059°33.896'
2b	Discofan	ROV	19/Jul/2017	11:17	UTC-4	67°57.984'	059°29.311'
2b	GE Float	Float	20/Jul/2017	02:55	UTC-4	69°33.218'	060°46.143'
2b	8.1	Coring	20/Jul/2017	17:52	UTC-4	69°24.365'	064°43.656'

2b	BB3	Nutrient	21/Jul/2017	22:54	UTC-4	71°24.891'	068°36.842'
2b	BB2	Full	22/Jul/2017	09:23	UTC-4	72°46.066'	066°00.014'
2b	BA06	Mooring	23/Jul/2017	18:45	UTC-4	75°39.674'	070°25.598'
2b	101	Full	24/Jul/2017	08:20	UTC-4	76°22.980'	077°24.192'
2b	102	CTD	24/Jul/2017	18:08	UTC-4	76°22.319'	076°59.965'
2b	103	Nutrient	24/Jul/2017	19:19	UTC-4	76°20.737'	076°35.642'
2b	104	CTD	24/Jul/2017	20:53	UTC-4	76°20.672'	076°10.421'
2b	105	Basic	24/Jul/2017	22:16	UTC-4	76°19.015'	075°45.602'
2b	106	CTD	25/Jul/2017	05:02	UTC-4	76°18.423'	075°21.383'
2b	107	Nutrient	25/Jul/2017	07:06	UTC-4	76°16.895'	074°59.291'
2b	BA06	Mooring	25/Jul/2017	15:10	UTC-4	76°39.382'	070°24.530'
2b	BA05	Mooring	25/Jul/2017	18:15	UTC-4	75°48.244'	070°12.284'
2b	MVP Start	MVP	26/Jul/2017	00:00	UTC-4	76°34.226'	071°00.036'
2b	115	Full	26/Jul/2017	04:51	UTC-4	76°19.935'	071°11.848'
2b	126	Nutrient	27/Jul/2017	05:53	UTC-4	78°19.420'	074°53.666'
2b	127	Nutrient	27/Jul/2017	07:29	UTC-4	78°19.437'	074°30.514'
2b	MacEwan	Coring	27/Jul/2017	10:08	UTC-4	78°18.123'	074°26.260'
2b	129	Basic	27/Jul/2017	12:10	UTC-4	78°19.522'	074°06.745'
2b	130	Nutrient	27/Jul/2017	19:18	UTC-4	78°19.393'	073°39.773'
2b	131	Nutrient	27/Jul/2017	22:17	UTC-4	78°19.693'	073°05.272'
2b	TRINITY	Full	28/Jul/2017	05:43	UTC-4	77°46.951'	076°29.364'
2b	114	CTD	29/Jul/2017	05:14	UTC-4	76°19.556'	071°47.398'
2b	113	Nutrient	29/Jul/2017	06:22	UTC-4	76°19.247'	072°13.083'
2b	112	CTD	29/Jul/2017	08:05	UTC-4	76°18.944'	072°42.763'
2b	111	Basic	29/Jul/2017	09:17	UTC-4	76°18.470'	073°13.079'
2b	110	Nutrient	29/Jul/2017	16:16	UTC-4	76°18.061'	073°37.113'
2b	109	CTD	29/Jul/2017	17:59	UTC-4	76°17.384'	074°06.744'
2b	108	Basic	29/Jul/2017	19:08	UTC-4	76°15.838'	074°36.146'
2b	Manson Glacier bay	Coring	30/Jul/2017	09:04	UTC-4	76°23.949'	078°45.065'
2b	Jones Sound	HiBio	30/Jul/2017	15:42	UTC-4	76°05.054'	081°56.415'
2b	Belcher	Glacier	30/Jul/2017	19:25	UTC-4	75°42.105'	080°44.967'
2b	323	Full	31/Jul/2017	07:48	UTC-4	74°09.246'	080°29.110'
2b	ROV POND	ROV	01/Aug/2017	10:34	UTC-4	72°49.627'	077°36.611'
2b	ROV NBI	ROV	02/Aug/2017	06:33	UTC-4	73°43.742'	081°06.475'

2b	325	Nutrient	02/Aug/2017	12:11	UTC-4	73°49.096'	080°29.690'
2b	324	Nutrient	02/Aug/2017	15:12	UTC-4	73°58.951'	080°29.401'
2b	300	Nutrient	02/Aug/2017	18:15	UTC-4	74°19.057'	080°29.774'
2b	322	Nutrient	02/Aug/2017	21:12	UTC-4	74°29.401'	080°33.057'
2b	301	Full	03/Aug/2017	02:32	UTC-4	74°16.669'	083°21.845'
2b	303	Nutrient	04/Aug/2017	09:16	UTC-4	74°22.024'	089°36.212'
2b	304	Basic	04/Aug/2017	13:18	UTC-4	74°14.830'	091°30.642'
2b	305a	Nutrient	05/Aug/2017	00:08	UTC-4	74°13.328'	093°30.820'
2b	305b	Basic	05/Aug/2017	01:52	UTC-4	74°21.152'	093°35.001'
2b	305c	Nutrient	05/Aug/2017	06:21	UTC-4	74°28.980'	093°38.466'
2b	305d	Nutrient	05/Aug/2017	08:00	UTC-4	74°36.159'	093°42.609'
2b	5.1	Coring	05/Aug/2017	22:25	UTC-4	74°29.759'	099°04.761'
2b	3.9	Coring	06/Aug/2017	08:40	UTC-4	73°39.270'	096°09.670'
2b	QMG-M	Basic	08/Aug/2017	02:06	UTC-4	68°18.163'	101°44.466'
2b	QMG-WF1	Mooring	08/Aug/2017	08:43	UTC-4	68°14.830'	101°48.652'
2b	QMG-4	Basic	08/Aug/2017	20:14	UTC-4	68°29.098'	103°25.781'
2b	QMG-3	Basic	09/Aug/2017	01:23	UTC-4	68°19.693'	102°56.484'
2b	QMG-WF1	Mooring	09/Aug/2017	07:13	UTC-4	68°14.559'	101°47.954'
2b	QMG-1	Basic	09/Aug/2017	13:02	UTC-4	68°29.468'	099°53.719'
2b	QMG-2	Basic	09/Aug/2017	18:10	UTC-4	68°18.363'	100°48.087'
2b	312	Basic	10/Aug/2017	01:43	UTC-4	69°10.227'	100°42.252'
2b	3.7	Coring	11/Aug/2017	06:41	UTC-4	72°05.622'	096°02.566'
2b	Bellot	Basic	11/Aug/2017	13:02	UTC-4	71°59.568'	094°48.170'
2b	3.4	Coring	11/Aug/2017	20:49	UTC-4	71°28.509'	091°59.795'
2b	3.5	Coring	12/Aug/2017	08:11	UTC-4	70°26.183'	091°14.199'
2b	5.11W	Coring	12/Aug/2017	18:42	UTC-4	69°57.318'	087°40.382'
2b	5.11	Coring	12/Aug/2017	23:36	UTC-4	69°52.871'	086°04.311'
2b	A15	Nutrient	13/Aug/2017	12:17	UTC-4	69°16.271'	080°36.457'
2b	333	Basic	13/Aug/2017	15:03	UTC-4	68°46.217'	080°50.328'
2b	3.10-2	Coring	14/Aug/2017	01:52	UTC-4	68°52.754'	078°09.759'
2b	3.10	Coring	14/Aug/2017	12:04	UTC-4	67°47.844'	080°50.820'
2b	A8	Nutrient	15/Aug/2017	03:16	UTC-4	65°27.043'	083°15.454'
2b	1.1	Coring	15/Aug/2017	10:04	UTC-4	65°09.304'	081°21.269'
2b	A1	Nutrient	15/Aug/2017	22:20	UTC-4	63°42.428'	079°50.479'

2b	A2	Nutrient	16/Aug/2017	00:42	UTC-4	63°37.978'	079°15.308'
2b	A3	Nutrient	16/Aug/2017	02:50	UTC-4	63°33.149'	078°43.289'
Leg 4							
4	356	Nutrient	07/Oct/2017	03:44	UTC-4	60°38.358'	064°42.418'
4	354	Nutrient	07/Oct/2017	05:15	UTC-4	60°58.062'	064°49.298'
4	DFO-1	Mooring	07/Oct/2017	16:02	UTC-4	60°27.677'	061°15.846'

Leg	Station ID	Station Type	Local Date	Ship Time	UTC to local	Latitude (N)	Longitude (W)	Heading (°)	Activity	Depth (m)	Wind		Air (ºC)	Water (ºC)	Pr Baro	Hum (%)	Ice
											Dir	Speed					
Sea Trial																	
ST	Site1	CTD	20/May/2017	07:05	UTC-4	48°13.728'	069°28.324'	191	CTD-Rosette ↓	280	340	6	7.5	6.3	1026,0	47	0/10
ST	Site1	CTD	20/May/2017	07:41	UTC-4	48°13.582'	069°28.685'	082	CTD-Rosette ↑	276	340	13	6.8	6.6	1026.8	46	0/10
ST	Site1	CTD	20/May/2017	11:20	UTC-4	48°13.729'	069°28.182'	289	Piston Core ↓	284	170	9	8.5	6.3	1027.9	54	0/10
ST	Site1	CTD	20/May/2017	11:26	UTC-4	48°13.714'	069°28.194'	332	Piston Core (bottom)	284	150	8	8.5	6.3	1027.9	54	0/10
ST	Site1	CTD	20/May/2017	11:40	UTC-4	48°13.739'	069°28.229'	059	Piston Core ↑	283	140	6	8.8	6.6	1027.8	52	0/10
ST	Site2	CTD	20/May/2017	13:07	UTC-4	48°12.416'	069°26.286'	340	CTD-Rosette ↓	290	135	10	8.9	4.9	1027.7	56	0/10
ST	Site2	CTD	20/May/2017	13:42	UTC-4	48°12.348'	069°26.106'	056	CTD-Rosette ↑	288	155	7	9.6	4.5	1027.7	56	0/10
ST	Site2	CTD	20/May/2017	14:59	UTC-4	48°12.501'	069°26.234'	332	Piston Core ↓	290	185	5	8.0	6.8	1027.7	64	0/10
ST	Site2	CTD	20/May/2017	15:08	UTC-4	48°12.505'	069°25.947'	008	Piston Core (bottom)	289	160	5	8.0	6.8	1027.8	61	0/10
ST	Site2	CTD	20/May/2017	15:17	UTC-4	48°12.567'	069°25.620'	328	Piston Core ↑	297	145	5	9.0	6.6	1027.8	57	0/10
ST	Site2	CTD	20/May/2017	16:19	UTC-4	48°12.488'	069°26.397'	225	Box Core ↓	289	190	5	9.4	8.0	1027.7	63	0/10
ST	Site2	CTD	20/May/2017	16:24	UTC-4	48°12.494'	069°26.391'	226	Box Core (bottom)	289	190	5	9.4	8.0	1027.7	63	0/10
ST	Site2	CTD	20/May/2017	16:30	UTC-4	48°12.503'	069°26.368'	244	Box Core ↑	289	150	5	9.7	7.8	1027.6	51	0/10
ST	Site2	CTD	20/May/2017	17:34	UTC-4	48°12.160'	069°25.240'	045	MVP ↓								0/10
ST	Site2	CTD	20/May/2017	17:43	UTC-4	48°12.595'	069°24.566'	045	MVP (bottom)	177	210	4	11.4	6.6	1027.5	45	0/10
ST	Site2	CTD	20/May/2017	18:26	UTC-4	48°13.684'	069°23.090'	195	MVP ↑	321	180	7	10.7	7.3	1027.3	44	0/10
ST	ROV1	CTD	21/May/2017	09:27	UTC-4	48°18.967'	070°18.419'	315	ROV ↓	257	320	9	5.6	6.8	1032.5	74	0/10
ST	ROV1	CTD	21/May/2017	12:32	UTC-4	48°18.762'	070°18.321'	243	ROV ↑	240	010	9	9.7	7.0	1029.9	55	0/10
ST	ROV1	CTD	21/May/2017	13:54	UTC-4	48°18.898'	070°18.358'	307	Mooring Deployment ↓	257	350	5	11.0	7.5	1028.4	49	0/10
ST	ROV1	CTD	21/May/2017	14:25	UTC-4	48°18.894'	070°18.435'	317	Mooring Recovery ↑	257	010	3	12.8	7.3	1028,0	36	0/10
ST	ROV1	CTD	21/May/2017	14:59	UTC-4	48°18.593'	070°19.070'	292	Mooring Deployment ↓	185	050	3	15.1	7.6	1027.3	32	0/10
ST	ROV1	CTD	21/May/2017	15:19	UTC-4	48°18.532'	070°19.096'	134	Mooring Recovery ↑	166	075	6	15.2	7.6	1027.1	29	0/10
ST	ROV1	CTD	21/May/2017	16:00	UTC-4	48°18.932'	070°18.381'	308	CTD-Rosette ↓	254	340	2	14.6	7.5	1026.2	28	0/10
ST	ROV1	CTD	21/May/2017	16:31	UTC-4	48°18.938'	070°18.374'	326	CTD-Rosette ↑	254	000	0	15.3	7.2	1025.7	32	0/10
ST	ROV1	CTD	21/May/2017	18:53	UTC-4	48°18.967'	070°18.373'	021	ROV elevator ↓	256	120	4	13.7	7.0	1025,0	45	0/10
ST	ROV1	CTD	21/May/2017	19:28	UTC-4	48°18.983'	070°18.318'	039	ROV elevator ↕	257	150	1	14.3	7.0	1024.9	40	0/10
ST	ROV1	CTD	22/May/2017						ROV elevator ↑								0/10
ST	ROV1	CTD	22/May/2017	06:03	UTC-4	48°19.104'	070°18.182'	278	CTD-Rosette ↓	259	120	9	7.8	6.5	1022.2	73	0/10
ST	ROV1	CTD	22/May/2017	06:32	UTC-4	48°19.111'	070°18.196'	278	CTD-Rosette ↑	259	120	8	7.4	6.7	1022,0	74	0/10
ST	ROV1	CTD	22/May/2017	09:32	UTC-4	48°19.014'	070°18.290'	287	ROV ↓	253	120	10	9.4	6.6	1020.9	62	0/10
ST	ROV1	CTD	22/May/2017	11:15	UTC-4	48°19.011'	070°18.332'	017	ROV ↑	253	105	10	10.9	6.4	1018.7	57	0/10
ST	ROV1	CTD	22/May/2017	13:02	UTC-4	48°18.977'	070°18.391'	084	Elevator ↑	253	100	4	12.0	7.3	1018.5	65	0/10
ST	ROV1	CTD	22/May/2017	14:33	UTC-4	48°18.742'	070°18.640'	243	Hydrobios ↓	237	070	6	13.6	7.8	1016.4	58	0/10
ST	ROV1	CTD	22/May/2017	14:43	UTC-4	48°18.739'	070°18.640'	238	Hydrobios ↑	237	070	9	13.5	7.6	1016.2	59	0/10
ST	ROV1	CTD	22/May/2017	15:33	UTC-4	48°18.346'	070°15.702'	292	Gravity Core ↓	270	110	14	14.8	7.1	1014.8	50	0/10
ST	ROV1	CTD	22/May/2017	15:40	UTC-4	48°18.320'	070°15.716'	278	Gravity Core (bottom)	270	120	17	14.5	6.9	1014.9	52	0/10
ST	ROV1	CTD	22/May/2017	15:45	UTC-4	48°18.308'	070°15.711'	333	Gravity Core ↑	270	120	16	14.5	6.9	1014.9	52	0/10
ST	ROV1	CTD	22/May/2017	18:25	UTC-4	48°08.596'	069°46.866'	270	Piston Core ↓	206	100	8	11.5	6.7	1014.1	65	0/10
ST	ROV1	CTD	22/May/2017	18:31	UTC-4	48°08.628'	069°46.740'	288	Piston Core (bottom)	200	100	7	11.4	6.8	1014.1	68	0/10
ST	ROV1	CTD	22/May/2017	18:37	UTC-4	48°08.645'	069°46.630'	293	Piston Core ↑	196	100	7	11.4	6.8	1014.1	68	0/10
Leg 1																	
1	Test	Test	06/Jun/2017	15:05	UTC-4	49°54.860'	054°48.700'	269	EM Sampling	371	180	5	5.6	-0.9	1016.3		9/10
1	Test	Test	06/Jun/2017	15:40	UTC-4	49°54.873'	054°47.914'	048	EM Sampling End	367	170	2	4.7	-0.8	1015.3		9/10
1	Test	Test	06/Jun/2017	15:45	UTC-4	49°54.860'	054°48.320'	011	Ice Cage Sampling ↓	369	160	5	5.1	-0.9	1015.9		9/10
1	Test	Test	06/Jun/2017	16:42	UTC-4	49°54.873'	054°47.914'	049	Ice Cage Sampling ↑	367	170	2	4.7	-0.8	1015.3		9/10
1	Test	Test	06/Jun/2017	17:40	UTC-4	49°57.070'	054°43.900'	148	Box Core ↓	361	130	10	2.3	0.2	1014.9		0/10
1	Test	Test	06/Jun/2017	17:50	UTC-4	49°57.070'	054°43.882'	164	Box Core (bottom)	361	120	10	2.3	0.8	1014.9		0/10
1	Test	Test	06/Jun/2017	18:00	UTC-4	49°57.060'	054°43.840'	155	Box Core ↑	361	120	10	2.2	0.8	1014.9		0/10
1	NFLD	Ice	08/Jun/2017	12:32	UTC-4	50°08.190'	055°16.440'	161	CTD-Rosette ↓	134	150	11	1.6	1.3	1010.6		0/10
1	NFLD	Ice	08/Jun/2017	12:51	UTC-4	50°08.240'	055°16.310'	153	CTD-Rosette ↑	134	150	14	1.5	1.0	1010.4		0/10
1	NFLD	Ice	08/Jun/2017	14:15	UTC-4	50°07.250'	055°21.920'	018	EM Sampling	150	140	12	2.3	-0.3	1009.5		9/10
1	NFLD	Ice	08/Jun/2017	14:40	UTC-4	50°07.290'	055°21.900'	324	EM Sampling End	147	130	9	3.9	-0.5	1009.4		9/10
1	NFLD	Ice	08/Jun/2017	14:49	UTC-4	50°07.290'	055°21.890'	313	On Ice Work ↓	147	140	8	3.9	-0.5	1009.4		9/10
1	NFLD	Ice	08/Jun/2017	15:51	UTC-4	50°07.370'	055°21.700'	151	On Ice Work ↑	146	152	10	2.4	-0.1	1008.9		9/10
1	NFLD	Ice	08/Jun/2017	17:10	UTC-4	50°06.804'	055°26.147'	181	EM Sampling	192	152	9	3.6	-0.7	1008.4		8/10
1	NFLD	Ice	08/Jun/2017	17:13	UTC-4	50°06.800'	055°26.150'	181	EM Sampling End	192	150	9	3.8	-0.7	1008.4		8/10
1	NFLD	Ice	08/Jun/2017	17:20	UTC-4	50°06.807'	055°26.114'	185	On Ice Work ↓	191	140	9	4.1	-0.7	1008.4		8/10
1	NFLD	Ice	08/Jun/2017	19:46	UTC-4	50°06.964'	055°24.916'	146	On Ice Work ↑	185	160	9	4.4	-0.6	1007.9		8/10
Leg 2a																	
2a	732	Short Basic	07/Jul/2017	18:35	UTC-4	55°23.256'	077°59.780'	326	PNF	103	230	12	10.8	11.0	1009.1		0/10
2a	732	Short Basic	07/Jul/2017	18:42	UTC-4	55°23.298'	077°59.740'	339	Secchi Disk	105	230	12	10.8	11.0	1009.1		0/10
2a	732	Short Basic	07/Jul/2017	19:44	UTC-4	55°23.201'	077°59.534'	079	CTD-Rosette ↓	117	230	7	14.4	9.8	1008.6		0/10
2a	732	Short Basic	07/Jul/2017	20:31	UTC-4	55°23.523'	077°59.388'	085	CTD-Rosette ↑	102	230	7	13.3	10.2	1008.2		0/10
2a	732	Short Basic	07/Jul/2017	20:53	UTC-4	55°23.099'	077°59.523'	034	5NVS ↓	120	210	7	11.7	10.4	1008,0		0/10
2a	732	Short Basic	07/Jul/2017	21:02	UTC-4	55°23.105'	077°59.487'	048	5NVS ↑	119	220	11	10.2	10.5	1007.9		0/10
2a	732	Short Basic	07/Jul/2017	21:32	UTC-4	55°23.240'	077°59.306'		DSN ↓	117	220	11	10.2	10.4	1007.6		0/10

2a	732	Short Basic	07/Jul/2017	21:46	UTC-4	55°23.694'	077°58.936'	035	DSN ↑	112	220	11	10.2	10.7	1007.4		0/10
2a	732	Short Basic	07/Jul/2017	21:52	UTC-4	55°23.791'	077°58.832'	017	DSN ↓	109	220	11	9.8	10.8	1007.3		0/10
2a	732	Short Basic	07/Jul/2017	22:04	UTC-4	55°24.207'	077°58.825'	328	DSN ↑	115	220	11	9.7	10.7	1007.2		0/10
2a	732	Short Basic	07/Jul/2017	22:17	UTC-4	55°24.511'	077°58.738'	045	Agassiz Trawl ↓	119	190	10	9.7	10.8	1007.1		0/10
2a	732	Short Basic	07/Jul/2017	22:29	UTC-4	55°24.833'	077°58.343'	348	Agassiz Trawl ↑	120	200	9	10.7	10.9	1006.7		0/10
2a	732	Short Basic	07/Jul/2017	22:55	UTC-4	55°22.920'	077°59.684'	026	Box Core ↓	121	210	14	10.0	10.9	1003.8		0/10
2a	732	Short Basic	07/Jul/2017	22:58	UTC-4	55°22.941'	077°59.664'	034	Box Core (bottom)	121	210	14	10.0	10.91	1003.98		0/10
2a	732	Short Basic	07/Jul/2017	23:02	UTC-4	55°22.927'	077°59.631'	051	Box Core ↑	121	200	10	10.4	10.92	1003.98		0/10
2a	732	Short Basic	07/Jul/2017	23:14	UTC-4	55°23.127'	077°59.470'	123	Box Core ↓	119	210	4	12.1	10.93	1006.23		0/10
2a	732	Short Basic	07/Jul/2017	23:17	UTC-4	55°23.158'	077°59.422'	125	Box Core (bottom)	118	210	4	12.1	10.93	1006.23		0/10
2a	732	Short Basic	07/Jul/2017	23:21	UTC-4	55°23.191'	077°59.371'	125	Box Core ↑	118	220	7	10.6	10.94	1006.07		0/10
2a	732	Short Basic	07/Jul/2017	23:35	UTC-4	55°23.339'	077°59.123'	125	Box Core ↓	112	220	11	10.6	10.95	1005.84		0/10
2a	732	Short Basic	07/Jul/2017	23:37	UTC-4	55°23.364'	077°59.080'	124	Box Core (bottom)	113	220	11	10.6	10.95	1005.84		0/10
2a	732	Short Basic	07/Jul/2017	23:41	UTC-4	55°23.392'	077°59.029'	127	Box Core ↑	111	220	11	10.7	10.92	1005.71		0/10
2a	736	Short Basic	08/Jul/2017	17:10	UTC-4	58°25.439'	078°18.720'	280	PNF + Secchi Disk ↓	95	260	10					0/10
2a	736	Short Basic	08/Jul/2017	17:36	UTC-4	58°25.425'	078°18.614'	257	PNF + Secchi Disk ↑	93	250	12	6.2	7.14	1004.07		0/10
2a	736	Short Basic	08/Jul/2017	17:57	UTC-4	58°25.493'	078°18.263'	125	CTD-Rosette ↓	89	250	13	6.2	7.23	1004.15		0/10
2a	736	Short Basic	08/Jul/2017	18:47	UTC-4	58°25.759'	078°17.748'	128	CTD-Rosette ↑	69	260	5	7.4	7.24	1004.34		0/10
2a	736	Short Basic	08/Jul/2017	19:05	UTC-4	58°25.196'	078°18.524'	050	DSN ↓	100	250	5	7.0	7.22	1004.39		0/10
2a	736	Short Basic	08/Jul/2017	19:18	UTC-4	58°25.574'	078°18.271'	357	DSN ↑	86	240	11	5.6	7.39	1004.4		0/10
2a	736	Short Basic	08/Jul/2017	19:32	UTC-4	58°25.180'	078°18.645'	051	DSN ↓	102	240	11	5.7	7.36	1004.37		0/10
2a	736	Short Basic	08/Jul/2017	19:43	UTC-4	58°25.584'	078°18.402'	357	DSN ↑	87	250	13	6.1	7.39	1004.4		0/10
2a	736	Short Basic	08/Jul/2017	20:23	UTC-4	58°25.407'	078°18.728'	017	5NVS ↓	95	240	11	6.0	7.26	1004.19		0/10
2a	736	Short Basic	08/Jul/2017	20:31	UTC-4	58°25.372'	078°18.731'	048	5NVS ↑	96	240	13	5.9	7.31	1004.29		0/10
2a	736	Short Basic	08/Jul/2017	20:56	UTC-4	58°25.393'	078°18.305'	059	Agassiz Trawl ↓	91	260	3	6.9	7.36	1004.23		0/10
2a	736	Short Basic	08/Jul/2017	21:13	UTC-4	58°25.738'	078°17.968'	336	Agassiz Trawl ↑	75	230	14	5.6	7.29	1004.17		0/10
2a	720	Short Basic	09/Jul/2017	:	UTC-4	60°39.158'	078°34.168'	055	PNF ↓	106	220	6	4.6	4.39	995.88		0/10
2a	720	Short Basic	09/Jul/2017	11:32	UTC-4	60°39.158'	078°34.168'	055	PNF ↑	106	220	6	4.6	4.39	995.88		0/10
2a	720	Short Basic	09/Jul/2017	11:33	UTC-4	60°39.158'	078°34.168'	055	Secchi Disk ↓	106	220	6	4.6	4.39	995.88		0/10
2a	720	Short Basic	09/Jul/2017	11:35	UTC-4	60°39.158'	078°34.168'	055	Secchi Disk ↑	106	220	6	4.6	4.39	995.88		0/10
2a	720	Short Basic	09/Jul/2017	12:40	UTC-4	60°41.711'	078°33.895'	118	CTD-Rosette ↓	88	210	14	3.9	3.28	996.5		0/10
2a	720	Short Basic	09/Jul/2017	13:14	UTC-4	60°41.965'	078°33.239'	137	CTD-Rosette ↑	84	210	14	4.6	2.86	996.58		0/10
2a	720	Short Basic	09/Jul/2017	13:25	UTC-4	60°41.543'	078°32.033'	289	DSN ↓	92	200	12	4.2	2.88	996.53		0/10
2a	720	Short Basic	09/Jul/2017	13:38	UTC-4	60°41.681'	078°32.991'	246	DSN ↑	89	210	13	4.0	2.74	996.92		0/10
2a	720	Short Basic	09/Jul/2017	13:51	UTC-4	60°41.412'	078°33.555'	304	DSN ↓	94	210	11	4.1	2.78	996.97		0/10
2a	720	Short Basic	09/Jul/2017	14:05	UTC-4	60°41.591'	078°34.435'	244	DSN ↑	88	205	13	4.0	2.97	997.04		0/10
2a	720	Short Basic	09/Jul/2017	14:33	UTC-4	60°41.482'	078°33.345'	007	5NVS ↓	85	205	8	4.5	3.15	997.79		0/10
2a	720	Short Basic	09/Jul/2017	14:41	UTC-4	60°41.452'	078°33.276'	046	5NVS ↑	88	180	11	4.8	3.09	997.15		0/10
2a	720	Short Basic	09/Jul/2017	15:11	UTC-4	60°41.404'	078°33.813'	280	Agassiz Trawl ↓	91	180	10	4.4	3.09	997.24		0/10
2a	720	Short Basic	09/Jul/2017	15:20	UTC-4	60°41.387'	078°34.147'	233	Agassiz Trawl ↑	92	170	14	4.4	3.09	997.24		0/10
2a	694	Short Basic	10/Jul/2017	03:12	UTC-4	62°30.450'	078°30.037'	180	DSN ↓	102	145	17	4.7	3.63	1001.55		0/10
2a	694	Short Basic	10/Jul/2017	03:26	UTC-4	62°30.525'	078°29.785'	313	DSN ↑	100	140	15	5.2	3.62	1001.74		0/10
2a	694	Short Basic	10/Jul/2017	03:43	UTC-4	62°30.847'	078°28.892'	300	DSN ↓	95	150	16	5.8	3.56	1001.94		0/10
2a	694	Short Basic	10/Jul/2017	03:55	UTC-4	62°30.893'	078°29.767'	205	DSN ↑	105	150	15	4.7	3.58	1002.06		0/10
2a	694	Short Basic	10/Jul/2017	04:23	UTC-4	62°30.811'	078°28.986'	333	5NVS ↓	95	150	11	5.9	3.32	1002.43		0/10
2a	694	Short Basic	10/Jul/2017	04:31	UTC-4	62°30.851'	078°28.905'	299	5NVS ↑	97	140	10	6.3	3,0	1002.64		0/10
2a	694	Short Basic	10/Jul/2017	04:41	UTC-4	62°30.891'	078°28.827'	049	PNF ↓	96	150	6	6.4	2.88	1002.95		0/10
2a	694	Short Basic	10/Jul/2017	04:44	UTC-4	62°30.924'	078°28.824'	063	PNF ↑	96	150	6	6.4	2.88	1002.95		0/10
2a	694	Short Basic	10/Jul/2017	04:45	UTC-4	62°30.939'	078°28.832'	062	Secchi Disk ↓	97	150	6	6.4	2.88	1002.95		0/10
2a	694	Short Basic	10/Jul/2017	04:48	UTC-4	62°30.963'	078°28.889'	072	Secchi Disk ↑	97	150	6	6.4	2.88	1002.95		0/10
2a	694	Short Basic	10/Jul/2017	05:05	UTC-4	62°30.735'	078°29.317'	016	CTD-Rosette ↓	96	150	11	5.1	2.83	1003.03		0/10
2a	694	Short Basic	10/Jul/2017	05:46	UTC-4	62°31.330'	078°28.723'	147	CTD-Rosette ↑	100	050	3	4.7	3.12	1003.62		0/10
2a	694	Short Basic	10/Jul/2017	05:59	UTC-4	62°30.712'	078°29.372'	314	Agassiz Trawl ↓	96	100	6	4.8	3.26	1004.1		0/10
2a	694	Short Basic	10/Jul/2017	06:08	UTC-4	62°30.974'	078°29.365'	290	Agassiz Trawl ↑	103	100	6	5.4	3.26	1004.1		0/10
2a	694	Short Basic	10/Jul/2017	06:09	UTC-4	62°31.046'	078°29.340'	296	Agassiz Trawl ↓	103	060	2	5.3	3.26	1005.01		0/10
2a	694	Short Basic	10/Jul/2017	06:19	UTC-4	62°31.276'	078°29.663'	277	Agassiz Trawl ↑	108	060	2	5.3	3.26	1005.0		0/10
2a	694	Short Basic	10/Jul/2017	06:39	UTC-4	62°30.717'	078°29.025'	233	Box Core ↓	93	060	8	5.3	3.4	1005.2		0/10
2a	694	Short Basic	10/Jul/2017	06:42	UTC-4	62°30.731'	078°29.026'	225	Box Core (bottom)	94	070	10	5.0	3.23	1004.41		0/10
2a	694	Short Basic	10/Jul/2017	06:44	UTC-4	62°30.739'	078°29.031'	219	Box Core ↑	94	070	10	5.0	3.23	1004.41		0/10
2a	694	Short Basic	10/Jul/2017	07:05	UTC-4	62°31.240'	078°29.525'	190	Box Core ↓	109	080	13	5.0	3.47	1003.98		0/10
2a	694	Short Basic	10/Jul/2017	07:07	UTC-4	62°31.253'	078°29.463'	221	Box Core (bottom)	110	080	13	5.0	3.47	1003.98		0/10
2a	694	Short Basic	10/Jul/2017	07:10	UTC-4	62°31.254'	078°29.430'	225	Box Core ↑	109	080	13	5.0	3.47	1003.98		0/10
2a	688	Short Basic	10/Jul/2017	16:29	UTC-4	62°21.744'	074°40.329'	296	PNF ↓	103	050	19	5.4	3.91	1008.03		0/10
2a	688	Short Basic	10/Jul/2017	16:32	UTC-4	62°21.712'	074°40.415'	299	PNF ↑	102	050	14	4.5	4.21	1008.22		0/10
2a	688	Short Basic	10/Jul/2017	16:34	UTC-4	62°21.706'	074°40.456'	312	Secchi Disk ↓	103	050	14	4.5	4.21	1008.22		0/10
2a	688	Short Basic	10/Jul/2017	16:36	UTC-4	62°21.699'	074°40.560'	322	Secchi Disk ↑	103	050	14	4.5	4.21	1008.22		0/10
2a	688	Short Basic	10/Jul/2017	16:56	UTC-5	62°22.023'	074°39.693'	202	CTD-Rosette ↓	105	060	20	4.5	4.35	1007.9		0/10
2a	688	Short Basic	10/Jul/2017	17:35	UTC-6	62°21.906'	074°39.502'	176	CTD-Rosette ↑	104	050	20	4.4	4.12	1008.2		0/10
2a	688	Short Basic	10/Jul/2017	17:56	UTC-7	62°21.093'	074°40.144'	209	DSN ↓	109	060	17	4.9	4.26	1008.3		0/10
2a	688	Short Basic	10/Jul/2017	18:12	UTC-4	62°21.802'	074°40.023'	165	DSN ↑	101	050	16	5.4	4.23	1008.51		0/10
2a	688	Short Basic	10/Jul/2017	18:26	UTC-4	62°22.135'	074°39.971'	228	DSN ↓	107	060	17	5.6	4.38	1008.4		0/10
2a	688	Short Basic	10/Jul/2017	18:39	UTC-4	62°21.887'	074°40.047'	145	DSN ↑	102	060	13	5.5	4.32	1008.56		0/10
2a	688	Short Basic	10/Jul/2017	19:07	UTC-4	62°22.171'	074°39.845'	246	5NVS ↓	107	050	15	4.7	4.45	1008.55		0/10

2a	688	Short Basic	10/Jul/2017	19:16	UTC-4	62°22.183'	074°39.733'	242	5NVS ↑	109	050	11	6.5	4.39	1008.82		0/10
2a	688	Short Basic	10/Jul/2017	19:36	UTC-4	62°22.267'	074°40.382'	219	Agassiz Trawl ↓	107	070	7	5.1	4.13	1008.91		0/10
2a	688	Short Basic	10/Jul/2017	19:47	UTC-4	62°21.924'	074°40.325'	159	Agassiz Trawl ↑	106	050	16	3.8	4.26	1008.84		0/10
2a	684	Short Basic	11/Jul/2017	04:45	UTC-4	61°47.302'	071°54.932'	135	PNF ↓	103	130	7	1.6	1.95	1008.68		0/10
2a	684	Short Basic	11/Jul/2017	04:47	UTC-4	61°47.268'	071°54.919'	140	PNF ↑	103	130	7	1.6	1.95	1008.68		0/10
2a	684	Short Basic	11/Jul/2017	04:47	UTC-4	61°47.267'	071°54.918'	140	Secchi Disk ↓	103	130	7	1.6	1.95	1008.68		0/10
2a	684	Short Basic	11/Jul/2017	04:50	UTC-4	61°47.260'	071°54.911'	148	Secchi Disk ↑	103	150	5	1.7	2.5	1008.89		0/10
2a	684	Short Basic	11/Jul/2017	04:58	UTC-4	61°47.232'	071°54.846'	322	Niskin ↓	103	150	5	1.7	2.5	1008.89		0/10
2a	684	Short Basic	11/Jul/2017	05:00	UTC-4	61°47.225'	071°54.829'	337	Niskin ↑	104	130	5	1.8	2.25	1008.84		0/10
2a	684	Short Basic	11/Jul/2017	05:02	UTC-4	61°47.227'	071°54.815'	334	CTD-Rosette ↓	104	130	5	1.8	2.25	1008.84		0/10
2a	684	Short Basic	11/Jul/2017	05:40	UTC-4	61°46.949'	071°54.371'	288	CTD-Rosette ↑	106	170	3	1.8	1.79	1008.72		0/10
2a	684	Short Basic	11/Jul/2017	05:50	UTC-4	61°47.369'	071°55.106'	210	DSN ↓	104	170	3	1.8	1.79	1008.72		0/10
2a	684	Short Basic	11/Jul/2017	06:10	UTC-4	61°47.630'	071°54.556'	276	DSN ↑	104	180	3	2.4	2.38	1008.66		0/10
2a	684	Short Basic	11/Jul/2017	06:20	UTC-4	61°47.432'	071°55.014'	169	DSN ↓	104	180	3	2.4	2.38	1008.66		0/10
2a	684	Short Basic	11/Jul/2017	06:39	UTC-4	61°47.629'	071°54.741'	264	DSN ↑	104	230	4	3.0	2.59	1008.46		0/10
2a	684	Short Basic	11/Jul/2017	07:00	UTC-4	61°47.308'	071°54.830'	024	5NVS ↓	105	190	6	2.7	2.56	1008.18		0/10
2a	684	Short Basic	11/Jul/2017	07:09	UTC-4	61°47.228'	071°54.759'	027	5NVS ↑	106	210	3	3.6	2.59	1008.19		0/10
2a	684	Short Basic	11/Jul/2017	07:32	UTC-4	61°47.093'	071°54.706'	036	Agassiz Trawl ↓	108	200	7	4.0	2.28	1008.09		0/10
2a	684	Short Basic	11/Jul/2017	07:43	UTC-4	61°47.336'	071°54.979'	268	Agassiz Trawl ↑	106	200	3	3.7	2.26	1008.08		0/10
2a	682	Short Basic	11/Jul/2017	14:38	UTC-4	61°02.600'	069°43.028'	280	PNF ↓	106	000	7	3.6	4.42	1006.94		0/10
2a	682	Short Basic	11/Jul/2017	14:41	UTC-4	61°02.610'	069°43.027'	265	PNF ↑	107	000	7	3.6	4.42	1006.94		0/10
2a	682	Short Basic	11/Jul/2017	14:42	UTC-4	61°02.611'	069°43.028'	265	Secchi Disk ↓	107	000	7	3.6	4.42	1006.94		0/10
2a	682	Short Basic	11/Jul/2017	14:45	UTC-4	61°02.614'	069°43.029'	246	Secchi Disk ↑	107	010	8	3.6	4.42	1006.94		0/10
2a	682	Short Basic	11/Jul/2017	14:54	UTC-4	61°02.636'	069°43.038'	253	Niskin ↓	105	015	7	4.2	4.25	1006.84		0/10
2a	682	Short Basic	11/Jul/2017	14:55	UTC-4	61°02.645'	069°43.024'	262	Niskin ↑	105	015	7	4.2	4.25	1006.84		0/10
2a	682	Short Basic	11/Jul/2017	14:57	UTC-4	61°02.647'	069°43.021'	264	Niskin ↓	105	015	7	4.2	4.25	1006.84		0/10
2a	682	Short Basic	11/Jul/2017	14:59	UTC-4	61°02.654'	069°43.006'	269	Niskin ↑	105	015	7	4.2	4.25	1006.84		0/10
2a	682	Short Basic	11/Jul/2017	15:03	UTC-4	61°02.663'	069°42.984'	279	Niskin ↓	102	025	7	4.2	4.25	1006.84		0/10
2a	682	Short Basic	11/Jul/2017	15:04	UTC-4	61°02.666'	069°42.974'	283	Niskin ↑	102	025	7	4.8	4,0	1006.87		0/10
2a	682	Short Basic	11/Jul/2017	15:10	UTC-4	61°02.691'	069°42.924'	294	Niskin ↓	100	025	7	5.0	3.86	1006.88		0/10
2a	682	Short Basic	11/Jul/2017	15:11	UTC-4	61°02.692'	069°42.924'	296	Niskin ↑	100	020	7	5.0	3.86	1006.9		0/10
2a	682	Short Basic	11/Jul/2017	15:27	UTC-4	61°02.502'	069°42.981'	117	CTD-Rosette ↓	103	015	7	4.4	3.7	1006.87		0/10
2a	682	Short Basic	11/Jul/2017	16:06	UTC-4	61°02.550'	069°42.843'	125	CTD-Rosette ↑	99	350	8	3.4	4.13	1006.87		0/10
2a	682	Short Basic	11/Jul/2017	16:20	UTC-4	61°02.515'	069°42.740'	137	DSN ↓	93	350	8	3.4	4.22	1006.92		0/10
2a	682	Short Basic	11/Jul/2017	16:30	UTC-4	61°02.585'	069°42.051'	356	DSN ↑	70	350	7	3.4	4.29	1007,0		0/10
2a	682	Short Basic	11/Jul/2017	16:41	UTC-4	61°02.632'	069°43.239'	166	DSN ↓	108	000	8	3.7	4.41	1006.84		0/10
2a	682	Short Basic	11/Jul/2017	16:56	UTC-4	61°02.662'	069°42.225'	007	DSN ↑	72	350	8	3.8	4.56	1006.53		0/10
2a	682	Short Basic	11/Jul/2017	17:14	UTC-4	61°02.612'	069°43.123'	130	5NVS ↓	106	010	8	3.9	3.93	1006.09		0/10
2a	682	Short Basic	11/Jul/2017	17:25	UTC-4	61°02.168'	069°43.092'	180	5NVS ↑	107	350	9	3.9	3.93	1006.09		0/10
2a	682	Short Basic	11/Jul/2017	17:51	UTC-4	61°02.514'	069°42.770'	259	Agassiz Trawl ↓	95	350	9	3.7	4.17	1006.1		0/10
2a	682	Short Basic	11/Jul/2017	18:00	UTC-4	61°02.374'	069°43.016'	124	Agassiz Trawl ↑	101	350	9	3.7	4.17	1006.1		0/10
Leg 2a																	
2b	676	Short Basic	12/Jul/2017	00:10	UTC-4	60°07.572'	069°03.852'	191	Niskin ↓	111	000	15	2.4	1.68	1002.68		1/10
2b	676	Short Basic	12/Jul/2017	00:12	UTC-4	60°07.571'	069°03.868'	202	Niskin ↑	112	000	15	2.4	1.68	1002.68		1/10
2b	676	Short Basic	12/Jul/2017	00:13	UTC-4	60°07.571'	069°03.877'	203	CTD-Rosette ↓	113	000	15	2.4	1.68	1002.68		1/10
2b	676	Short Basic	12/Jul/2017	00:52	UTC-4	60°07.565'	069°03.932'	217	CTD-Rosette ↑	93	000	23	2.7	1.73	1002.47		1/10
2b	676	Short Basic	12/Jul/2017	01:06	UTC-4	60°07.616'	069°04.078'	164	DSN ↓	110	000	24	2.5	1.7	1002.3		1/10
2b	676	Short Basic	12/Jul/2017	01:24	UTC-4	60°07.330'	069°04.147'	121	DSN ↑	98	000	19	1.6	1.71	1002.23		1/10
2b	676	Short Basic	12/Jul/2017	01:39	UTC-4	60°07.661'	069°03.940'	175	DSN ↓	103	000	25	1.8	1.69	1001.83		Bergy
2b	676	Short Basic	12/Jul/2017	01:55	UTC-4	60°07.599'	069°04.044'	210	DSN ↑	100	000	28	1.4	1.69	1001.86		Bergy
2b	676	Short Basic	12/Jul/2017	02:17	UTC-4	60°07.542'	069°03.972'	216	5NVS ↓	108	000	29	1.6	1.64	1002.24		Bergy
2b	676	Short Basic	12/Jul/2017	02:27	UTC-4	60°07.622'	069°03.938'	182	5NVS ↑	106	000	26	2.0	1.67	1002.77		Bergy
2b	676	Short Basic	12/Jul/2017	02:48	UTC-4	60°07.566'	069°03.656'	197	Agassiz Trawl ↓	98	000	21	2.0	1.68	1002.96		Bergy
2b	676	Short Basic	13/Jul/2017	03:00	UTC-4	60°07.327'	069°03.134'	163	Agassiz Trawl ↑	93	005	21	1.6	1.67	1002.54		Bergy
2b	676	Short Basic	13/Jul/2017	09:38	UTC-4	58°58.011'	067°52.827'	116	PNF ↓	71							
2b	676	Short Basic	13/Jul/2017	09:40	UTC-4	58°57.940'	067°52.807'	103	PNF ↑	72							
2b	676	Short Basic	13/Jul/2017	09:42	UTC-4	58°57.883'	067°52.766'	091	PNF ↓	71							
2b	676	Short Basic	13/Jul/2017	09:48	UTC-4	58°57.802'	067°52.708'	080	PNF ↑	70							
2b	676	Short Basic	13/Jul/2017	10:13	UTC-4	59°00.316'	067°55.882'	029	PNF ↓	122	000	19	1.3	1.02	1000,0		1/10
2b	676	Short Basic	13/Jul/2017	10:16	UTC-4	59°00.281'	067°55.932'	091	PNF ↑	121	000	19	1.3	1.02	1000,0		1/10
2b	676	Short Basic	13/Jul/2017	10:19	UTC-4	59°00.207'	067°55.973'	082	Secchi Disk ↓	121	340	19	1.3	0.88	1000.1		1/10
2b	676	Short Basic	13/Jul/2017	10:23	UTC-4	59°00.135'	067°56.006'	106	Secchi Disk ↑	123	340	19	1.3	0.88	1000.1		1/10
2b	676	Short Basic	13/Jul/2017	10:36	UTC-4	58°59.782'	067°56.119'	119	CTD-Rosette ↓	141	350	16	1.1	0.83	1000.46		1/10
2b	676	Short Basic	13/Jul/2017	11:18	UTC-4	58°59.218'	067°56.275'	206	CTD-Rosette ↑	100	350	16	2.0	0.88	1000.59		1/10
2b	670	Short Basic	13/Jul/2017	12:04	UTC-4	59°00.266'	067°55.730'	150	DSN ↓	121	000	20	1.6	0.82	1001.14		1/10
2b	670	Short Basic	13/Jul/2017	12:19	UTC-4	59°00.301'	067°54.890'	036	DSN ↑	125	000	19	1.4	0.75	1001.13		1/10
2b	670	Short Basic	13/Jul/2017	12:36	UTC-4	59°00.600'	067°56.114'	162	DSN ↓	122	000	19	1.8	0.75	1001.2		1/10
2b	670	Short Basic	13/Jul/2017	12:53	UTC-4	59°00.577'	067°54.984'	066	DSN ↑	117	350	18	1.8	0.75	1001.36		1/10
2b	670	Short Basic	13/Jul/2017	13:18	UTC-4	59°00.382'	067°55.903'	152	5NVS ↓	120	350	15	1.8	0.76	1001.81		1/10
2b	670	Short Basic	13/Jul/2017	13:28	UTC-4	59°00.415'	067°55.783'	141	5NVS ↑	119	350	16	2.6	0.83	1001.99		1/10
2b	670	Short Basic	13/Jul/2017	14:01	UTC-4	59°00.268'	067°55.724'	144	Agassiz Trawl ↓	117	330	16	2.6	0.96	1002.25		1/10
2b	670	Short Basic	13/Jul/2017	14:11	UTC-4	59°00.288'	067°56.054'	055	Agassiz Trawl ↑	112	330	14	2.4	0.97	1002.37		1/10
2b	670	Short Basic	13/Jul/2017	14:31	UTC-4	59°00.204'	067°56.029'	150	Box Core ↓	120	330	15	2.6	1.06	1002.5		1/10
2b	670	Short Basic	13/Jul/2017	14:41	UTC-4	59°00.311'	067°55.758'	103	Box Core ↑	116	330	14	2.9	1.2	1002.77		1/10
2b	OF-B2	Benthic Cam	14/Jul/2017	06:27	UTC-4	63°00.089'	067°19.818'	194	CTD-Rosette ↓	422	290	5	3.1	0.3	1001.89		3/10
2b	OF-B2	Benthic Cam	14/Jul/2017	07:26	UTC-4	62°59.995'	067°20.003'	219	CTD-Rosette ↑	440	300	12	2.8	0.34	1001.63		3/10

2b	OF-B2	Benthic Cam	14/Jul/2017	07:46	UTC-4	62°59.967'	067°20.095'	055	Box Core ↓	441	300	14	2.8	0.34	1001.43		3/10
2b	OF-B2	Benthic Cam	14/Jul/2017	07:54	UTC-4	62°59.963'	067°19.992'	047	Box Core (bottom)	442	290	14	2.8	0.16	1001.16		3/10
2b	OF-B2	Benthic Cam	14/Jul/2017	08:02	UTC-4	62°59.949'	067°20.005'	067	Box Core ↑	441	290	14	2.7	0.25	1001.07		3/10
2b	OF-B2	Benthic Cam	14/Jul/2017	08:55	UTC-4	62°57.224'	067°08.366'	093	Box Core ↓	389	290	11	3.0	0.46	1001.01		2/10
2b	OF-B2	Benthic Cam	14/Jul/2017	09:02	UTC-4	62°57.208'	067°08.306'	077	Box Core (bottom)	383	280	12	2.7	0.6	1001.8		2/10
2b	OF-B2	Benthic Cam	14/Jul/2017	09:09	UTC-4	62°57.167'	067°08.320'	082	Box Core ↑	433	270	12	2.7	0.7	1000.66		2/10
2b	OF-B2	Benthic Cam	14/Jul/2017	09:22	UTC-4	62°57.232'	067°08.360'	119	Agassiz Trawl ↓	402	280	10	4.3	0.75	1000.56		2/10
2b	OF-B2	Benthic Cam	14/Jul/2017	09:58	UTC-4	62°57.141'	067°06.707'	048	Agassiz Trawl ↑	281	270	13	2.8	0.84	1000.49		2/10
2b	OF-B2	Benthic Cam	14/Jul/2017	10:46	UTC-4	62°49.183'	066°56.376'	092	Box Core ↓	480	280	13	3.4	1.22	1000.37		1/10
2b	OF-B2	Benthic Cam	14/Jul/2017	10:54	UTC-4	62°49.126'	066°56.354'	163	Box Core (bottom)	507	270	13	3.3	1.19	1000.05		1/10
2b	OF-B2	Benthic Cam	14/Jul/2017	11:09	UTC-4	62°49.065'	066°56.296'	120	Box Core ↑	522	310	12	5.2	1.11	999.99		1/10
2b	OF-B2	Benthic Cam	14/Jul/2017	11:19	UTC-4	62°49.093'	066°55.944'	102	Agassiz Trawl ↓	470	300	9	3.9	1,0	999.92		1/10
2b	OF-B2	Benthic Cam	14/Jul/2017	11:53	UTC-4	62°48.989'	066°54.599'	011	Agassiz Trawl ↑	460	300	11	3.3	1.09	999.93		1/10
2b	OF-B6	Benthic Cam	14/Jul/2017	12:38	UTC-4	62°44.740'	066°42.390'	138	Box Core ↓	493	315	9	4.3	1.17	999.6		1/10
2b	OF-B6	Benthic Cam	14/Jul/2017	12:46	UTC-4	62°44.740'	066°42.350'	130	Box Core (bottom)	493	315	10	4.3	1.25	999.52		1/10
2b	OF-B6	Benthic Cam	14/Jul/2017	12:56	UTC-4	62°44.730'	066°42.360'	152	Box Core ↑	493	330	9	4.2	1.22	999.45		1/10
2b	OF-B6	Benthic Cam	14/Jul/2017	13:14	UTC-4	62°44.848'	066°42.870'	156	Agassiz Trawl ↓	493	315	9	5.1	1.28	999.34		1/10
2b	OF-B6	Benthic Cam	14/Jul/2017	13:41	UTC-4	62°44.775'	066°41.590'	003	Agassiz Trawl ↑	485	300	8	4.8	1.46	999.45		1/10
2b	Outer Bay A	Coring	14/Jul/2017	18:18	UTC-4	63°07.577'	067°26.206'	242	Piston Core ↓	344	275	8	5.0	0.31	998.48		5/10
2b	Outer Bay A	Coring	14/Jul/2017	18:25	UTC-4	63°07.615'	067°26.212'	315	Piston Core (bottom)	331	278	9.4	5.1	0.37	998.69		5/10
2b	Outer Bay A	Coring	14/Jul/2017	18:37	UTC-4	63°07.630'	067°26.344'	058	Piston Core ↑	337	285	8.5	5.2	0.37	998.55		5/10
2b	Outer Bay A	Coring	14/Jul/2017	21:03	UTC-4	63°07.904'	067°25.922'	254	Piston Core ↓	295	290	9	4.7	0.32	997.28		6/10
2b	Outer Bay A	Coring	14/Jul/2017	21:11	UTC-4	63°07.965'	067°25.932'	249	Piston Core (bottom)	291	290	11	5.0	0.35	997.13		6/10
2b	Outer Bay A	Coring	14/Jul/2017	21:17	UTC-4	63°08.058'	067°25.918'	257	Piston Core ↑	292	290	11	5.0	0.35	997.13		6/10
2b	FB2-2-2-5g	Benthic	15/Jul/2017	02:04	UTC-4	63°39.801'	068°25.290'	195	Box Core ↓	82	310	8	4.4	1.33	996.36		0/10
2b	FB2-2-2-5g	Benthic	15/Jul/2017	02:06	UTC-4	63°39.784'	068°25.250'	182	Box Core (bottom)	82	310	8	4.4	1.33	996.39		0/10
2b	FB2-2-2-5g	Benthic	15/Jul/2017	02:09	UTC-4	63°39.787'	068°25.210'	164	Box Core ↑	87	310	8	4.4	1.33	996.39		0/10
2b	FB2-2-2-5g	Benthic	15/Jul/2017	02:31	UTC-4	63°39.824'	068°25.234'	185	Box Core ↓	85	315	6.5	4.3	0.99	996.52		0/10
2b	FB2-2-2-5g	Benthic	15/Jul/2017	02:33	UTC-4	63°39.820'	068°25.207'	184	Box Core (bottom)	86	315	6.5	4.3	0.99	996.52		0/10
2b	FB2-2-2-5g	Benthic	15/Jul/2017	02:36	UTC-4	63°39.802'	068°25.133'	177	Box Core ↑ (Didn't work)	94	315	6.5	4.3	0.99	996.52		0/10
2b	FB2-2-2-5g	Benthic	15/Jul/2017	02:42	UTC-4	63°39.807'	068°25.234'	185	Box Core ↓	84	330	7	4.2	1.08	996.58		0/10
2b	FB2-2-2-5g	Benthic	15/Jul/2017	02:44	UTC-4	63°39.802'	068°25.226'	186	Box Core (bottom)	84	330	7	4.2	1.08	996.58		0/10
2b	FB2-2-2-5g	Benthic	15/Jul/2017	02:47	UTC-4	63°39.785'	068°25.187'	191	Box Core ↑	89	330	7	4.2	1.08	996.58		0/10
2b	FB2-2-2-5g	Benthic	15/Jul/2017	03:02	UTC-4	63°39.804'	068°25.155'	172	Box Core ↓	93	330	8	4.2	1.03	996.64		0/10
2b	FB2-2-2-5g	Benthic	15/Jul/2017	03:04	UTC-4	63°39.802'	068°25.121'	130	Box Core (bottom)	94	330	8	4.2	1.03	996.64		0/10
2b	FB2-2-2-5g	Benthic	15/Jul/2017	03:07	UTC-4	63°39.785'	068°25.079'	123	Box Core ↑	96	330	8	4.2	1.03	996.64		0/10
2b	FB2-2-2-5g	Benthic	15/Jul/2017	03:26	UTC-4	63°40.125'	068°25.652'	164	Agassiz Trawl ↓	75	330	6.5	2.7	0.91	996.67		0/10
2b	FB2-2-2-5g	Benthic	15/Jul/2017	03:26	UTC-4	63°39.852'	068°25.246'	110	Agassiz Trawl ↑	87	335	7	3.0	0.81	996.68		0/10
2b	FB2-2-2-5d	Benthic	15/Jul/2017	04:05	UTC-4	63°40.487'	068°25.380'	039	Box Core ↓	31	320	7	2.9	1.17	996.59		0/10
2b	FB2-2-2-5d	Benthic	15/Jul/2017	04:08	UTC-4	63°40.474'	068°25.345'	042	Box Core ↑	29	320	7	2.9	1.17	996.59		0/10
2b	FB2-2-2-5d	Benthic	15/Jul/2017	04:41	UTC-4	63°40.487'	068°25.325'	103	Box Core ↓	24	320	7	2.9	0.74	996.56		0/10
2b	FB2-2-2-5d	Benthic	15/Jul/2017	04:43	UTC-4	63°40.477'	068°25.305'	115	Box Core (bottom)	29	320	7	2.9	0.74	996.56		0/10
2b	FB2-2-2-5d	Benthic	15/Jul/2017	04:46	UTC-4	63°40.494'	068°25.419'	112	Box Core ↑	31	320	7	2.9	0.74	996.56		0/10
2b	FB2-2-2-5d	Benthic	15/Jul/2017	05:03	UTC-4	63°40.468'	068°25.330'	046	Box Core ↓	27	330	5	2.7	0.69	996.63		0/10
2b	FB2-2-2-5d	Benthic	15/Jul/2017	05:05	UTC-4	63°40.463'	068°25.324'	056	Box Core (bottom)	31	330	5	2.7	0.69	996.63		0/10
2b	FB2-2-2-5d	Benthic	15/Jul/2017	05:07	UTC-4	63°40.452'	068°25.329'	074	Box Core ↑	37	330	5	2.7	0.69	996.63		0/10
2b	Bell 12	Coring	15/Jul/2017	06:37	UTC-4	63°41.234'	068°37.459'	226	Piston Core ↓	143	290	3	3.1	1.2	996.46		0/10
2b	Bell 12	Coring	15/Jul/2017	06:52	UTC-4	63°41.225'	068°37.485'	240	Piston Core (bottom)	146	270	4	3.2	1.09	996.4		0/10
2b	Bell 12	Coring	15/Jul/2017	07:13	UTC-4	63°41.231'	068°37.472'	196	Piston Core ↑	145	270	4	3.5	0.92	996.27		0/10
2b	Bell 12	Coring	15/Jul/2017	08:07	UTC-4	63°41.262'	068°37.444'	195	Box Core ↓	141	270	4	3.9	0.96	996.05		0/10
2b	Bell 12	Coring	15/Jul/2017	08:11	UTC-4	63°41.263'	068°37.455'	174	Box Core (bottom)	141	260	4	3.5	0.83	996,0		0/10
2b	Bell 12	Coring	15/Jul/2017	08:14	UTC-4	63°41.263'	068°37.463'	167	Box Core ↑	142	260	4	3.5	0.83	996,0		0/10
2b	PCX A1	Coring	15/Jul/2017	09:35	UTC-4	63°35.891'	068°31.405'	152	Piston Core ↓	180		Calm	4.8	2.04	995.6		0/10
2b	PCX A1	Coring	15/Jul/2017	09:39	UTC-4	63°35.877'	068°31.421'	126	Piston Core (bottom)	180		Calm	5.0	2.18	995.32		0/10
2b	A16	Basic	15/Jul/2017	10:37	UTC-4	63°38.345'	068°37.656'	224	PNF ↓	132	350	7	4.1	2.61	992.75		0/10
2b	A16	Basic	15/Jul/2017	10:47	UTC-4	63°38.342'	068°37.707'	221	PNF ↑	107	000	2	5.3	2.17	995.11		0/10
2b	A16	Basic	15/Jul/2017	10:48	UTC-4	63°38.395'	068°37.712'	218	Secchi Disk ↓	114	000	2	5.3	2.17	995.11		0/10
2b	A16	Basic	15/Jul/2017	10:49	UTC-4	63°38.349'	068°37.723'	218	Secchi Disk ↑	109	000	2	5.3	2.17	995.11		0/10
2b	A16	Basic	15/Jul/2017	11:02	UTC-4	63°38.361'	068°37.554'	080	CTD-Rosette ↓	143	350	4	5.0	1.97	995.73		0/10
2b	A16	Basic	15/Jul/2017	11:52	UTC-4	63°38.372'	068°37.172'	083	CTD-Rosette ↑	133	320	7	4.5	2.06	994.87		0/10
2b	A16	Basic	15/Jul/2017	12:35	UTC-4	63°38.671'	068°37.655'	212	DSN ↓	120	330	7	6.3	2.19	994.83		0/10
2b	A16	Basic	15/Jul/2017	12:50	UTC-4	63°38.451'	068°36.787'	056	DSN ↑	120	330	2.5	6.3	2.19	994.83		0/10
2b	A16	Basic	15/Jul/2017	13:12	UTC-4	63°38.404'	068°37.590'	151	5NVS ↓	143	300	8.5	5.7	2.07	994.82		0/10
2b	A16	Basic	15/Jul/2017	13:23	UTC-4	63°38.384'	068°37.489'	140	5NVS ↑	143	300	8	6.3	2.18	994.78		0/10
2b	A16	Basic	15/Jul/2017	13:37	UTC-4	63°38.358'	068°37.420'	098	CTD-Rosette ↓	140	285	6	6.1	1.9	994.75		0/10
2b	A16	Basic	15/Jul/2017	14:15	UTC-4	63°38.326'	068°37.848'	061	CTD-Rosette ↑	122	315	13	6.2	1.53	994.93		0/10
2b	A16	Basic	15/Jul/2017	14:27	UTC-4	63°38.390'	068°37.642'	175	Agassiz Trawl ↓	141	300	15	5.8	1.63	994.89		0/10
2b	A16	Basic	15/Jul/2017	14:38	UTC-4	63°38.363'	068°37.113'	035	Agassiz Trawl ↑	131	300	8	6.1	1.94	994.91		0/10

2b	A16	Basic	15/Jul/2017	15:01	UTC-4	63°38.358'	068°37.620'	160	Box Core ↓	137	300	18	6.3	2.04	994.95		0/10
2b	A16	Basic	15/Jul/2017	15:04	UTC-4	63°38.355'	068°37.567'	147	Box Core (bottom)	140	300	14	6.3	2.04	994.95		0/10
2b	A16	Basic	15/Jul/2017	15:08	UTC-4	63°38.347'	068°37.567'	152	Box Core ↑	140	300	14	6.3	2.04	994.95		0/10
2b	A16	Basic	15/Jul/2017	15:21	UTC-4	63°38.352'	068°37.581'	140	Box Core ↓	139	315	13	7.8	1.7	995.08		0/10
2b	A16	Basic	15/Jul/2017	15:24	UTC-4	63°38.355'	068°37.584'	129	Box Core (bottom)	139	315	13	7.8	1.7	995.08		0/10
2b	A16	Basic	15/Jul/2017	15:28	UTC-4	63°38.351'	068°37.601'	127	Box Core ↑	139	330	13	7.8	1.7	995.08		0/10
2b	A16	Basic	15/Jul/2017	15:38	UTC-4	63°38.359'	068°37.640'	134	Box Core ↓	137	330	15	7.0	1.51	995.1		0/10
2b	A16	Basic	15/Jul/2017	15:41	UTC-4	63°38.353'	068°37.648'	135	Box Core (bottom)	137	330	13	6.6	1.48	995.14		0/10
2b	A16	Basic	15/Jul/2017	15:44	UTC-4	63°38.346'	068°37.654'	133	Box Core ↑	136	330	13	6.6	1.48	995.14		0/10
2b	A16	Basic	15/Jul/2017	16:03	UTC-4	63°38.290'	068°37.646'	115	Box Core ↓	113	320	8	8.3	1.51	995.2		0/10
2b	A16	Basic	15/Jul/2017	16:06	UTC-4	63°38.287'	068°37.672'	172	Box Core (bottom)	109	320	8	8.3	1.51	995.2		0/10
2b	A16	Basic	15/Jul/2017	16:09	UTC-4	63°38.289'	068°37.644'	185	Box Core ↑	109	320	8	8.3	1.51	995.2		0/10
2b	A16	Basic	15/Jul/2017	16:27	UTC-4	63°38.306'	068°37.600'	094	Box Core ↓	140	300	9	8.4	1.1	995.28		0/10
2b	A16	Basic	15/Jul/2017	16:31	UTC-4	63°38.312'	068°37.637'	153	Box Core (bottom)	135	310	12	8.9	1.07	995.22		0/10
2b	A16	Basic	15/Jul/2017	16:35	UTC-4	63°38.307'	068°37.611'	151	Box Core ↑	138	310	12	8.9	1.07	995.22		0/10
2b	Bell 11	Coring	15/Jul/2017	18:21	UTC-4	63°21.653'	068°10.785'	338	CTD-Rosette ↓	112	290	8	6.3	2.78	995.43		0/10
2b	Bell 11	Coring	15/Jul/2017	18:57	UTC-4	63°21.694'	068°10.868'	015	CTD-Rosette ↑	113	280	7	7.2	2.84	995.43		0/10
2b	Bell 11	Coring	15/Jul/2017	19:46	UTC-4	63°21.714'	068°10.945'	076	Piston Core ↓	117	270	8	7.2	2.3	995.48		0/10
2b	Bell 11	Coring	15/Jul/2017	19:50	UTC-4	63°21.724'	068°10.924'	101	Piston Core (bottom)	118	265	11	6.9	2.47	995.42		0/10
2b	Bell 11	Coring	15/Jul/2017	20:05	UTC-4	63°21.694'	068°11.016'	173	Piston Core ↑	119	260	6	7.7	2.45	995.4		0/10
2b	Bell 11	Coring	15/Jul/2017	20:39	UTC-4	63°21.599'	068°10.933'	040	Box Core ↓	119	280	9	6.4	2.55	995.18		0/10
2b	Bell 11	Coring	15/Jul/2017	20:43	UTC-4	63°21.591'	068°10.924'	044	Box Core (bottom)	119	280	9	6.4	2.55	995.18		0/10
2b	Bell 11	Coring	15/Jul/2017	:	UTC-4	63°21.577'	068°10.921'	050	Box Core ↑	118	280	9	6.4	2.55	995.18		0/10
2b	OF-S22	Benthic Cam	16/Jul/2017	00:46	UTC-4	62°52.024'	066°44.707'	179	Box Core ↓	281	345	7	3.5	0.69	994.29		1/10
2b	OF-S22	Benthic Cam	16/Jul/2017	00:51	UTC-4	62°52.017'	066°44.776'	155	Box Core (bottom)	289	345	7	3.5	0.69	994.29		1/10
2b	OF-S22	Benthic Cam	16/Jul/2017	00:57	UTC-4	62°51.993'	066°44.860'	139	Box Core ↑	284	345	6	3.9	0.76	994.29		1/10
2b	OF-S22	Benthic Cam	16/Jul/2017	01:07	UTC-4	62°51.928'	066°44.871'	126	Agassiz Trawl ↓	253	345	1.6	4.0	0.56	994.33		1/10
2b	OF-S22	Benthic Cam	16/Jul/2017	01:23	UTC-4	62°52.088'	066°44.740'	311	Agassiz Trawl ↑	288	345	5	3.4	0.67	994.31		1/10
2b	OF-B9	Benthic Cam	16/Jul/2017	03:25	UTC-4	62°34.051'	066°16.909'	186	Box Core ↓	375	210	11	4.5	0.46	994.76		5/10
2b	OF-B9	Benthic Cam	16/Jul/2017	03:32	UTC-4	62°34.014'	066°16.942'	133	Box Core (bottom)	377	210	11	4.5	0.46	994.76		5/10
2b	OF-B9	Benthic Cam	16/Jul/2017	03:39	UTC-4	62°33.983'	066°16.978'	295	Box Core ↑	377	235	9.9	3.2	0.24	994.96		5/10
2b	OF-B14	Benthic Cam	16/Jul/2017	05:32	UTC-4	62°23.060'	066°01.836'	164	CTD-Rosette ↓	412	260	9	3.8	-0.5	995.2		7/10
2b	OF-B14	Benthic Cam	16/Jul/2017	06:30	UTC-4	62°23.066'	066°01.375'	053	CTD-Rosette ↑	410	130	2	4.2	-0.36	995.72		7/10
2b	OF-B14	Benthic Cam	16/Jul/2017	06:45	UTC-4	62°23.155'	066°01.344'	235	Box Core ↓	411	70	3	2.9	-0.38	995.81		8/10
2b	OF-B14	Benthic Cam	16/Jul/2017	06:52	UTC-4	62°23.183'	066°01.312'	268	Box Core (bottom)	411	120	1	3.8	-0.32	995.81		8/10
2b	OF-B14	Benthic Cam	16/Jul/2017	07:00	UTC-4	62°23.216'	066°01.238'	328	Box Core ↑	412	100	2	4.2	-0.26	995.86		8/10
2b	OF-B14	Benthic Cam	16/Jul/2017	08:11	UTC-4	62°27.774'	065°52.909'	212	Box Core ↓	278	210	1	3.7	-0.62	996.03		8/10
2b	OF-B14	Benthic Cam	16/Jul/2017	08:16	UTC-4	62°27.810'	065°52.957'	237	Box Core (bottom)	278	210	1	3.7	-0.62	996.03		8/10
2b	OF-B14	Benthic Cam	16/Jul/2017	08:23	UTC-4	62°27.849'	065°53.013'	240	Box Core ↑	278	240	2	3.7	-0.61	996.01		8/10
2b	BB1	Nutrient	18/Jul/2017	01:49	UTC-4	66°51.673'	059°03.477'	349	CTD-Rosette ↓	1048	150	20	0.5	-0.57	997.19		8/10
2b	BB1	Nutrient	18/Jul/2017	03:32	UTC-4	66°53.087'	059°03.312'	349	CTD-Rosette ↑	1065	150	22	0.9	-0.5	996.11		8/10
2b	180	Basic	18/Jul/2017	12:29	UTC-4	67°24.679'	061°27.137'	139	Secchi Disk ↓	530	105	12	0.3	-0.71	985.3		1/10
2b	180	Basic	18/Jul/2017	12:39	UTC-4	67°24.684'	061°27.120'	149	Secchi Disk ↑	532	105	12	0.3	-0.71	985.3		1/10
2b	180	Basic	18/Jul/2017	12:42	UTC-4	67°24.687'	061°26.867'	332	CTD-Rosette ↓	538	120	12.5	-0.1	-0.72	984.9		1/10
2b	180	Basic	18/Jul/2017	13:44	UTC-4	67°25.018'	061°26.576'	025	CTD-Rosette ↑	584	135	8	0.9	-0.66	986.17		1/10
2b	180	Basic	18/Jul/2017	14:15	UTC-4	67°24.006'	061°24.498'	028	DSN ↓	578	150	6	0.1	-0.63	984.16		2/10
2b	180	Basic	18/Jul/2017	14:30	UTC-4	67°24.497'	061°24.332'	354	DSN ↑	620	135	5	0.7	-0.59	984.158		2/10
2b	180	Basic	18/Jul/2017	14:50	UTC-4	67°24.648'	061°24.113'	316	5NVS ↓	635	135	6	1.1	-0.53	984.01		2/10
2b	180	Basic	18/Jul/2017	15:30	UTC-4	67°24.702'	061°23.535'	325	5NVS ↑	656	225	2	0.6	-0.46	983.6		4/10
2b	180	Basic	18/Jul/2017	15:48	UTC-4	67°25.080'	061°23.238'	299	Plankton Net ↓	679	270	0.2	0.4	-0.45	983.53		1/10
2b	180	Basic	18/Jul/2017	16:02	UTC-4	67°25.074'	061°23.146'	331	Plankton Net ↑	682	240	1	0.7	-0.42	983.77		1/10
2b	180	Basic	18/Jul/2017	16:05	UTC-4	67°25.072'	061°23.126'	333	Plankton Net ↓	682	240	1	0.7	-0.42	983.77		1/10
2b	180	Basic	18/Jul/2017	16:18	UTC-4	67°25.070'	061°22.969'	329	Plankton Net ↑	687	220	2	0.3	-0.5	983.9		1/10
2b	180	Basic	18/Jul/2017	16:29	UTC-4	67°25.555'	061°23.298'	146	CTD-Rosette ↓	706	240	2	0.0	-0.5	983.96		2/10
2b	180	Basic	18/Jul/2017	17:46	UTC-4	67°25.162'	061°22.224'	186	CTD-Rosette ↑	711	300	10	0.4	-0.54	983.82		2/10
2b	180	Basic	18/Jul/2017	18:00	UTC-4	67°25.736'	061°21.631'	000	Gravity Core ↓	701	315	9	-0.3	-0.49	983.57		2/10
2b	180	Basic	18/Jul/2017	18:19	UTC-4	67°24.712'	061°21.126'	010	Gravity Core (bottom)	713	300	9	-0.6	-0.4	983.28		2/10
2b	180	Basic	18/Jul/2017	18:38	UTC-4	67°24.643'	061°20.345'	001	Gravity Core ↑	732	260	12	-0.8	-0.39	984,0		2/10
2b	Discofan	ROV	19/Jul/2017	00:44	UTC-4	67°58.051'	059°30.160'	250	CTD-Rosette ↓	911	225	10	-0.6	-0.02	984,0		5/10
2b	Discofan	ROV	19/Jul/2017	02:06	UTC-4	67°57.843'	059°29.191'	153	CTD-Rosette ↑	885	280	12	-0.4	0.03	983.98		5/10
2b	Patch	Coring	19/Jul/2017	02:41	UTC-4	68°00.954'	059°34.813'	299	Box Core ↓	958	270	10	-0.8	-0.12	984.11		5/10
2b	Patch	Coring	19/Jul/2017	02:54	UTC-4	68°00.909'	059°34.732'	354	Box Core (bottom)	947	270	10	-0.8	-0.2	984.15		5/10
2b	Patch	Coring	19/Jul/2017	03:08	UTC-4	68°00.838'	059°34.649'	028	Box Core ↑	950	285	10	-0.9	-0.15	984.14		5/10
2b	Patch	Coring	19/Jul/2017	03:24	UTC-4	68°01.453'	059°34.991'	131	Box Core ↓	939	270	10	-0.8	-0.23	984.2		5/10
2b	Patch	Coring	19/Jul/2017	03:37	UTC-4	68°01.373'	059°34.807'	140	Box Core (bottom)	937	270	10	-0.5	-0.24	984.54		5/10
2b	Patch	Coring	19/Jul/2017	03:50	UTC-4	68°01.314'	059°34.717'	158	Box Core ↑	935	270	10	-0.4	-0.19	984.6		5/10
2b	Bare	Coring	19/Jul/2017	04:14	UTC-4	67°59.520'	059°33.896'	142	Box Core ↓	1009	260	9	-0.6	-0.21	984.6		2/10
2b	Bare	Coring	19/Jul/2017	04:28	UTC-4	67°59.545'	059°33.953'	143	Box Core (bottom)	1012	260	3	-0.5	-0.13	985.11		2/10
2b	Bare	Coring	19/Jul/2017	04:41	UTC-4	67°59.571'	059°33.984'	175	Box Core ↑	1014	270	7	-0.5	-0.04	985.22		2/10

2b	Bare	Coring	19/Jul/2017	04:55	UTC-4	67°59.565'	059°33.919'	161	Box Core ↓	1010	270	7	-0.5	-0.05	985.4		2/10
2b	Bare	Coring	19/Jul/2017	05:08	UTC-4	67°59.567'	059°33.874'	143	Box Core (bottom)	1007	270	2	-0.5	-0.07	985.57		2/10
2b	Bare	Coring	19/Jul/2017	05:22	UTC-4	67°59.551'	059°33.757'	140	Box Core ↑	1004	260	2	-0.4	-0.12	985.69		2/10
2b	Discofan	ROV	19/Jul/2017	11:17	UTC-4	67°57.984'	059°29.311'	351	Box Core ↓	872	240	10	0.3	0.18	990.29		2/10
2b	Discofan	ROV	19/Jul/2017	11:32	UTC-4	67°57.890'	059°29.106'	043	Box Core (bottom)	873	220	13	-0.3	0.2	990.89		2/10
2b	Discofan	ROV	19/Jul/2017	11:48	UTC-4	67°57.786'	059°28.840'	128	Box Core ↑	874	230	10	0.5	0.19	991.89		2/10
2b	Discofan	ROV	19/Jul/2017	12:36	UTC-4	67°58.127'	059°29.562'	087	Box Core ↓	878	225	16	0.1	0.17	992.05		2/10
2b	Discofan	ROV	19/Jul/2017	12:48	UTC-4	67°58.082'	059°29.405'	057	Box Core (bottom)	874	225	15	0.7	0.19	992.4		2/10
2b	Discofan	ROV	19/Jul/2017	13:05	UTC-4	67°58.038'	059°29.361'	096	Box Core ↑	872	225	17	1.1	0.22	992.42		2/10
2b	Discofan	ROV	19/Jul/2017	13:49	UTC-4	67°58.134'	059°30.159'	331	ROV ↓		225	19	0.0	0.23	993.01		2/10
2b	Discofan	ROV	19/Jul/2017	14:43	UTC-4	67°58.148'	059°30.205'	281	ROV (20m)	900	210	17	0.6	0.23	994.19		2/10
2b	Discofan	ROV	19/Jul/2017	15:10	UTC-4	67°58.149'	059°30.213'	209	ROV (bottom)		210	10	0.6	0.23	994.8		2/10
2b	Discofan	ROV	19/Jul/2017	15:51	UTC-4	67°58.106'	059°30.174'	176	ROV ↑		235	16	0.7	0.2	995.64		2/10
2b	Discofan	ROV	19/Jul/2017	16:41	UTC-4	67°58.129'	059°30.167'	183	ROV (recovery)		220	16	1.0	0.23	996.52		2/10
2b	GE Float	Float	20/Jul/2017	02:55	UTC-4	69°33.218'	060°46.143'	334	CTD-Rosette ↓	1715	135	13	0.2	-0.07	1001.02		1/10
2b	GE Float	Float	20/Jul/2017	05:03	UTC-4	69°33.532'	060°47.262'	359	CTD-Rosette ↑	1713	150	13	1.7	0.08	1001.76		1/10
2b	GE Float	Float	20/Jul/2017	05:46	UTC-4	69°37.742'	060°44.949'	358	Deployment of Float 1	1674	130	8	1.2	0.12	1002.07		1/10
2b	GE Float	Float	20/Jul/2017	06:10	UTC-4	69°38.136'	060°43.961'	332	Deployment of Float 2	1672	150	8	1.3	0.15	1002.27		1/10
2b	GE Float	Float	20/Jul/2017	06:25	UTC-4	69°38.525'	060°43.237'	300	Deployment of Float 3	1667	140	10	1.3	0.18	1002.66		1/10
2b	GE Float	Float	20/Jul/2017	06:46	UTC-4	69°38.948'	060°42.329'	309	Deployment of Float 4	1659	130	12	0.6	0.27	1002.69		1/10
2b	GE Float	Float	20/Jul/2017	07:43	UTC-4	69°38.640'	060°44.697'	216	CTD-Rosette ↓	1671	120	14	0.0	0.18	1003.15		1/10
2b	GE Float	Float	20/Jul/2017	09:01	UTC-4	69°38.803'	060°43.867'	010	CTD-Rosette ↑	1668	160	1	0.7	0.12	1003.55		1/10
2b	8.1	Coring	20/Jul/2017	17:52	UTC-4	69°24.365'	064°43.656'	268	Box Core ↓	1042	135	10	0.6	-0.69	1002.36		9/10
2b	8.1	Coring	20/Jul/2017	18:07	UTC-4	69°24.437'	064°43.929'	332	Box Core (bottom)	1054	120	9	0.1	-0.75	1002.43		9/10
2b	8.1	Coring	20/Jul/2017	18:20	UTC-4	69°24.514'	064°44.183'	011	Box Core ↑	1055	130	2	1.1	-0.76	1002.54		9/10
2b	8.1	Coring	20/Jul/2017	19:07	UTC-4	69°24.590'	064°43.871'	327	Piston Core ↓	1065	145	7.5	0.0	0,0	1002,0		9/10
2b	8.1	Coring	20/Jul/2017	19:37	UTC-4	69°24.669'	064°43.900'	061	Piston Core (bottom)	1076	160	3	2.1	-0.77	1002.64		9/10
2b	8.1	Coring	20/Jul/2017	19:50	UTC-4	69°24.882'	064°43.692'	053	Piston Core ↑	1088	150	7	0.7	-0.75	1002.54		9/10
2b	8.1	Coring	20/Jul/2017	22:42	UTC-4	69°36.846'	065°23.468'	343	PNF ↓	282	130	5	0.5	-0.71	1002.27		9/10
2b	8.1	Coring	20/Jul/2017	22:48	UTC-4	69°36.820'	065°23.479'	355	PNF ↑	282	130	5	0.5	-0.71	1002.22		9/10
2b	8.1	Coring	20/Jul/2017	22:49	UTC-4	69°36.820'	065°23.479'	355	Secchi Disk ↓	282	130	5	0.5	-0.71	1002.22		9/10
2b	8.1	Coring	20/Jul/2017	22:52	UTC-4	69°36.814'	065°23.845'	003	Secchi Disk ↑	282	130	5	0.5	-0.71	1002.22		9/10
2b	8.1	Coring	20/Jul/2017	23:00	UTC-4	69°36.789'	065°23.477'	024	CTD-Rosette ↓	283	140	6	1.0	-0.83	1002.25		9/10
2b	8.1	Coring	20/Jul/2017	23:50	UTC-4	69°36.618'	065°23.130'	051	CTD-Rosette ↑	300	170	3	0.0	-0.77	1002.19		9/10
2b	8.1	Coring	21/Jul/2017	00:11	UTC-4	69°36.815'	065°23.697'	228	5NVS ↓	287	250	9	0.1	-0.77	1002.21		9/10
2b	8.1	Coring	21/Jul/2017	00:30	UTC-4	69°36.694'	065°23.601'	326	5NVS ↑	281	165	7	0.1	-0.82	1002.12		9/10
2b	8.1	Coring	21/Jul/2017	00:43	UTC-4	69°36.439'	065°23.654'	341	Plankton Net ↓	284	195	12	1.1	-0.8	1002.14		9/10
2b	8.1	Coring	21/Jul/2017	00:57	UTC-4	69°36.387'	065°23.637'	037	Plankton Net ↑	287	180	15	3.3	-0.82	1002.01		9/10
2b	8.1	Coring	21/Jul/2017	01:17	UTC-4	69°36.200'	065°23.610'	035	CTD-Rosette ↓	288	180	12	1.9	-0.84	1002.05		9/10
2b	8.1	Coring	21/Jul/2017	02:14	UTC-4	69°36.161'	065°24.003'	068	CTD-Rosette ↑	275	165	10	1.2	-0.81	1002.01		9/10
2b	8.1	Coring	21/Jul/2017	02:30	UTC-4	69°35.853'	065°24.176'	297	Box Core ↓	270	165	11	0.8	-0.82	1001.96		9/10
2b	8.1	Coring	21/Jul/2017	02:34	UTC-4	69°35.852'	065°24.226'	303	Box Core (bottom)	267	180	11	0.8	-0.82	1001.96		9/10
2b	8.1	Coring	21/Jul/2017	02:38	UTC-4	69°35.845'	065°24.237'	324	Box Core ↑	168	180	10	0.8	-0.82	1001.93		9/10
2b	BB3	Nutrient	21/Jul/2017	22:54	UTC-4	71°24.891'	068°36.842'	246	CTD-Rosette ↓	1271	340	2	0.4	-0.76	1006.17		9/10
2b	BB3	Nutrient	22/Jul/2017	00:40	UTC-4	71°24.744'	068°36.748'	212	CTD-Rosette ↑	1253	315	6	0.1	-0.74	1006.67		9/10
2b	BB2	Full	22/Jul/2017	09:23	UTC-4	72°46.066'	066°00.014'	203	PNF ↓	2371	120	2	0.6	3.96	1010.16		0/10
2b	BB2	Full	22/Jul/2017	09:26	UTC-4	72°46.085'	066°00.085'	197	PNF ↑	2372	120	2	0.6	3.96	1010.16		0/10
2b	BB2	Full	22/Jul/2017	09:27	UTC-4	72°46.095'	066°00.097'	199	Secchi Disk ↓	2372	120	2	0.6	3.96	1010.16		0/10
2b	BB2	Full	22/Jul/2017	09:28	UTC-4	72°46.106'	066°00.109'	201	Secchi Disk ↑	2372	120	2	0.6	3.96	1010.16		0/10
2b	BB2	Full	22/Jul/2017	09:29	UTC-4	72°46.106'	066°00.136'	209	Niskin↓	2372	120	2	0.6	3.96	1010.16		0/10
2b	BB2	Full	22/Jul/2017	09:31	UTC-4	72°46.109'	066°00.147'	214	Niskin ↑	2372	120	2	0.6	3.96	1010.16		0/10
2b	BB2	Full	22/Jul/2017	09:48	UTC-4	72°46.113'	067°00.249'	030	CTD-Rosette ↓	2371	000	0	1.6	3.72	1010.25		0/10
2b	BB2	Full	22/Jul/2017	11:43	UTC-4	72°46.214'	067°01.956'	348	CTD-Rosette ↑	2372	170	1	1.6	3.94	1011.14		0/10
2b	BB2	Full	22/Jul/2017	12:40	UTC-4	72°46.349'	066°50.660'	268	DSN ↓	2371	210	0.6	0.8	4.5	1011.39		0/10
2b	BB2	Full	22/Jul/2017	12:46	UTC-4	72°45.916'	066°59.402'	171	DSN ↑	2372	210	2.5	1.0	0.48	1011.43		0/10
2b	BB2	Full	22/Jul/2017	13:55	UTC-4	72°46.631'	067°02.156'	235	Manta Net ↓	2373	180	3	1.1	4.559	1012,0		0/10
2b	BB2	Full	22/Jul/2017	14:20	UTC-4	72°45.452'	067°01.056'	132	Manta Net ↑	2372	270	4	1.6	4.69	1011.99		0/10
2b	BB2	Full	22/Jul/2017	15:07	UTC-4	72°45.851'	066°59.381'	350	CTD-Rosette ↓	2371	220	3	1.8	4.94	1012.36		0/10
2b	BB2	Full	22/Jul/2017	16:42	UTC-4	72°45.790'	066°59.069'	306	CTD-Rosette ↑	2372	210	3	1.7	4.73	1013.07		0/10
2b	BB2	Full	22/Jul/2017	16:57	UTC-4	72°45.989'	067°00.102'	281	5NVS ↓	2372	190	3	1.6	4.72	1013.15		0/10
2b	BB2	Full	22/Jul/2017	19:18	UTC-4	72°45.992'	067°01.310'	314	5NVS ↑	2372	160	3	2.1	4.5	1013.86		0/10
2b	BB2	Full	22/Jul/2017	19:34	UTC-4	72°46.030'	067°00.499'	344	Plankton Net ↓	2372	170	5	1.5	4.25	1013.89		0/10
2b	BB2	Full	22/Jul/2017	19:49	UTC-4	72°46.014'	067°00.738'	324	Plankton Net ↑	2371	160	6	1.3	4.3	1013.96		0/10
2b	BB2	Full	22/Jul/2017	19:53	UTC-4	72°45.989'	067°00.723'	289	Plankton Net ↓	2372	150	4	1.6	4.28	1013.96		0/10
2b	BB2	Full	22/Jul/2017	20:08	UTC-4	72°46.029'	067°00.749'	290	Plankton Net ↑	2373	150	5	1.6	4.17	1013.96		0/10
2b	BB2	Full	22/Jul/2017	20:20	UTC-4	72°45.955'	067°00.601'	291	Box Core ↓	2373	150	5	1.9	4.11	1013.98		0/10
2b	BB2	Full	22/Jul/2017	20:46	UTC-4	72°45.080'	067°00.910'	273	Box Core (bottom)	2373	140	4	1.5	4.14	1014,0		0/10
2b	BB2	Full	22/Jul/2017	21:23	UTC-4	72°46.241'	067°01.360'	274	Box Core ↑	2373	130	5	1.3	4.13	1014.05		0/10
2b	BB2	Full	22/Jul/2017	22:17	UTC-4	72°46.127'	067°00.485'	043	Float 1	2373	170	3	1.5	4.43	1014.33		0/10
2b	BB2	Full	22/Jul/2017	22:53	UTC-4	72°46.295'	067°01.885'	264	Float 2	2373	130	5	1.0	4.35	1014.51		0/10
2b	BB2	Full	22/Jul/2017	23:08	UTC-4	72°46.180'	067°00.400'	059	Float 3	2372	140	5	1.0	4.35	1014.47		0/10

2b	BB2	Full	22/Jul/2017	23:30	UTC-4	72°45.825'	066°59.406'	045	CTD-Rosette ↓	2372	150	2	1.2	4.48	1014.46		0/10
2b	BB2	Full	23/Jul/2017	01:08	UTC-4	72°46.069'	066°59.537'	341	CTD-Rosette ↑	2372	160	6	1.4	4.2	1014.33		0/10
2b	BA06	Mooring	23/Jul/2017	18:45	UTC-4	75°39.674'	070°25.598'	276	CTD-Rosette ↓	533	120	13		5.69	1015.86		0/10
2b	BA06	Mooring	23/Jul/2017	19:23	UTC-4	75°40.088'	070°26.228'	313	CTD-Rosette ↑	531	100	7		5.66	1015.82		0/10
2b	BA06	Mooring	23/Jul/2017	20:08	UTC-4	75°39.454'	070°24.585'	009	Mooring Recovery ↑	533	110	14		5.67	1016.04		0/10
2b	BA06	Mooring	23/Jul/2017	21:42	UTC-4	75°48.320'	070°12.364'	270	CTD-Rosette ↓	540	110	14		5.88	1015.7		0/10
2b	BA06	Mooring	23/Jul/2017	22:12	UTC-4	75°48.632'	070°13.448'	288	CTD-Rosette ↑	546	110	12		5.88	1015.66		0/10
2b	BA06	Mooring	23/Jul/2017	22:39	UTC-4	75°48.211'	070°12.176'	340	Mooring Recovery ↑	540	100	16		5.88	1015.24		0/10
2b	101	Full	24/Jul/2017	08:20	UTC-4	76°22.980'	077°24.192'	183	CTD-Rosette ↓	358	010	15	0.5	0.57	1012.54		1/10
2b	101	Full	24/Jul/2017	09:12	UTC-4	76°23.017'	077°25.757'	194	CTD-Rosette ↑	392	020	15	1.0	0.8	1012.3		1/10
2b	101	Full	24/Jul/2017	09:19	UTC-4	76°22.451'	077°23.878'	101	DSN ↓	374	270	15	1.0	0.71	1011.85		1/10
2b	101	Full	24/Jul/2017	09:48	UTC-4	76°22.694'	077°24.224'	185	DSN ↑	365	010	15	1.0	0.59	1011.97		1/10
2b	101	Full	24/Jul/2017	10:12	UTC-4	76°22.614'	077°25.173'	216	Beam Trawl ↓	386	020	10	1.0	0.8	1012.22		1/10
2b	101	Full	24/Jul/2017	11:03	UTC-4	76°20.920'	077°24.126'	083	Beam Trawl ↑	394	000	15	1.0	1.61	1011.85		1/10
2b	101	Full	24/Jul/2017	12:21	UTC-4	76°23.091'	077°24.090'	160	PNF ↓	353	030	16	1.0	1.53	1010.87		Bergy
2b	101	Full	24/Jul/2017	12:25	UTC-4	76°23.089'	077°24.090'	175	PNF ↑	354	030	16	1.0	1.53	1010.89		Bergy
2b	101	Full	24/Jul/2017	12:26	UTC-4	76°23.101'	077°24.213'	195	Secchi Disk ↓	354	030	17	1.0	1.53	1010.87		Bergy
2b	101	Full	24/Jul/2017	12:27	UTC-4	76°23.101'	077°24.213'	206	Secchi Disk ↑	355	030	17	1.0	1.53	1010.87		Bergy
2b	101	Full	24/Jul/2017	12:35	UTC-4	76°23.117'	077°24.319'	242	CTD-Rosette ↓	357	015	17	1.0	1.05	1010.97		Bergy
2b	101	Full	24/Jul/2017	13:22	UTC-4	76°23.012'	077°23.970'	268	CTD-Rosette ↑	357	015	16	1.0	1.37	1011.22		Bergy
2b	101	Full	24/Jul/2017	13:34	UTC-4	76°22.950'	077°23.806'	239	5NVS ↓	354	030	17	1.0	1.34	1011.41		Bergy
2b	101	Full	24/Jul/2017	13:57	UTC-4	76°22.852'	077°23.650'	244	5NVS ↑	355	035	12	1.0	1.34	1011.41		Bergy
2b	101	Full	24/Jul/2017	14:28	UTC-4	76°22.835'	077°23.319'	206	Hydrobios ↓	355	030	14		1.23	1010.65		Bergy
2b	101	Full	24/Jul/2017	14:48	UTC-4	76°22.812'	077°23.294'	189	Hydrobios ↑	355	030	10	1.3	1.5	1010.64	98	Bergy
2b	101	Full	24/Jul/2017	15:12	UTC-4	76°23.058'	077°23.387'	012	Plankton Net ↓	347	025	14	2.2	1.57	1010.62	96	Bergy
2b	101	Full	24/Jul/2017	15:27	UTC-4	76°23.039'	077°23.722'	246	Plankton Net ↑	350	030	15	1.4	1.09	1010.67	99	Bergy
2b	101	Full	24/Jul/2017	15:36	UTC-4	76°22.902'	077°23.451'	238	Plankton Net ↓	353	015	18	1.4	1.34	1010.88	99	Bergy
2b	101	Full	24/Jul/2017	15:50	UTC-4	76°22.794'	077°23.069'	251	Plankton Net ↑	358	015	19	1.4	1.41	1011.02	98	Bergy
2b	101	Full	24/Jul/2017	16:16	UTC-4	76°21.504'	077°31.130'	212	Box Core ↓	376	040	13	1.4	1.46	1011.17	98	Bergy
2b	101	Full	24/Jul/2017	16:22	UTC-4	76°21.473'	077°30.960'	242	Box Core (bottom)	378	030	12	1.5	1.54	1011.11	97	Bergy
2b	101	Full	24/Jul/2017	16:31	UTC-4	76°21.406'	077°30.720'	199	Box Core ↑	378	020	16	1.5	1.64	1010.83	98	Bergy
2b	101	Full	24/Jul/2017	16:40	UTC-4	76°21.507'	077°31.530'	320	Agassiz Trawl ↓	373	020	16	1.5	1.64	1010.83	98	Bergy
2b	101	Full	24/Jul/2017	17:11	UTC-4	76°20.898'	077°30.046'	074	Agassiz Trawl ↑	377	000	13	0.8	1.79	1011,0	99	Bergy
2b	102	CTD	24/Jul/2017	18:08	UTC-4	76°22.319'	076°59.965'	181	CTD-Rosette ↓	258	020	11	1.2	1.12	1008.93	97	Bergy
2b	102	CTD	24/Jul/2017	18:24	UTC-4	76°22.228'	076°59.893'	274	CTD-Rosette ↑	261	020	11	1.5	1.22	1008.99	96	Bergy
2b	103	Nutrient	24/Jul/2017	19:19	UTC-4	76°20.737'	076°35.642'	274	CTD-Rosette ↓	157	040	11	1.4	1.61	1008.71	97	Bergy
2b	103	Nutrient	24/Jul/2017	19:57	UTC-4	76°21.117'	076°36.435'	253	CTD-Rosette ↑	145	030	3	3.1	1.37	1008.64	87	Bergy
2b	104	CTD	24/Jul/2017	20:53	UTC-4	76°20.672'	076°10.421'	294	CTD-Rosette ↓	191	090	17	3.1	1.24	1008.34	93	Bergy
2b	104	CTD	24/Jul/2017	21:07	UTC-4	76°20.752'	076°10.461'	262	CTD-Rosette ↑	188	080	4	3.7	1.21	1008.32	89	Bergy
2b	104	CTD	24/Jul/2017	21:12	UTC-4	76°20.781'	076°10.492'	253	CTD-Rosette ↓	189	070	4	4.0	1.21	1008.29	88	Bergy
2b	104	CTD	24/Jul/2017	21:27	UTC-4	76°20.894'	076°10.877'	246	CTD-Rosette ↑	186	070	7	2.9	1.25	1008.26	93	Bergy
2b	105	Basic	24/Jul/2017	22:16	UTC-4	76°19.015'	075°45.602'	259	CTD-Rosette ↓	327	120	12	2.8	1.92	1007.87	95	Bergy
2b	105	Basic	24/Jul/2017	23:09	UTC-4	76°19.438'	075°47.343'	227	CTD-Rosette ↑	345	110	13	2.7	2.33	1007.65	94	Bergy
2b	105	Basic	24/Jul/2017	23:59	UTC-4	76°19.233'	075°46.279'	291	DSN ↓	333	135	13	3.7	2.24	1007.72	90	Bergy
2b	105	Basic	25/Jul/2017	00:17	UTC-4	76°18.947'	075°48.054'	110	DSN ↑	337	135	13	3.1	2.33	1007.67	93	Bergy
2b	105	Basic	25/Jul/2017	00:40	UTC-4	76°19.125'	075°45.674'	312	5NVS ↓	329	120	11	3.0	2.28	1007.68	94	Bergy
2b	105	Basic	25/Jul/2017	01:05	UTC-4	76°19.165'	075°45.686'	280	5NVS ↑	330	120	14	3.0	2.13	1007.73	93	Bergy
2b	105	Basic	25/Jul/2017	01:15	UTC-4	76°19.085'	075°45.676'	281	Plankton Net ↓	329	120	15	3.2	2.21	1007.68	92	Bergy
2b	105	Basic	25/Jul/2017	01:29	UTC-4	76°19.135'	075°45.783'	282	Plankton Net ↑	330	120	15	4.0	2.08	1007.64	90	Bergy
2b	105	Basic	25/Jul/2017	01:37	UTC-4	76°19.087'	075°45.676'	040	PNF ↕	330	135	14	2.8	2.15	1007.7	95	Bergy
2b	105	Basic	25/Jul/2017	01:41	UTC-4	76°19.087'	075°45.676'	053	Secchi Disk ↕	332	135	14	2.8	2.15	1007.7	95	Bergy
2b	105	Basic	25/Jul/2017	01:52	UTC-4	76°19.098'	075°45.939'	266	CTD-Rosette ↓	331	125	14	3.3	2.14	1007.69	93	Bergy
2b	105	Basic	25/Jul/2017	02:49	UTC-4	76°18.957'	075°46.077'	294	CTD-Rosette ↑	331	115	15	4.1	2.29	1007.7	90	Bergy
2b	105	Basic	25/Jul/2017	03:08	UTC-4	76°19.095'	075°45.432'	295	Box Core ↓	329	120	13	2.8	2.29	1007.63	95	Bergy
2b	105	Basic	25/Jul/2017	03:14	UTC-4	76°19.061'	075°45.484'	306	Box Core (bottom)	331	120	13	2.8	2.28	1007.53	95	Bergy
2b	105	Basic	25/Jul/2017	03:19	UTC-4	76°19.019'	075°45.575'	281	Box Core ↑	327	120	13	2.8	2.19	1007.53	95	Bergy
2b	105	Basic	25/Jul/2017	03:28	UTC-4	76°19.020'	075°46.255'	286	Agassiz Trawl ↓	333	120	14	4.2	1.76	1007.54	89	Bergy
2b	105	Basic	25/Jul/2017	03:52	UTC-4	76°18.667'	075°48.319'	260	Agassiz Trawl ↑	332	120	14	2.7	2.18	1007.41	95	Bergy
2b	106	CTD	25/Jul/2017	05:02	UTC-4	76°18.423'	075°21.383'	254	CTD-Rosette ↓	380	120	11	3.6	1.79	1007.71	90	Bergy
2b	106	CTD	25/Jul/2017	05:33	UTC-4	76°18.343'	075°22.150'	326	CTD-Rosette ↑	378	110	9	5.7	1.68	1007.84	81	Bergy
2b	106	CTD	25/Jul/2017	06:10	UTC-4	76°18.494'	075°21.831'	345	Lander Deployment ↓	377	110	5	4.4	1.67	1007.95	86	Bergy
2b	107	Nutrient	25/Jul/2017	07:06	UTC-4	76°16.895'	074°59.291'	266	CTD-Rosette ↓	439	120	18	3.8	1.76	1007.79	87	Bergy
2b	107	Nutrient	25/Jul/2017	07:55	UTC-4	76°16.963'	075°00.686'	300	CTD-Rosette ↑	434	100	11	4.8	1.94	1008.31	83	Bergy
2b	BA06	Mooring	25/Jul/2017	15:10	UTC-4	76°39.382'	070°24.530'	256	Mooring Deployment ↓	531	120	13	3.4	5.96	1007.46	82	0/10
2b	BA06	Mooring	25/Jul/2017	16:06	UTC-4	75°39.173'	070°24.218'	305	CTD-Rosette ↓	532	120	12	6.0	5.97	1007.25	82	0/10
2b	BA06	Mooring	25/Jul/2017	16:30	UTC-4	75°39.179'	070°24.531'	318	CTD-Rosette ↑	532	110	8	8.5	5.96	1007.28	72	0/10
2b	BA05	Mooring	25/Jul/2017	18:15	UTC-4	75°48.244'	070°12.284'	245	Mooring Deployment ↓	539	120	8	6.0	6.08	1007.08	81	0/10
2b	BA05	Mooring	25/Jul/2017	18:30	UTC-4	75°48.074'	070°13.299'	230	Triangulation 1 (808m)	590							0/10
2b	BA05	Mooring	25/Jul/2017	18:36	UTC-4	75°48.504'	070°12.943'	015	Triangulation 2 (853m)	539							0/10
2b	BA05	Mooring	25/Jul/2017	18:48	UTC-4	75°48.219'	070°11.052'	100	Triangulation 3 (820m)	541							0/10
2b	BA05	Mooring	25/Jul/2017	19:12	UTC-4	75°48.210'	070°11.672'	329	CTD-Rosette ↓	539	130	10	6.5	6.32	1006.95	81	0/10

2b	BA05	Mooring	25/Jul/2017	19:50	UTC-4	75°48.469'	070°11.583'	324	CTD-Rosette ↑	537	120	9	8.2	6,0	1007.1	75	0/10
2b	MVP Start	MVP	26/Jul/2017	00:00	UTC-4	76°34.226'	071°00.036'	299	MVP ↓	526	090	10	5.1	5.16	1006.64	81	Bergy
2b	MVP Start	MVP	26/Jul/2017	02:37	UTC-4	76°40.543'	071°20.528'	333	MVP ↑	172	105	13	4.0	2.14	1006.47	82	Bergy
2b	115	Full	26/Jul/2017	04:51	UTC-4	76°19.935'	071°11.848'	310	CTD-Rosette ↓	674	110	15	5.3	4.71	1006.15	81	Bergy
2b	115	Full	26/Jul/2017	06:04	UTC-4	76°19.837'	071°12.677'	304	CTD-Rosette ↑	649	100	18	6.8	4.89	1006.1	73	Bergy
2b	115	Full	26/Jul/2017	06:17	UTC-4	76°19.973'	071°12.166'	301	DSN ↓	671	110	15	7.5	4.9	1005.93	70	Bergy
2b	115	Full	26/Jul/2017	06:34	UTC-4	76°19.766'	071°14.129'	255	DSN ↑	669	110	18	5.8	4.72	1005.81	74	Bergy
2b	115	Full	26/Jul/2017	07:36	UTC-4	76°20.004'	071°12.390'	304	Manta Net ↓	671	110	21	6.1	4.64	1005.93	70	Bergy
2b	115	Full	26/Jul/2017	08:00	UTC-4	76°19.812'	071°17.195'	253	Manta Net ↑	670	100	18	5.5	4.61	1006.014	73	Bergy
2b	115	Full	26/Jul/2017	08:44	UTC-4	76°20.089'	071°12.073'	148	PNF ↓	655	110	17	5.7	4.64	1006.17	77	Bergy
2b	115	Full	26/Jul/2017	08:48	UTC-4	76°20.087'	071°12.220'	213	PNF ↑	660	110	17	5.7	4.64	1006.09	77	Bergy
2b	115	Full	26/Jul/2017	08:49	UTC-4	76°20.089'	071°12.291'	220	Secchi Disk ↓	660	110	17	5.6	4.59	1006.19	77	Bergy
2b	115	Full	26/Jul/2017	08:51	UTC-4	76°20.093'	071°12.436'	223	Secchi Disk ↑	664	110	17	5.6	4.59	1006.19	77	Bergy
2b	115	Full	26/Jul/2017	09:03	UTC-4	76°20.173'	071°13.047'	253	CTD-Rosette ↓	663	100	14	6.0	4.48	1006.3	76	Bergy
2b	115	Full	26/Jul/2017	10:02	UTC-4	76°20.698'	071°15.549'	266	CTD-Rosette ↑	657	100	19	6.7	4.45	1005.97	73	Bergy
2b	115	Full	26/Jul/2017	10:42	UTC-4	76°20.014'	071°12.871'	281	Plankton Net ↓	673	120	21	6.6	4.78	1005.65	70	Bergy
2b	115	Full	26/Jul/2017	11:00	UTC-4	76°20.309'	071°12.690'	290	Plankton Net ↑	653	120	19	6.3	4.72	1005.66	72	Bergy
2b	115	Full	26/Jul/2017	11:12	UTC-4	76°20.409'	071°12.714'	310	Plankton Net ↓	654	120	19	6.3	4.72	1005.66	72	Bergy
2b	115	Full	26/Jul/2017	11:25	UTC-4	76°20.709'	071°13.899'	286	Plankton Net ↑	653	120	18	6.3	4.63	1005.75	74	Bergy
2b	115	Full	26/Jul/2017	12:35	UTC-4	76°20.288'	071°13.060'	210	IKMT ↓	659	120	18	6.1	4.68	1005.5	75	Bergy
2b	115	Full	26/Jul/2017	13:36	UTC-4	76°20.468'	071°17.292'	144	IKMT ↑	654	090	14	7.2	4.64	1008.74	85	Bergy
2b	115	Full	26/Jul/2017	14:03	UTC-4	76°19.877'	071°10.888'	302	5NVS ↓	675	090	20	6.2	4.67	1005.62	81	Bergy
2b	115	Full	26/Jul/2017	14:46	UTC-4	76°20.072'	071°10.762'	326	5NVS ↑	658	105	35	9.6	4.26	1005.57	74	Bergy
2b	115	Full	26/Jul/2017	15:36	UTC-4	76°19.913'	071°15.323'	301	Box Core ↓	665	105	32	5.9	4.72	1005.19	90	Bergy
2b	115	Full	26/Jul/2017	15:46	UTC-4	76°19.915'	071°15.284'	306	Box Core (bottom)	668	100	28	6.0	4.65	1005.65	77	Bergy
2b	115	Full	26/Jul/2017	15:58	UTC-4	76°19.907'	071°15.399'	295	Box Core ↑	668	100	28	10.1	4.56	1005.67	75	Bergy
2b	115	Full	26/Jul/2017	16:13	UTC-4	76°19.996'	071°16.224'	298	Agassiz Trawl ↓	665	100	29	7.5	4.55	1006.03	86	Bergy
2b	115	Full	26/Jul/2017	16:54	UTC-4	76°20.081'	071°22.455'	294	Agassiz Trawl ↑	668	100	22	5.3	4.71	1006.52	93	Bergy
2b	126	Nutrient	27/Jul/2017	05:53	UTC-4	78°19.420'	074°53.666'	290	CTD-Rosette ↓	313	090	5	4.3	0.51	1011.79	90	Bergy
2b	126	Nutrient	27/Jul/2017	06:42	UTC-4	78°19.162'	074°54.801'	275	CTD-Rosette ↑		140	2	3.4	0.59	1012.18	93	Bergy
2b	127	Nutrient	27/Jul/2017	07:29	UTC-4	78°19.437'	074°30.514'	307	CTD-Rosette ↓	502	170	6	4.8	0.28	1012.35	92	Bergy
2b	127	Nutrient	27/Jul/2017	08:26	UTC-4	78°19.376'	074°34.003'	006	CTD-Rosette ↑	568	210	7	3.6	0.46	1011.06	94	Bergy
2b	MacEwan	Coring	27/Jul/2017	10:08	UTC-4	78°18.123'	074°26.260'	035	Piston Core ↓	521	240	8	4.0	0.64	1011.9	95	Bergy
2b	MacEwan	Coring	27/Jul/2017	10:19	UTC-4	78°18.136'	074°26.279'	040	Piston Core (bottom)	521	240	8	4.9	0.79	1011.93	96	2/10
2b	MacEwan	Coring	27/Jul/2017	10:40	UTC-4	78°18.157'	074°26.419'	035	Piston Core ↑	316	240	8	4.8	0.72	1012.35	96	2/10
2b	129	Basic	27/Jul/2017	12:10	UTC-4	78°19.522'	074°06.745'	235	CTD-Rosette ↓	543	240	3	5.8	0.09	1013.85	99	5/10
2b	129	Basic	27/Jul/2017	13:24	UTC-4	78°19.572'	074°09.519'	029	CTD-Rosette ↑	490	270	1.5	5.2	0.03	1014.08	99	5/10
2b	129	Basic	27/Jul/2017	13:45	UTC-4	78°19.346'	074°05.292'	188	5NVS ↓	552	300	6	5.2	0.1	1014.44	99	5/10
2b	129	Basic	27/Jul/2017	14:19	UTC-4	78°19.158'	074°06.121'	354	5NVS ↑	544	000	2	4.6	0.07	1013.3	99	5/10
2b	129	Basic	27/Jul/2017	14:45	UTC-4	78°18.926'	074°07.068'	246	Plankton Net ↓	524	090	4	3.9	0.13	1013.14	99	5/10
2b	129	Basic	27/Jul/2017	14:58	UTC-4	78°18.846'	074°07.552'	233	Plankton Net ↑	514	090	6	4.1	0.12	1012.74	99	5/10
2b	129	Basic	27/Jul/2017	15:03	UTC-4	78°18.812'	074°07.687'	252	Plankton Net ↓	513	090	6	4.1	0.12	1012.75	99	5/10
2b	129	Basic	27/Jul/2017	15:16	UTC-4	78°18.724'	074°08.132'	241	Plankton Net ↑	518	090	6	4.8	0.1	1012.06	99	5/10
2b	129	Basic	27/Jul/2017	15:20	UTC-4	78°18.697'	074°08.301'	236	PNF + Secchi Disk ↓	516	000	6	5.3	0.15	1012.48	99	5/10
2b	129	Basic	27/Jul/2017	15:25	UTC-4	78°18.658'	074°08.582'	236	PNF + Secchi Disk ↑	516	090	6	5.3	0.15	1012.48	99	5/10
2b	129	Basic	27/Jul/2017	15:49	UTC-4	78°19.440'	074°04.884'	001	CTD-Rosette ↓	567	070	6	6.1	0.12	1011.97	99	5/10
2b	129	Basic	27/Jul/2017	16:42	UTC-4	78°18.713'	074°06.894'	286	CTD-Rosette ↑	537	060	6	6.4	0.11	1012.12	96	5/10
2b	129	Basic	27/Jul/2017	17:02	UTC-4	78°19.384'	074°05.470'	041	Box Core ↓	547	040	9	5.1	0.22	1012.01	99	Bergy
2b	129	Basic	27/Jul/2017	17:09	UTC-4	78°19.360'	074°05.546'	046	Box Core (bottom)	545	040	9	5.1	0.22	1012.01	99	Bergy
2b	129	Basic	27/Jul/2017	17:20	UTC-4	78°19.329'	074°05.773'	064	Box Core ↑	546	040	7	5.8	0.12	1012.05	99	Bergy
2b	129	Basic	27/Jul/2017	17:37	UTC-4	78°19.009'	074°04.541'	095	Agassiz Trawl ↓	574	010	6	5.8	0.33	1012.11	99	Bergy
2b	129	Basic	27/Jul/2017	18:14	UTC-4	78°19.068'	074°06.092'	229	Agassiz Trawl ↑	554	060	5	5.5	0.32	1012.13	99	Bergy
2b	130	Nutrient	27/Jul/2017	19:18	UTC-4	78°19.393'	073°39.773'	242	CTD-Rosette ↓	724	030	15	6.1	0.2	1011.74	92	Bergy
2b	130	Nutrient	27/Jul/2017	20:28	UTC-4	78°18.361'	073°43.646'	269	CTD-Rosette ↑	616	030	11	4.2	0.07	1011.85	93	Bergy
2b	131	Nutrient	27/Jul/2017	22:17	UTC-4	78°19.693'	073°05.272'	151	CTD-Rosette ↓	171	000	15	1.9	0.22	1010.79	95	Bergy
2b	131	Nutrient	27/Jul/2017	23:02	UTC-4	78°19.667'	073°05.857'	212	CTD-Rosette ↑	172	020	9	5.7	0.39	1010.72	79	Bergy
2b	TRINITY	Full	28/Jul/2017	05:43	UTC-4	77°46.951'	076°29.364'	180	PNF ↓	555	050	24	5.4	0.96	1009.23	83	Bergy
2b	TRINITY	Full	28/Jul/2017	05:45	UTC-4	77°46.944'	076°29.504'	177	PNF ↑	555	050	24	5.4	0.96	1009.23	83	Bergy
2b	TRINITY	Full	28/Jul/2017	05:46	UTC-4	77°46.937'	076°29.616'	169	Secchi Disk ↓	554	050	22	5.4	0.96	1009.23	83	Bergy
2b	TRINITY	Full	28/Jul/2017	05:48	UTC-4	77°46.932'	076°29.695'	166	Secchi Disk ↑	553	050	22	5.4	0.96	1009.23	83	Bergy
2b	TRINITY	Full	28/Jul/2017	05:57	UTC-4	77°46.862'	076°30.182'	267	CTD-Rosette ↓	549	040	21	5.4	0.94	1009.46	82	Bergy
2b	TRINITY	Full	28/Jul/2017	07:06	UTC-4	77°46.142'	076°32.193'	269	CTD-Rosette ↑	506	040	19	5.8	1.16	1009.38	80	Bergy
2b	TRINITY	Full	28/Jul/2017	07:19	UTC-4	77°46.478'	076°32.122'	190	DSN ↓	528	030	21	5.7	1.19	1007.65	79	Bergy
2b	TRINITY	Full	28/Jul/2017	07:36	UTC-4	77°45.852'	076°32.924'	189	DSN ↑	485	030	17	5.6	1.23	1007.88	78	Bergy
2b	TRINITY	Full	28/Jul/2017	08:27	UTC-4	77°46.406'	076°34.004'	240	5NVS ↓	516	040	16	4.6	1.22	1007.75	81	Bergy
2b	TRINITY	Full	28/Jul/2017	08:58	UTC-4	77°46.305'	076°35.472'	206	5NVS ↑	504	040	23	5.6	1.14	1007.1	78	Bergy
2b	TRINITY	Full	28/Jul/2017	09:56	UTC-4	77°45.254'	076°36.149'	229	CTD-Rosette ↓	392	040	20	5.3	1.25	1007.01	80	Bergy
2b	TRINITY	Full	28/Jul/2017	10:47	UTC-4	77°45.347'	076°37.135'	262	CTD-Rosette ↑	397	040	10	6.4	1.09	1007.71	80	Bergy
2b	TRINITY	Full	28/Jul/2017	10:58	UTC-4	77°45.374'	076°38.851'	306	Manta Net ↓	404	090	6	5.5	1.17	1007.72	82	Bergy
2b	TRINITY	Full	28/Jul/2017	11:22	UTC-4	77°45.433'	076°35.384'	215	Manta Net ↑	407	060	17	5.6	1.31	1007.79	78	Bergy
2b	TRINITY	Full	28/Jul/2017	12:22	UTC-4	77°45.020'	076°42.816'	226	Plankton Net ↓	374	060	21	4.9	1.22	1007.76	81	Bergy
2b	TRINITY	Full	28/Jul/2017	12:36	UTC-4	77°45.055'	076°42.959'	236	Plankton Net ↑	379	060	20	5.5	1.18	1007.71	79	4/10
2b	TRINITY	Full	28/Jul/2017	13:17	UTC-4	77°45.161'	076°40.878'	233	Plankton Net ↓	387	060	17	4.9	0.87	1007.7	82	4/10
2b	TRINITY	Full	28/Jul/2017	13:36	UTC-4	77°45.181'	076°40.799'	246	Plankton Net ↑	389	050	20	4.6	0.84	1007.6	82	4/10

2b	TRINITY	Full	28/Jul/2017	13:44	UTC-4	77°45.201'	076°40.865'	241	Hydrobios ↓	389	060	17	4.9	0.82	1007.64	64	4/10
2b	TRINITY	Full	28/Jul/2017	14:07	UTC-4	77°45.244'	076°40.914'	218	Hydrobios ↑	393	045	15	6.7	0.8	1007.67	76	4/10
2b	TRINITY	Full	28/Jul/2017	14:25	UTC-4	77°45.301'	076°41.103'	202	Box Core ↓	396	045	14	4.8	0.86	1007.7	81	4/10
2b	TRINITY	Full	28/Jul/2017	14:31	UTC-4	77°45.313'	076°41.163'	230	Box Core (bottom)	396	030	15	4.0	0.86	1007.7	83	4/10
2b	TRINITY	Full	28/Jul/2017	14:39	UTC-4	77°45.335'	076°41.173'	232	Box Core ↑	397	030	15	5.8	0.87	1007.56	76	4/10
2b	TRINITY	Full	28/Jul/2017	14:56	UTC-4	77°45.385'	076°38.987'	304	Agassiz Trawl ↓	400	090	14	6.1	0.86	1007.55	76	4/10
2b	TRINITY	Full	28/Jul/2017	15:26	UTC-4	77°45.365'	076°40.939'	218	Agassiz Trawl ↑	403	045	13	5.6	0.8	1007.77	77	4/10
2b	TRINITY	Full	28/Jul/2017	15:45	UTC-4	77°45.285'	076°40.269'	324	Beam Trawl ↓	400	040	14	4.2	0.8	1007.55	83	4/10
2b	TRINITY	Full	28/Jul/2017	16:16	UTC-4	77°45.243'	076°40.177'	347	Beam Trawl ↑	394	040	14	4.2	0.8	1007.55	83	4/10
2b	114	CTD	29/Jul/2017	05:14	UTC-4	76°19.556'	071°47.398'	278	CTD-Rosette ↓	611	150	26	4.6	4.43	1011.3	97	1/10
2b	114	CTD	29/Jul/2017	05:46	UTC-4	76°19.713'	071°47.656'	288	CTD-Rosette ↑	612	130	23	5.2	4.39	1011.72	95	1/10
2b	113	Nutrient	29/Jul/2017	06:22	UTC-4	76°19.247'	072°13.083'	249	CTD-Rosette ↓	553	120	26	4.1	3.34	1011.96	99	1/10
2b	113	Nutrient	29/Jul/2017	07:21	UTC-4	76°18.626'	072°15.022'	274	CTD-Rosette ↑	546	130	21	4.4	2.48	1012.35	97	
2b	112	CTD	29/Jul/2017	08:05	UTC-4	76°18.944'	072°42.763'	273	CTD-Rosette ↓	567	120	21	3.5	2.28	1010.8	99	0/10
2b	112	CTD	29/Jul/2017	08:34	UTC-4	76°18.962'	072°43.508'	316	CTD-Rosette ↑	563	120	19	3.7	2.29	1012.93	98	0/10
2b	111	Basic	29/Jul/2017	09:17	UTC-4	76°18.470'	073°13.079'	267	CTD-Rosette ↓	596	110	20	3.3	2.52	1010.64	99	0/10
2b	111	Basic	29/Jul/2017	10:22	UTC-4	76°19.185'	073°13.330'	299	CTD-Rosette ↑	577	120	13	8.5	2.21	1012.99	80	0/10
2b	111	Basic	29/Jul/2017	10:40	UTC-4	76°18.549'	073°13.266'	276	DSN ↓	589	120	16	4.3	2.46	1012.64	97	1/10
2b	111	Basic	29/Jul/2017	10:53	UTC-4	76°18.942'	073°15.218'	266	DSN ↑	596	118	16	4.6	2.55	1012.87	93	0/10
2b	111	Basic	29/Jul/2017	11:30	UTC-4	76°18.585'	073°12.493'	318	5NVS ↓	601	120	11	5.0	2.41	1012.62	93	1/10
2b	111	Basic	29/Jul/2017	12:06	UTC-4	76°19.037'	073°11.290'	310	5NVS ↑	606	120	12	6.8	2.21	1012.63	86	1/10
2b	111	Basic	29/Jul/2017	12:17	UTC-4	76°19.185'	073°11.107'	005	PNF + Secchi Disk ↓	603	120	13	7.0	2.37	1012.69	83	1/10
2b	111	Basic	29/Jul/2017	12:25	UTC-4	76°19.185'	073°11.107'	350	PNF + Secchi Disk ↑	609	120	13	5.1	2.43	1012.58	91	1/10
2b	111	Basic	29/Jul/2017	12:58	UTC-4	76°18.123'	073°13.474'	180	CTD-Rosette ↓	580	120	17	3.6	2.35	1012.54	98	1/10
2b	111	Basic	29/Jul/2017	13:53	UTC-4	76°18.512'	073°13.131'	210	CTD-Rosette ↑	594	135	11	3.9	2.36	1012.5	96	1/10
2b	111	Basic	29/Jul/2017	14:20	UTC-4	76°18.366'	073°12.684'	290	Box Core ↓	595	135	12	4.1	2.33	1012.68	96	1/10
2b	111	Basic	29/Jul/2017	14:30	UTC-4	76°18.486'	073°12.428'	287	Box Core (bottom)	593	135	12	3.7	2.34	1012.74	96	1/10
2b	111	Basic	29/Jul/2017	14:41	UTC-4	76°18.593'	073°12.244'	331	Box Core ↑	605	135	10	4.8	2.32	1012.76	93	1/10
2b	111	Basic	29/Jul/2017	14:56	UTC-4	76°18.776'	073°11.579'	336	Agassiz Trawl ↓	601	135	9	4.6	2.19	1012.55	94	1/10
2b	111	Basic	29/Jul/2017	15:40	UTC-4	76°18.729'	073°11.866'		Agassiz Trawl ↑	602	150	10	3.8	2.29	1012.59	96	1/10
2b	110	Nutrient	29/Jul/2017	16:16	UTC-4	76°18.061'	073°37.113'	121	CTD-Rosette ↓	533	170	8	3.3	2.71	1012.73	98	
2b	110	Nutrient	29/Jul/2017	17:15	UTC-4	76°18.284'	073°36.631'	205	CTD-Rosette ↑	546	040	3	3.4	3.79	1012.92	98	
2b	109	CTD	29/Jul/2017	17:59	UTC-4	76°17.384'	074°06.744'	220	CTD-Rosette ↓	454	060	4	3.6	2.63	1012.94	98	0/10
2b	109	CTD	29/Jul/2017	18:21	UTC-4	76°17.402'	074°06.767'	205	CTD-Rosette ↑	453	060	5	3.2	2.33	1013.06	99	0/10
2b	108	Basic	29/Jul/2017	19:08	UTC-4	76°15.838'	074°36.146'	180	CTD-Rosette ↓	450	080	6	2.9	2.31	1013.4	99	0/10
2b	108	Basic	29/Jul/2017	20:07	UTC-4	76°15.558'	074°36.935'	218	CTD-Rosette ↑	448	110	7	3.0	2.31	1011.7	99	0/10
2b	108	Basic	29/Jul/2017	20:22	UTC-4	76°15.975'	074°35.300'	324	DSN ↓	447	110	6	3.0	2.34	1014.27	99	0/10
2b	108	Basic	29/Jul/2017	20:42	UTC-4	76°15.722'	074°37.579'	178	DSN ↑	448	130	8	3.1	2.46	1014.27	99	0/10
2b	108	Basic	29/Jul/2017	21:02	UTC-4	76°15.906'	074°35.517'	336	5NVS ↓	446	090	3	3.8	2.54	1014.85	96	0/10
2b	108	Basic	29/Jul/2017	21:32	UTC-4	76°15.877'	074°35.826'	354	5NVS ↑	447	120	4	4.2	2.57	1015.5	92	0/10
2b	108	Basic	29/Jul/2017	21:46	UTC-4	76°15.829'	074°36.039'	334	PNF ↓	450	120	5	4.1	2.59	1015.47	93	0/10
2b	108	Basic	29/Jul/2017	21:49	UTC-4	76°15.822'	074°36.108'	322	PNF ↑	451	110	6	4.5	2.59	1015.53	91	0/10
2b	108	Basic	29/Jul/2017	21:51	UTC-4	76°15.812'	074°36.115'	324	Secchi Disk ↓	451	110	6	4.5	2.59	1015.53	91	0/10
2b	108	Basic	29/Jul/2017	21:53	UTC-4	76°15.790'	074°36.116'	322	Secchi Disk ↑	449	110	6	4.5	2.59	1015.53	91	0/10
2b	108	Basic	29/Jul/2017	22:04	UTC-4	76°15.708'	074°36.305'	280	CTD-Rosette ↓	445	110	8	5.7	2.59	1015.57	86	0/10
2b	108	Basic	29/Jul/2017	22:53	UTC-4	76°15.563'	074°37.650'	316	CTD-Rosette ↑	445	100	6	4.0	2.61	1015.85	92	0/10
2b	108	Basic	29/Jul/2017	23:13	UTC-4	76°15.872'	074°36.220'	300	Box Core ↓	450	100	11	3.1	2.58	1015.92	96	0/10
2b	108	Basic	29/Jul/2017	23:19	UTC-4	76°15.861'	074°36.373'	297	Box Core (bottom)	448	100	10	3.2	2.56	1016.12	95	0/10
2b	108	Basic	29/Jul/2017	23:26	UTC-4	76°15.840'	074°36.404'	275	Box Core ↑	449	110	10	3.5	2.56	1016.12	95	0/10
2b	108	Basic	29/Jul/2017	23:38	UTC-4	76°15.796'	074°36.222'	298	Box Core ↓	447	110	10	3.0	2.57	1016.19	96	0/10
2b	108	Basic	29/Jul/2017	23:45	UTC-4	76°15.781'	074°36.349'	294	Box Core (bottom)	449	110	11	3.5	2.58	1016.19	95	0/10
2b	108	Basic	29/Jul/2017	23:52	UTC-4	76°15.763'	074°36.466'	330	Box Core ↑	449	110	11	3.5	2.59	1016.12	95	0/10
2b	108	Basic	30/Jul/2017	00:20	UTC-4	76°15.689'	074°35.372'	010	Agassiz Trawl ↓	442	120	14	3.4	2.61	1016.28	95	0/10
2b	108	Basic	30/Jul/2017	00:54	UTC-4	76°15.413'	074°36.945'	052	Agassiz Trawl ↑	448	120	16	2.9	2.59	1016.51	96	0/10
2b	Manson Glacier bay	Coring	30/Jul/2017	09:04	UTC-4	76°23.949'	078°45.065'	166	Gravity Core ↓	188	020	12	3.2	0.28	1018.41	85	
2b	Manson Glacier bay	Coring	30/Jul/2017	09:08	UTC-4	76°23.933'	078°45.030'	157	Gravity Core (bottom)	188	020	12	3.2	0.28	1018.41	85	
2b	Manson Glacier bay	Coring	30/Jul/2017	09:12	UTC-4	76°23.915'	078°44.981'	149	Gravity Core ↑	189	040	6	2.5	0.75	1018.45	89	
2b	Jones Sound	HiBio	30/Jul/2017	15:42	UTC-4	76°05.054'	081°56.415'	260	CTD-Rosette ↓	769	090	31	2.9	1.32	1014.09	91	Bergy
2b	Jones Sound	HiBio	30/Jul/2017	16:47	UTC-4	76°05.009'	081°57.301'	264	CTD-Rosette ↑	781	080	25	4.1	1.41	1013.65	90	Bergy
2b	Belcher	Glacier	30/Jul/2017	19:25	UTC-4	75°42.105'	080°44.967'	059	Box Core ↓	623	080	17	2.5	1.3	1011.67	98	Bergy
2b	Belcher	Glacier	30/Jul/2017	19:34	UTC-4	75°42.130'	080°45.122'	060	Box Core (bottom)	623	080	18	2.6	1,0	1011.76	98	Bergy
2b	Belcher	Glacier	30/Jul/2017	19:43	UTC-4	75°42.154'	080°45.220'	056	Box Core ↑	624	080	19	2.3	0.97	1011.8	99	Bergy
2b	Belcher	Glacier	30/Jul/2017	20:45	UTC-4	75°42.348'	080°45.572'	079	Piston Core ↓	626	080	21	2.5	1.26	1011.89	99	Bergy
2b	Belcher	Glacier	30/Jul/2017	20:54	UTC-4	75°42.384'	080°45.593'	056	Piston Core (bottom)	626	080	22	2.5	1.22	1011.7	99	Bergy
2b	Belcher	Glacier	30/Jul/2017	21:05	UTC-4	75°42.429'	080°45.760'	064	Piston Core ↑	626	080	23	2.6	1.2	1011.58	99	Bergy
2b	323	Full	31/Jul/2017	07:48	UTC-4	74°09.246'	080°29.110'	146	PNF ↓	792	000	10	2.9	3.81	1006.03	99	0/10
2b	323	Full	31/Jul/2017	07:51	UTC-4	74°09.191'	080°29.332'	164	PNF ↑	793	020	9	2.9	3.79	1006.17	99	0/10
2b	323	Full	31/Jul/2017	07:52	UTC-4	74°09.168'	080°29.418'	178	Secchi Disk ↓	788	020	9	2.9	3.79	1006.17	99	0/10
2b	323	Full	31/Jul/2017	07:54	UTC-4	74°09.152'	080°29.491'	191	Secchi Disk ↑	786	020	9	2.9	3.79	1006.17	99	0/10
2b	323	Full	31/Jul/2017	08:14	UTC-4	74°09.377'	080°28.600'	190	CTD-Rosette ↓	788	020	11	3.4	3.81	1004.68	99	0/10
2b	323	Full	31/Jul/2017	09:23	UTC-4	74°09.164'	080°29.654'	208	CTD-Rosette ↑	787	040	4	4.7	3.87	1005.4	91	0/10

2b	323	Full	31/Jul/2017	09:47	UTC-4	74°09.444'	080°27.703'	340	DSN ↓	789	080	6	3.9	3.9	1005.35	94	0/10
2b	323	Full	31/Jul/2017	10:08	UTC-4	74°09.195'	080°30.441'	186	DSN ↑	782	100	11	2.7	3.91	1005.67	97	0/10
2b	323	Full	31/Jul/2017	10:36	UTC-4	74°09.447'	080°28.542'	296	Hydrobios ↓	792	120	11	2.5	3.87	1005.81	98	0/10
2b	323	Full	31/Jul/2017	11:22	UTC-4	74°09.760'	080°29.522'	241	Hydrobios ↑	788	110	9	2.8	3.75	1006.2	97	0/10
2b	323	Full	31/Jul/2017	12:22	UTC-4	74°09.364'	080°28.026'	267	5NVS ↓	788	135	9	3.1	3.89	1006.73	95	0/10
2b	323	Full	31/Jul/2017	13:10	UTC-4	74°09.489'	080°27.914'	278	5NVS ↑	787	165	6	3.6	3.65	1004.45	93	0/10
2b	323	Full	31/Jul/2017	13:32	UTC-4	74°09.517'	080°27.676'	357	CTD-Rosette ↓	783	105	8	4.7	3.77	1006.99	88	0/10
2b	323	Full	31/Jul/2017	14:36	UTC-4	74°09.761'	080°26.423'	317	CTD-Rosette ↑	784	110	4	7.2	4.14	1007.58	77	0/10
2b	323	Full	31/Jul/2017	14:55	UTC-4	74°09.319'	080°28.449'	234	Plankton Net ↓	788	120	8	6.7	4.17	1007.58	77	0/10
2b	323	Full	31/Jul/2017	15:07	UTC-4	74°09.334'	080°28.309'	263	Plankton Net ↑	789	150	8	4.8	4.23	1007.54	82	0/10
2b	323	Full	31/Jul/2017	15:12	UTC-4	74°08.993'	080°30.355'	270	Manta Net ↓	785	150	7	5.0	4.2	1007.82	78	0/10
2b	323	Full	31/Jul/2017	15:34	UTC-4	74°08.761'	080°29.195'	070	Manta Net ↑	788	120	7	5.1	4.22	1007.76	79	0/10
2b	323	Full	31/Jul/2017	15:45	UTC-4	74°09.408'	080°28.341'	219	Box Core ↓	786	060	6	5.2	4.23	1007.7	81	0/10
2b	323	Full	31/Jul/2017	16:00	UTC-4	74°09.396'	080°28.076'	093	Box Core (bottom)	787	080	8	4.2	4.23	1007.83	89	0/10
2b	323	Full	31/Jul/2017	16:15	UTC-4	74°09.383'	080°28.067'	166	Box Core ↑	790	120	8	4.6	3.99	1007.83	84	0/10
2b	323	Full	31/Jul/2017	16:29	UTC-4	74°09.418'	080°28.182'	349	Agassiz Trawl ↓	786	110	8	4.9	3.99	1007.9	80	0/10
2b	323	Full	31/Jul/2017	17:27	UTC-4	74°09.433'	080°27.113'	338	Agassiz Trawl ↑	803	110	5	4.7	4.35	1008.06	86	0/10
2b	323	Full	31/Jul/2017	17:47	UTC-4	74°09.282'	080°27.264'	038	Beam Trawl ↓	800	135	4	5.0	4.31	1008.24	86	0/10
2b	323	Full	31/Jul/2017	18:52	UTC-4	74°07.920'	080°25.607'	134	Beam Trawl ↑	794	020	1	5.1	4.35	1008.68	80	0/10
2b	ROV POND	ROV	01/Aug/2017	10:34	UTC-4	72°49.627'	077°36.611'	079	ROV ↓	± 1000	260	11	2.7	0.65	1016.45	90	1/10
2b	ROV POND	ROV	01/Aug/2017	16:55	UTC-4	72°50.304'	077°35.424'	292	ROV ↑	412	120	1	4.3	1.14	1019.75	80	1/10
2b	ROV POND	ROV	01/Aug/2017	18:03	UTC-4	72°49.679'	077°36.385'	315	CTD-Rosette ↓	857	240	5	4.8	1.14	1020.05	78	1/10
2b	ROV POND	ROV	01/Aug/2017	19:24	UTC-4	72°49.644'	077°34.785'	020	CTD-Rosette ↑	941	230	4	7.2	0.91	1020.55	68	1/10
2b	ROV NBI	ROV	02/Aug/2017	06:33	UTC-4	73°43.742'	081°06.475'	100	CTD-Rosette ↓	363	280	14	2.7	2.11	1023.71	86	0/10
2b	ROV NBI	ROV	02/Aug/2017	07:30	UTC-4	73°43.335'	081°04.253'	093	CTD-Rosette ↑	488	280	15	6.7	2.25	1023.93	72	0/10
2b	ROV NBI	ROV	02/Aug/2017	08:44	UTC-4	73°43.802'	081°07.279'	272	ROV ↓	327	280	18	2.7	2.32	1024.06	85	0/10
2b	ROV NBI	ROV	02/Aug/2017	09:24	UTC-4	73°43.681'	081°07.108'	255	ROV ↑ Cancelled	327	280	21	2.5	2.38	1023.98	85	0/10
2b	325	Nutrient	02/Aug/2017	12:11	UTC-4	73°49.096'	080°29.690'	085	CTD-Rosette ↓	689	280	17	3.8	3.25	1023.7	80	0/10
2b	325	Nutrient	02/Aug/2017	13:19	UTC-4	73°48.710'	080°24.060'	138	CTD-Rosette ↑	686	270	15	4.5	3.38	1023.83	79	0/10
2b	324	Nutrient	02/Aug/2017	15:12	UTC-4	73°58.951'	080°29.401'	072	CTD-Rosette ↓	772	270	18	3.0	3.13	1023.28	86	0/10
2b	324	Nutrient	02/Aug/2017	16:23	UTC-4	73°58.257'	080°27.415'	092	CTD-Rosette ↑	786	270	11	6.4	2.93	1023.56	75	0/10
2b	300	Nutrient	02/Aug/2017	18:15	UTC-4	74°19.057'	080°29.774'	096	CTD-Rosette ↓	710	240	24	3.3	3.69	1022.1	85	0/10
2b	300	Nutrient	02/Aug/2017	19:27	UTC-4	74°19.232'	080°29.419'	046	CTD-Rosette ↑	701	230	21	4.7	3.75	1021.88	82	0/10
2b	322	Nutrient	02/Aug/2017	21:12	UTC-4	74°29.401'	080°33.057'	086	CTD-Rosette ↓	660	250	18	3.2	1.48	1020.65	84	0/10
2b	322	Nutrient	02/Aug/2017	22:31	UTC-4	74°29.113'	080°35.111'	009	CTD-Rosette ↑	665	220	18	5.6	0.71	1020.42	77	0/10
2b	301	Full	03/Aug/2017	02:32	UTC-4	74°16.669'	083°21.845'	058	CTD-Rosette ↓	721	180	6	3.3	2.9	1021.21	86	0/10
2b	301	Full	03/Aug/2017	03:49	UTC-4	74°16.923'	083°21.684'	129	CTD-Rosette ↑	723	255	5	4.2	2.99	1021.25	86	0/10
2b	301	Full	03/Aug/2017	04:05	UTC-4	74°16.725'	083°22.127'	331	DSN ↓	718	320	7	4.0	3.03	1021.35	88	0/10
2b	301	Full	03/Aug/2017	04:26	UTC-4	74°16.410'	083°23.521'	165	DSN ↑	712	320	2	3.4	3.01	1021.36	89	0/10
2b	301	Full	03/Aug/2017	04:52	UTC-4	74°16.501'	083°23.004'	324	Hydrobios ↓	712	260	2	3.5	2.98	1021.33	87	0/10
2b	301	Full	03/Aug/2017	05:36	UTC-4	74°16.673'	083°22.157'	285	Hydrobios ↑	720	250	2	3.7	3.02	1021.16	87	0/10
2b	301	Full	03/Aug/2017	05:48	UTC-4	74°16.717'	083°21.918'	135	PNF ↓	719	240	4	3.6	3.04	1021.18	87	0/10
2b	301	Full	03/Aug/2017	05:52	UTC-4	74°16.735'	083°21.830'	126	PNF ↑	720	220	3	3.4	3.02	1021.14	90	0/10
2b	301	Full	03/Aug/2017	05:53	UTC-4	74°16.740'	083°21.805'	126	Secchi Disk ↓	720	220	3	3.4	3.02	1021.14	90	0/10
2b	301	Full	03/Aug/2017	05:55	UTC-4	74°16.754'	083°21.755'	120	Secchi Disk ↑	720	220	3	3.4	3.02	1021.14	90	0/10
2b	301	Full	03/Aug/2017	06:13	UTC-4	74°16.355'	083°22.739'	122	CTD-Rosette ↓	715	220	5	3.6	2.99	1021.16	89	0/10
2b	301	Full	03/Aug/2017	07:16	UTC-4	74°16.701'	083°22.036'	077	CTD-Rosette ↑	720	230	7	3.9	3.07	1020.98	89	0/10
2b	301	Full	03/Aug/2017	08:55	UTC-4	74°16.669'	083°18.727'	228	ROV ↓	762	280	6	3.2	3.04	1020.85	92	0/10
2b	301	Full	03/Aug/2017	13:45	UTC-4	74°16.700'	083°21.100'		ROV ↑		270	4	4.0	3.04			0/10
2b	301	Full	03/Aug/2017	14:19	UTC-4	74°16.674'	083°18.716'	308	Benthic Frame ↓	± 740	240	4	4.7	3.58	1020.25	88	0/10
2b	301	Full	03/Aug/2017	14:51	UTC-4	74°16.672'	083°18.732'	275	Benthic Frame (bottom)	726	270	4	4.7	3.38	1020.24	84	0/10
2b	301	Full	03/Aug/2017	15:25	UTC-4	74°16.702'	083°19.160'	244	Benthic Frame ↑		270	4	5.2	3.34	1020.13	81	0/10
2b	301	Full	03/Aug/2017	15:57	UTC-4	74°16.642'	083°22.065'	007	CTD-Rosette ↓	718	250	5	5.2	3.83	1020.06	83	0/10
2b	301	Full	03/Aug/2017	16:28	UTC-4	74°16.831'	083°21.744'	046	CTD-Rosette ↑	720	240	3	5.7	3.23	1019.97	79	0/10
2b	301	Full	03/Aug/2017	16:50	UTC-4	74°16.528'	083°21.938'	356	5NVS ↓	717	230	8	5.9	3.51	1019.81	74	0/10
2b	301	Full	03/Aug/2017	17:34	UTC-4	74°16.613'	083°21.233'	081	5NVS ↑	719	230	6	7.0	3.14	1019.7	72	Bergy
2b	301	Full	03/Aug/2017	18:09	UTC-4	74°16.481'	083°22.125'	260	Plankton Net ↓	714	230	8	5.8	3.5	1019.49	75	0/10
2b	301	Full	03/Aug/2017	18:23	UTC-4	74°16.535'	083°22.096'	253	Plankton Net ↑	716	240	8	5.8	3.39	1019.45	75	0/10
2b	301	Full	03/Aug/2017	18:28	UTC-4	74°16.549'	083°22.082'	233	Plankton Net ↓	715	240	8	5.8	3.39	1019.45	75	0/10
2b	301	Full	03/Aug/2017	18:43	UTC-4	74°16.560'	083°22.103'	225	Plankton Net ↑	715	240	9	6.1	3.258	1019.32	73	0/10
2b	301	Full	03/Aug/2017	18:51	UTC-4	74°16.555'	083°22.180'	221	Manta Net ↓	716	240	9	6.3	3.3	1019.32	71	0/10
2b	301	Full	03/Aug/2017	19:12	UTC-4	74°16.015'	083°25.643'	234	Manta Net ↑	706	230	8	7.0	3.53	1019.17	69	0/10
2b	301	Full	03/Aug/2017	19:34	UTC-4	74°16.645'	083°19.099'	281	Box Core ↓	727	250	7	7.3	3.44	1019.1	71	0/10
2b	301	Full	03/Aug/2017	19:45	UTC-4	74°16.654'	083°19.131'	225	Box Core (bottom)	715	260	7	7.4	3.29	1019.05	71	0/10
2b	301	Full	03/Aug/2017	19:54	UTC-4	74°16.654'	083°19.121'	208	Box Core ↑	715	250	8	7.2	2.98	1018.94	71	0/10
2b	301	Full	03/Aug/2017	20:05	UTC-4	74°16.661'	083°19.114'	210	Box Core ↓	715	250	9	7.1	2.74	1018.9	74	0/10
2b	301	Full	03/Aug/2017	20:17	UTC-4	74°16.644'	083°19.158'	206	Box Core (bottom)	718	240	9	7.2	2.61	1018.83	72	0/10
2b	301	Full	03/Aug/2017	20:28	UTC-4	74°16.661'	083°19.150'	146	Box Core ↑	718	250	9	7.2	2.72	1018.78	72	0/10
2b	301	Full	03/Aug/2017	21:00	UTC-4	74°16.642'	083°20.131'	132	Box Core ↓	740	230	10	5.9	3.1	1018.64	76	0/10
2b	301	Full	03/Aug/2017	21:25	UTC-4	74°16.646'	083°20.112'	112	Box Core (bottom)	740	230	9	5.9	2.9	1018.48	78	0/10
2b	301	Full	03/Aug/2017	21:34	UTC-4	74°16.692'	083°20.136'	121	Box Core ↑	740	230	3	6.2	3.16	1018.46	78	0/10
2b	301	Full	03/Aug/2017	21:55	UTC-4	74°16.597'	083°20.138'	029	Box Core ↓	740	220	10	6.4	3.16	1018.29	77	0/10

2b	301	Full	03/Aug/2017	22:09	UTC-4	74°16.626'	083°20.183'	102	Box Core (bottom)	740	230	3	7.2	2.79	1018.2	77	0/10
2b	301	Full	03/Aug/2017	22:19	UTC-4	74°16.678'	083°20.337'	111	Box Core ↑	740	000	0	6.7	3.01	1018.1	80	0/10
2b	301	Full	03/Aug/2017	22:38	UTC-4	74°16.601'	083°21.872'	046	Agassiz Trawl ↓	719	210	4	6.6	3.08	1017.95	81	0/10
2b	301	Full	03/Aug/2017	23:28	UTC-4	74°17.157'	083°21.990'	318	Agassiz Trawl ↑	724	250	8	6.3	3.19	1017.12	84	0/10
2b	301	Full	03/Aug/2017	23:57	UTC-4	74°16.579'	083°22.404'	051	Beam Trawl ↓	716	255	10	6.1	3.2	1017.33	87	0/10
2b	301	Full	04/Aug/2017	00:48	UTC-4	74°16.911'	083°23.478'	057	Beam Trawl ↑	717	240	8	5.7	3.28	1017.2	91	0/10
2b	303	Nutrient	04/Aug/2017	09:16	UTC-4	74°22.024'	089°36.212'	285	CTD-Rosette ↓	289	110	12	1.2	2.34	1014.81	97	1/10
2b	303	Nutrient	04/Aug/2017	09:55	UTC-4	74°22.022'	089°36.269'	294	CTD-Rosette ↑	290	100	4	2.9	2.56	1014.49	91	1/10
2b	304	Basic	04/Aug/2017	13:18	UTC-4	74°14.830'	091°30.642'	246	PNF + Secchi Disk ↓	316	090	9	0.8	1.16	1013.03	97	4/10
2b	304	Basic	04/Aug/2017	13:23	UTC-4	74°14.826'	091°30.607'	246	PNF + Secchi Disk ↑	314	090	9	0.8	1.16	1013.03	97	4/10
2b	304	Basic	04/Aug/2017	13:27	UTC-4	74°14.814'	091°30.562'	244	CTD-Rosette ↓	315	090	8	0.8	1.28	1013.01	97	4/10
2b	304	Basic	04/Aug/2017	14:07	UTC-4	74°14.753'	091°30.652'	152	CTD-Rosette ↑	315	075	6	0.8	1.94	1013.05	97	4/10
2b	304	Basic	04/Aug/2017	14:38	UTC-4	74°14.704'	091°28.629'	060	DSN ↓	316	090	8	0.9	1.69	1012.94	97	4/10
2b	304	Basic	04/Aug/2017	14:55	UTC-4	74°15.067'	091°26.841'	009	DSN ↑	320	090	8	0.9	1.69	1012.94	97	4/10
2b	304	Basic	04/Aug/2017	15:17	UTC-4	74°14.875'	091°32.074'	235	CTD-Rosette ↓	312	090	7	1.1	1.51	1013.03	96	4/10
2b	304	Basic	04/Aug/2017	16:04	UTC-4	74°14.733'	091°30.210'	339	CTD-Rosette ↑	313	050	6	1.9	1.82	1013.07	97	4/10
2b	304	Basic	04/Aug/2017	16:13	UTC-4	74°14.768'	091°30.187'	272	5NVS ↓	313	070	6	1.6	1.87	1013.08	94	4/10
2b	304	Basic	04/Aug/2017	16:32	UTC-4	74°14.765'	091°29.474'	303	5NVS ↑	315	060	7	2.2	1.81	1012.95	92	4/10
2b	304	Basic	04/Aug/2017	18:29	UTC-4	74°14.788'	091°30.854'	282	Box Core ↓	313	050	5	1.6	2.26	1012.93	94	2/10
2b	304	Basic	04/Aug/2017	18:39	UTC-4	74°14.786'	091°30.902'	289	Box Core (bottom)	315	070	4	1.7	2.29	1012.92	95	2/10
2b	304	Basic	04/Aug/2017	18:43	UTC-4	74°14.775'	091°30.784'	292	Box Core ↑	314	070	5	2.4	2.34	1012.83	91	2/10
2b	304	Basic	04/Aug/2017	18:58	UTC-4	74°14.709'	091°30.323'	259	Agassiz Trawl ↓	314	070	4	2.6	2.33	1012.85	91	2/10
2b	304	Basic	04/Aug/2017	19:21	UTC-4	74°14.313'	091°28.916'	099	Agassiz Trawl ↑	316	070	8	1.3	2.29	1012.83	96	2/10
2b	305a	Nutrient	05/Aug/2017	00:08	UTC-4	74°13.328'	093°30.820'	268	CTD-Rosette ↓	157	030	6	0.9	0.24	1012.49	99	2/10
2b	305a	Nutrient	05/Aug/2017	00:46	UTC-4	74°13.350'	093°29.126'	341	CTD-Rosette ↑	161	060	5	0.9	0.37	1012.14	99	3/10
2b	305b	Basic	05/Aug/2017	01:52	UTC-4	74°21.152'	093°35.001'	251	CTD-Rosette ↓	166	045	15	1.2	0.22	1011.64	99	2/10
2b	305b	Basic	05/Aug/2017	02:35	UTC-4	74°20.854'	093°34.832'	270	CTD-Rosette ↑	165	045	12	1.4	0.36	1012.07	99	2/10
2b	305b	Basic	05/Aug/2017	02:54	UTC-4	74°21.975'	093°32.901'	282	DSN ↓	166	045	12	1.1	0.38	1012.02	99	4/10
2b	305b	Basic	05/Aug/2017	03:11	UTC-4	74°21.475'	093°33.242'	155	DSN ↑	166	035	12	1.3	0.4	1012.2	99	2/10
2b	305b	Basic	05/Aug/2017	03:20	UTC-4	74°21.341'	093°33.741'	310	Manta Net ↓	164	035	12	1.0	0.37	1012.1	99	2/10
2b	305b	Basic	05/Aug/2017	03:41	UTC-4	74°20.948'	093°35.553'	110	Manta Net ↑	166	030	14	1.2	0.37	1012.3	99	2/10
2b	305b	Basic	05/Aug/2017	03:47	UTC-4	74°20.936'	093°35.399'	045	Plankton Net ↓	164	030	14	1.2	0.37	1012.3	99	2/10
2b	305b	Basic	05/Aug/2017	03:57	UTC-4	74°20.885'	093°35.154'	063	Plankton Net ↑	165	030	14	1.0	0.39	1012.28	99	2/10
2b	305b	Basic	05/Aug/2017	04:05	UTC-4	74°20.832'	093°35.089'	081	Plankton Net ↓	165	030	11	1.0	0.39	1012.28	99	2/10
2b	305b	Basic	05/Aug/2017	04:16	UTC-4	74°20.747'	093°35.013'	068	Plankton Net ↑	164	020	13	1.0	0.44	1012.35	99	2/10
2b	305b	Basic	05/Aug/2017	04:30	UTC-4	74°21.232'	093°35.325'	194	5NVS ↓	164	030	12	1.1	0.41	1012.36	99	2/10
2b	305b	Basic	05/Aug/2017	04:42	UTC-4	74°21.182'	093°35.266'	089	5NVS ↑	166	020	13	0.9	0.34	1012.38	99	2/10
2b	305c	Nutrient	05/Aug/2017	06:21	UTC-4	74°28.980'	093°38.466'	275	CTD-Rosette ↓	168	040	15	1.8	-0.13	1013.7	99	3/10
2b	305c	Nutrient	05/Aug/2017	06:54	UTC-4	74°28.854'	093°38.973'	290	CTD-Rosette ↑	168	030	18	1.8	0.03	1013.7	99	3/10
2b	305d	Nutrient	05/Aug/2017	08:00	UTC-4	74°36.159'	093°42.609'	223	CTD-Rosette ↓	124	040	7	4.2	2.23	1013.49	99	0/10
2b	305d	Nutrient	05/Aug/2017	08:30	UTC-4	74°36.126'	093°42.699'	254	CTD-Rosette ↑	125	050	9	7.5	2.51	1014.14	86	0/10
2b	5.1	Coring	05/Aug/2017	22:25	UTC-4	74°29.759'	099°04.761'	324	Piston Core ↓	215	050	6	0.6	-0.15	1014.94	99	6/10
2b	5.1	Coring	05/Aug/2017	22:29	UTC-4	74°29.728'	099°04.687'	284	Piston Core (bottom)	215	040	13	0.6	-0.16	1015.01	99	6/10
2b	5.1	Coring	05/Aug/2017	22:36	UTC-4	74°29.668'	099°04.367'	263	Piston Core ↑	216	040	13	0.6	-0.16	1015.01	99	6/10
2b	5.1	Coring	05/Aug/2017	23:19	UTC-4	74°29.340'	099°04.490'	303	Box Core ↓	223	040	13	0.5	-0.14	1015.09	99	6/10
2b	5.1	Coring	05/Aug/2017	23:26	UTC-4	74°29.303'	099°04.587'	328	Box Core (bottom)	223	040	13	0.5	-0.14	1015.09	99	6/10
2b	5.1	Coring	05/Aug/2017	23:37	UTC-4	74°29.300'	099°04.581'	330	Box Core ↑	224	030	13	0.4	-0.14	1015.2	99	6/10
2b	5.1	Coring	06/Aug/2017	00:14	UTC-4	74°29.389'	099°05.425'	200	CTD-Rosette ↓	218	030	18	0.9	-0.22	1015.09	99	5/10
2b	5.1	Coring	06/Aug/2017	00:59	UTC-4	74°29.209'	099°06.358'	299	CTD-Rosette ↑	215	045	16	0.7	-0.22	1014.94	99	5/10
2b	3.9	Coring	06/Aug/2017	08:40	UTC-4	73°39.270'	096°09.670'	221	Gravity Core ↓	261	350	7	1.3	0.15	1012.29	96	5/10
2b	3.9	Coring	06/Aug/2017	08:44	UTC-4	73°39.282'	096°09.712'	193	Gravity Core (bottom)	260	350	7	1.3	0.15	1012.29	96	5/10
2b	3.9	Coring	06/Aug/2017	08:48	UTC-4	73°39.280'	096°09.718'	293	Gravity Core ↑	261	330	4	1.5	0.19	1012.37	94	5/10
2b	3.9	Coring	06/Aug/2017	09:02	UTC-4	73°39.268'	096°09.739'	197	Box Core ↓	262	320	7	1.9	0.18	1012.36	92	5/10
2b	3.9	Coring	06/Aug/2017	09:07	UTC-4	73°39.276'	096°09.686'	168	Box Core (bottom)	262	320	7	1.9	0.18	1012.36	92	5/10
2b	3.9	Coring	06/Aug/2017	09:13	UTC-4	73°39.285'	096°09.645'	218	Box Core ↑	261	330	7	2.3	0.18	1012.37	90	0/10
2b	QMG-M	Basic	08/Aug/2017	02:06	UTC-4	68°18.163'	101°44.466'	195	CTD-Rosette ↓	113	000	0	4.6	4.47	1016.47	90	0/10
2b	QMG-M	Basic	08/Aug/2017	02:40	UTC-4	68°18.288'	101°44.876'	236	CTD-Rosette ↑	117	000	7	5.3	4.02	1016.51	88	0/10
2b	QMG-M	Basic	08/Aug/2017	02:59	UTC-4	68°18.282'	101°45.061'	204	DSN ↓	118	355	7	5.4	4.07	1016.48	88	0/10
2b	QMG-M	Basic	08/Aug/2017	03:08	UTC-4	68°17.719'	101°44.301'	075	DSN ↑	112	358	8.3	4.9	4.92	1016.61	88	0/10
2b	QMG-M	Basic	08/Aug/2017	03:28	UTC-4	68°18.277'	101°44.232'	249	5NVS ↓	118	012	7.5	4.8	4.86	1016.47	89	0/10
2b	QMG-M	Basic	08/Aug/2017	03:37	UTC-4	68°18.337'	101°44.297'	236	5NVS ↑	115	010	7.3	5.1	4.4	1016.55	89	0/10
2b	QMG-M	Basic	08/Aug/2017	03:47	UTC-4	68°18.349'	101°44.537'	208	Plankton Net ↓	111	002	6.8	5.1	1.39	1016.55	89	0/10
2b	QMG-M	Basic	08/Aug/2017	03:56	UTC-4	68°18.319'	101°44.686'	227	Plankton Net ↑	116	180	10	5.2	4.53	1016.56	88	0/10
2b	QMG-M	Basic	08/Aug/2017	04:01	UTC-4	68°18.339'	101°44.740'	227	Plankton Net ↓	113	180	8	5.2	4.72	1016.66	88	0/10
2b	QMG-M	Basic	08/Aug/2017	04:08	UTC-4	68°18.360'	101°44.835'	218	Plankton Net ↑	114	180	7	5.2	4.72	1016.66	88	0/10
2b	QMG-M	Basic	08/Aug/2017	04:14	UTC-4	68°18.357'	101°44.963'	221	Manta Net ↓	115	180	6	5.0	4.69	1016.78	89	0/10
2b	QMG-M	Basic	08/Aug/2017	04:36	UTC-4	68°17.359'	101°44.667'	131	Manta Net ↑	108	180	6	4.9	5.04	1016.81	88	0/10
2b	QMG-M	Basic	08/Aug/2017	04:50	UTC-4	68°18.308'	101°44.509'	086	PNF ↓	111	180	8	4.1	5.33	1016.81	90	0/10
2b	QMG-M	Basic	08/Aug/2017	04:53	UTC-4	68°18.313'	101°44.514'	115	PNF ↑	113	180	8	4.1	5.37	1016.77	92	0/10
2b	QMG-M	Basic	08/Aug/2017	04:54	UTC-4	68°18.307'	101°44.514'	119	Secchi Disk ↓	113	180	8	4.1	5.37	1016.77	92	0/10
2b	QMG-M	Basic	08/Aug/2017	04:55	UTC-4	68°18.306'	101°44.525'	121	Secchi Disk ↑	113	180	8	4.1	5.37	1016.77	92	0/10
2b	QMG-M	Basic	08/Aug/2017	05:08	UTC-4	68°18.151'	101°44.268'	281	CTD-Rosette ↓	110	000	6	3.9	5.05	1016.79	93	0/10

2b	QMG-M	Basic	08/Aug/2017	05:46	UTC-4	68°18.272'	101°44.626'	201	CTD-Rosette ↑	111	000	6	4.5	4.6	1017.01	93	0/10
2b	QMG-M	Basic	08/Aug/2017	05:54	UTC-4	68°18.176'	101°44.554'	107	Box Core ↓	114	000	5	4.8	4.68	1017.02	91	0/10
2b	QMG-M	Basic	08/Aug/2017	05:57	UTC-4	68°18.175'	101°44.517'	108	Box Core (bottom)	114	000	4	4.8	4.68	1017.02	91	0/10
2b	QMG-M	Basic	08/Aug/2017	06:00	UTC-4	68°18.180'	101°44.525'	111	Box Core ↑	114	000	5	4.1	4.89	1017.07	93	0/10
2b	QMG-M	Basic	08/Aug/2017	06:10	UTC-4	68°18.205'	101°44.627'	353	Agassiz Trawl ↓	117	000	7	4.1	4.74	1017.07	93	0/10
2b	QMG-M	Basic	08/Aug/2017	06:23	UTC-4	68°18.277'	101°45.785'	224	Agassiz Trawl ↑	112	000	3	4.2	4.5	1017.11	94	0/10
2b	QMG-M	Basic	08/Aug/2017	06:38	UTC-4	68°18.230'	101°44.733'	006	Beam Trawl ↓	114	000	6	4.1	5.04	1017.04	94	0/10
2b	QMG-M	Basic	08/Aug/2017	06:54	UTC-4	68°18.386'	101°46.304'	238	Beam Trawl ↑ (Empty)	113	000	2	4.2	5.14	1017.1	92	0/10
2b	QMG-M	Basic	08/Aug/2017	07:05	UTC-4	68°18.199'	101°44.345'	326	Beam Trawl ↓	109	090	5	4.5	5.19	1017.12	90	0/10
2b	QMG-M	Basic	08/Aug/2017	07:24	UTC-4	68°17.856'	101°46.783'	183	Beam Trawl ↑	110	090	2	4.6	5.3	1017.15	89	0/10
2b	QMG-WF1	Mooring	08/Aug/2017	08:43	UTC-4	68°14.830'	101°48.652'	057	CTD-Rosette ↓	100	030	4	4.2	4.52	1017.28	94	0/10
2b	QMG-WF1	Mooring	08/Aug/2017	08:53	UTC-4	68°14.841'	101°48.638'	360	CTD-Rosette ↑	109	060	4	3.9	4.43	1017.34	94	0/10
2b	QMG-WF1	Mooring	08/Aug/2017	09:30	UTC-4	68°14.817'	101°48.375'	111	Mooring Recovery ↑		045	6	3.7	4.54	1017.32	92	0/10
2b	QMG-4	Basic	08/Aug/2017	20:14	UTC-4	68°29.098'	103°25.781'	280	PNF + Secchi Disk ↓	67	140	18	6.5	5.68	1011.48	95	0/10
2b	QMG-4	Basic	08/Aug/2017	20:21	UTC-4	68°29.144'	103°25.749'	284	PNF + Secchi Disk ↑	66	140	16	6.6	5.59	1011.23	91	0/10
2b	QMG-4	Basic	08/Aug/2017	20:27	UTC-4	68°29.183'	103°25.708'	345	CTD-Rosette ↓	67	140	16	6.6	2.29	1011.23	91	0/10
2b	QMG-4	Basic	08/Aug/2017	21:02	UTC-4	68°29.150'	103°26.241'	355	CTD-Rosette ↑	75	135	19	11.6	5.43	1010.81	71	0/10
2b	QMG-4	Basic	08/Aug/2017	21:16	UTC-4	68°29.110'	103°25.500'	340	DSN ↓	69	135	18	9.7	5.5	1010.39	81	0/10
2b	QMG-4	Basic	08/Aug/2017	21:27	UTC-4	68°29.188'	103°26.639'	259	DSN ↑	84	150	19	8.5	5.49	1010.31	84	0/10
2b	QMG-4	Basic	08/Aug/2017	21:51	UTC-4	68°29.047'	103°25.879'	325	5NVS ↓	80	150	19	8.4	5.46	1010.1	85	0/10
2b	QMG-4	Basic	08/Aug/2017	21:56	UTC-4	68°29.109'	103°25.843'	022	5NVS ↑	70	150	22	8.3	5.51	1009.84	85	0/10
2b	QMG-4	Basic	08/Aug/2017	22:21	UTC-4	68°29.082'	103°25.831'	340	Box Core ↓	68	150	21	8.9	4.99	1009.56	83	0/10
2b	QMG-4	Basic	08/Aug/2017	22:23	UTC-4	68°29.057'	103°25.840'	315	Box Core (bottom)	71	150	21	8.9	4.99	1009.56	86	0/10
2b	QMG-4	Basic	08/Aug/2017	22:25	UTC-4	68°29.057'	103°25.870'	314	Box Core ↑	71	150	21	8.9	4.99	1009.56	86	0/10
2b	QMG-4	Basic	08/Aug/2017	22:45	UTC-4	68°29.097'	103°25.602'	345	Agassiz Trawl ↓	71	150	20	10.0	4.76	1009.09	77	0/10
2b	QMG-4	Basic	08/Aug/2017	22:56	UTC-4	68°29.214'	103°26.637'	205	Agassiz Trawl ↑	72	150	20	9.5	4.77	1008.87	77	0/10
2b	QMG-4	Basic	08/Aug/2017	23:11	UTC-4	68°29.111'	103°25.771'	010	Beam Trawl ↓	66	150	22	9.3	5.21	1008.58	79	0/10
2b	QMG-4	Basic	08/Aug/2017	23:34	UTC-4	68°29.424'	103°27.792'	245	Beam Trawl ↑	74	180	20	10.2	5.36	1008.37	76	0/10
2b	QMG-3	Basic	09/Aug/2017	01:23	UTC-4	68°19.693'	102°56.484'	023	CTD-Rosette ↓	49	187	20.8	11.7	6.06	1007.54	80	0/10
2b	QMG-3	Basic	09/Aug/2017	01:46	UTC-4	68°19.673'	102°56.071'	062	CTD-Rosette ↑	52	210	19.5	12.9	5.83	1007.67	75	0/10
2b	QMG-3	Basic	09/Aug/2017	01:55	UTC-4	68°19.702'	102°55.485'	077	DSN ↓	45	214	19	15.8	5.77	1007.67	66	0/10
2b	QMG-3	Basic	09/Aug/2017	02:02	UTC-4	68°19.780'	102°54.928'	335	DSN ↑	56	217	16	12.0	5.83	1007.63	82	0/10
2b	QMG-3	Basic	09/Aug/2017	02:22	UTC-4	68°19.667'	102°56.547'	055	5NVS ↓	48	244	19.1	11.4	6.11	1007.34	82	0/10
2b	QMG-3	Basic	09/Aug/2017	02:27	UTC-4	68°19.645'	102°56.432'	020	5NVS ↑	49	255	18.1	12.6	6.16	1007.28	77	0/10
2b	QMG-3	Basic	09/Aug/2017	02:49	UTC-4	68°19.652'	102°56.532'	103	Box Core ↓	46	274	21.1	13.2	5.86	1007.46	75	0/10
2b	QMG-3	Basic	09/Aug/2017	02:52	UTC-4	68°19.650'	102°56.523'	109	Box Core (bottom)	45	274	21.1	13.2	5.86	1007.46	75	0/10
2b	QMG-3	Basic	09/Aug/2017	02:53	UTC-4	68°19.650'	102°56.513'	111	Box Core ↑	47	274	21.1	13.2	5.86	1007.46	75	0/10
2b	QMG-3	Basic	09/Aug/2017	03:07	UTC-4	68°19.646'	102°56.540'	131	Box Core ↓	47	278	24.1	16.2	5.69	1007.47	63	0/10
2b	QMG-3	Basic	09/Aug/2017	03:09	UTC-4	68°19.655'	102°56.527'	129	Box Core (bottom)	46	283	22.1	13.0	5.67	1007.46	74	0/10
2b	QMG-3	Basic	09/Aug/2017	03:12	UTC-4	68°19.665'	102°56.497'	134	Box Core ↑	47	287	23.5	13.0	5.67	1007.46	74	0/10
2b	QMG-3	Basic	09/Aug/2017	03:23	UTC-4	68°19.671'	102°56.026'	055	Agassiz Trawl ↓	52	286	20.4	11.7	5.67	1007.46	77	0/10
2b	QMG-3	Basic	09/Aug/2017	03:32	UTC-4	68°19.709'	102°55.399'	034	Agassiz Trawl ↑	47	286	15.6	13.0	5.85	1007.18	72	0/10
2b	QMG-3	Basic	09/Aug/2017	03:59	UTC-4	68°19.704'	102°56.374'	057	Gravity Core ↓	50	270	17	11.1	6.03	1007.17	80	0/10
2b	QMG-3	Basic	09/Aug/2017	04:03	UTC-4	68°19.678'	102°56.375'	116	Gravity Core (bottom)	52	280	19	10.2	5.95	1007.19	82	0/10
2b	QMG-3	Basic	09/Aug/2017	04:05	UTC-4	68°19.675'	102°56.366'	126	Gravity Core ↑	51	280	19	10.2	5.95	1007.19	82	0/10
2b	QMG-WF1	Mooring	09/Aug/2017	07:13	UTC-4	68°14.559'	101°47.954'	261	Mooring Deployment ↓	96	300	17	7.6	5.11	1007.81	94	0/10
2b	QMG-WF1	Mooring	09/Aug/2017	07:33	UTC-4	68°14.533'	101°47.609'	292	Triangulation 1 (250m)		300	20	7.3	5.13	1007.96	94	0/10
2b	QMG-WF1	Mooring	09/Aug/2017	07:39	UTC-4	68°14.476'	101°48.095'	241	Triangulation 2 (225m)		300	21	7.3	5.13	1007.96	94	0/10
2b	QMG-WF1	Mooring	09/Aug/2017	07:48	UTC-4	68°14.684'	101°48.000'	316	Triangulation 3 (290m)		300	22	7.3	5.13	1007.98	95	0/10
2b	QMG-WF1	Mooring	09/Aug/2017	08:04	UTC-4	68°14.557'	101°47.715'	123	CTD-Rosette ↓	94-111	315	22	7.1	5,0	1008.29	98	0/10
2b	QMG-WF1	Mooring	09/Aug/2017	08:16	UTC-4	68°14.549'	101°47.557'	160	CTD-Rosette ↑	94-111	300	21	7.2	4.55	1008.45	99	0/10
2b	QMG-1	Basic	09/Aug/2017	13:02	UTC-4	68°29.468'	099°53.719'	182	CTD-Rosette ↓	44	316	23.3	3.4	5.8	1010.9	95	0/10
2b	QMG-1	Basic	09/Aug/2017	13:18	UTC-4	68°29.383'	099°53.802'	164	CTD-Rosette ↑	42	316	23.8	6.0	5.4	1010.8	83	0/10
2b	QMG-1	Basic	09/Aug/2017	13:27	UTC-4	68°29.264'	099°53.938'	158	DSN ↓	45	321	24.2	6.0	5.4	1010.8	83	0/10
2b	QMG-1	Basic	09/Aug/2017	13:35	UTC-4	68°29.018'	099°53.696'	031	DSN ↑	47	320	23.2	6.0	5.1	1011,0	84	0/10
2b	QMG-1	Basic	09/Aug/2017	13:58	UTC-4	68°29.503'	099°53.776'	159	5NVS ↓	42	330	25	6.1	5.3	1011.3	84	0/10
2b	QMG-1	Basic	09/Aug/2017	14:03	UTC-4	68°29.484'	099°53.861'	182	5NVS ↑	39	330	26.1	6.1	5.3	1011.3	84	0/10
2b	QMG-1	Basic	09/Aug/2017	14:26	UTC-4	68°29.553'	099°53.858'	171	Box Core ↓	42	317	22.7	4.9	5.3	1011.6	88	0/10
2b	QMG-1	Basic	09/Aug/2017	14:28	UTC-4	68°29.551'	099°53.882'	172	Box Core (bottom)	40	320	25.1	4.9	5.3	1011.6	88	0/10
2b	QMG-1	Basic	09/Aug/2017	14:29	UTC-4	68°29.547'	099°53.897'	168	Box Core ↑	39	320	25.1	5.2	5.3	1011.8	88	0/10
2b	QMG-1	Basic	09/Aug/2017	14:37	UTC-4	68°29.562'	099°54.065'	163	Agassiz Trawl ↓	40	320	24.8	5.2	5.3	1011.8	86	0/10
2b	QMG-1	Basic	09/Aug/2017	14:45	UTC-4	68°29.313'	099°54.009'	148	Agassiz Trawl ↑	50	330	18	8.1	5.2	1009.6	74	0/10
2b	QMG-1	Basic	09/Aug/2017	15:12	UTC-4	68°29.137'	099°53.870'	156	Beam Trawl ↓	50	320	26.5	4.9	5.3	1012.3	88	0/10
2b	QMG-1	Basic	09/Aug/2017	15:38	UTC-4	68°29.187'	099°53.617'	171	Beam Trawl ↑	47	330	23.4	4.0	5.4	1012.4	90	0/10
2b	QMG-2	Basic	09/Aug/2017	18:10	UTC-4	68°18.363'	100°48.087'	187	CTD-Rosette ↓	94	350	18	4.7	6.6	1015.3	87	0/10
2b	QMG-2	Basic	09/Aug/2017	18:42	UTC-4	68°18.322'	100°48.013'	104	CTD-Rosette ↑	94	350	19	5.6	6.6	1015.7	84	0/10
2b	QMG-2	Basic	09/Aug/2017	18:53	UTC-4	68°18.200'	100°48.036'	164	DSN ↓	98	350	22	3.9	6.7	1015.8	88	0/10
2b	QMG-2	Basic	09/Aug/2017	19:10	UTC-4	68°17.899'	100°46.893'	128	DSN ↑	82	330	17	3.8	7,0	1016,0	87	0/10
2b	QMG-2	Basic	09/Aug/2017	19:30	UTC-4	68°18.425'	100°48.303'	183	5NVS ↓	91	350	18	6.7	6.9	1016.1	77	0/10

2b	QMG-2	Basic	09/Aug/2017	19:50	UTC-4	68°18.392'	100°48.284'	155	5NVS ↑	93	330	16	6.2	6.7	1016.3	79	0/10
2b	QMG-2	Basic	09/Aug/2017	19:57	UTC-4	68°18.391'	100°48.406'	179	Box Core ↓	92	340	16	6.2	6.7	1016.3	79	0/10
2b	QMG-2	Basic	09/Aug/2017	19:59	UTC-4	68°18.400'	100°48.444'	152	Box Core (bottom)	95	340	16	6.2	6.7	1016.3	79	0/10
2b	QMG-2	Basic	09/Aug/2017	20:02	UTC-4	68°18.394'	100°48.468'	154	Box Core ↑	94	340	16	5.9	6.7	1016.4	80	0/10
2b	QMG-2	Basic	09/Aug/2017	20:09	UTC-4	68°18.356'	100°48.567'	135	Agassiz Trawl ↓	91	340	16	5.9	6.7	1016.4	80	0/10
2b	QMG-2	Basic	09/Aug/2017	20:23	UTC-4	68°18.216'	100°47.438'	102	Agassiz Trawl ↑	96	345	15	4.6	6.4	1016.4	88	0/10
2b	312	Basic	10/Aug/2017	01:43	UTC-4	69°10.227'	100°42.252'	174	CTD-Rosette ↓	67	344	5.8	2.4	3.2	1017.4	91	0/10
2b	312	Basic	10/Aug/2017	02:12	UTC-4	69°10.177'	100°42.511'	189	CTD-Rosette ↑	66	316	2.2	2.8	3,0	1017.7	90	0/10
2b	312	Basic	10/Aug/2017	02:22	UTC-4	69°10.030'	100°42.562'	157	DSN ↓	64	330	6	2.6	3,0	1017.7	92	0/10
2b	312	Basic	10/Aug/2017	02:28	UTC-4	69°10.151'	100°42.016'	340	DSN ↑	67	326	6.9	2.2	3.1	1017.8	94	0/10
2b	312	Basic	10/Aug/2017	02:48	UTC-4	69°10.173'	100°42.103'	043	5NVS ↓	67	270	3.8	1.3	3.1	1017.8	97	0/10
2b	312	Basic	10/Aug/2017	02:58	UTC-4	69°10.174'	100°42.163'	060	5NVS ↑	67	280	4	1.3	3.1	1017.8	97	0/10
2b	312	Basic	10/Aug/2017	03:06	UTC-4	69°10.164'	100°42.168'	083	Manta Net ↓	67	270	3	1.1	3.2	1017.8	97	0/10
2b	312	Basic	10/Aug/2017	03:27	UTC-4	69°10.154'	100°41.961'	175	Manta Net ↑	65	290	5	1.3	3.2	1017.9	98	0/10
2b	312	Basic	10/Aug/2017	03:32	UTC-4	69°10.181'	100°41.972'	092	Plankton Net ↓	66	270	6	1.5	3.2	1017.9	98	0/10
2b	312	Basic	10/Aug/2017	03:37	UTC-4	69°10.196'	100°42.000'	087	Plankton Net ↑	66	270	6	1.5	3.2	1017.9	98	0/10
2b	312	Basic	10/Aug/2017	03:44	UTC-4	69°10.211'	100°42.006'	100	Plankton Net ↓	67	290	3	1.4	3.1	1017.8	98	0/10
2b	312	Basic	10/Aug/2017	03:48	UTC-4	69°10.215'	100°42.018'	103	Plankton Net ↑	67	290	4	1.3	3.1	1017.8	98	0/10
2b	312	Basic	10/Aug/2017	05:00	UTC-4	69°10.128'	100°42.132'	227	PNF ↓	65	260	4	1.9	3.2	1017.5	97	0/10
2b	312	Basic	10/Aug/2017	05:03	UTC-4	69°10.129'	100°42.105'	225	PNF ↑	65	260	4	1.9	3.2	1017.5	97	0/10
2b	312	Basic	10/Aug/2017	05:04	UTC-4	69°10.131'	100°42.093'	230	Secchi Disk ↓	65	260	6	1.9	3.2	1017.5	97	0/10
2b	312	Basic	10/Aug/2017	05:06	UTC-4	69°10.133'	100°42.077'	225	Secchi Disk ↑	65	260	4	1.9	3.2	1017.5	97	0/10
2b	312	Basic	10/Aug/2017	05:22	UTC-4	69°10.128'	100°41.845'	198	CTD-Rosette ↓	64	290	6	1.8	3.2	1017.7	98	0/10
2b	312	Basic	10/Aug/2017	05:44	UTC-4	69°10.163'	100°41.308'	189	CTD-Rosette ↑	64	290	6	1.8	3.2	1017.8	98	0/10
2b	312	Basic	10/Aug/2017	05:55	UTC-4	69°10.231'	100°41.757'	208	Box Core ↓	64	290	6	1.7	3.2	1017.9	98	0/10
2b	312	Basic	10/Aug/2017	05:57	UTC-4	69°10.235'	100°41.732'	223	Box Core (bottom)	65	290	5	1.7	3.2	1017.9	98	0/10
2b	312	Basic	10/Aug/2017	05:59	UTC-4	69°10.242'	100°41.702'	225	Box Core ↑	64	290	7	1.7	3.2	1017.9	98	0/10
2b	312	Basic	10/Aug/2017	06:08	UTC-4	69°10.218'	100°41.899'	320	Agassiz Trawl ↓	66	280	8	1.7	3.2	1017.8	99	0/10
2b	312	Basic	10/Aug/2017	06:16	UTC-4	69°10.447'	100°41.885'	322	Agassiz Trawl ↑	68	290	8	1.7	3.2	1017.8	89	0/10
2b	3.7	Coring	11/Aug/2017	06:41	UTC-4	72°05.622'	096°02.566'	019	Piston Core ↓	404	200	16	1.1	0.1	1011.6	96	5/10
2b	3.7	Coring	11/Aug/2017	07:01	UTC-4	72°05.690'	096°02.517'	009	Piston Core (bottom)	404	200	16	0.5	-0.3	1011.7	98	5/10
2b	3.7	Coring	11/Aug/2017	07:20	UTC-4	72°05.764'	096°02.645'	024	Piston Core ↑	406	200	14	4.4	-0.4	1011.8	85	5/10
2b	3.7	Coring	11/Aug/2017	08:29	UTC-4	72°05.336'	096°03.996'	014	Box Core ↓	416	225	18	1.0	-0.4	1011.7	97	5/10
2b	3.7	Coring	11/Aug/2017	08:36	UTC-4	72°05.348'	096°03.920'	359	Box Core (bottom)	414	225	18	1.1	-0.4	1011.8	97	5/10
2b	3.7	Coring	11/Aug/2017	08:42	UTC-4	72°05.359'	096°03.835'	347	Box Core ↑	414	225	18	0.7	-0.4	1011.8	98	5/10
2b	Bellot	Basic	11/Aug/2017	13:02	UTC-4	71°59.568'	094°48.170'	269	CTD-Rosette ↓	179	224	10.7	4.3	0.5	1013.3	98	1/10
2b	Bellot	Basic	11/Aug/2017	13:37	UTC-4	71°59.749'	094°47.977'	255	CTD-Rosette ↑	230	240	11.7	4.8	0.6	1013.4	99	1/10
2b	3.4	Coring	11/Aug/2017	20:49	UTC-4	71°28.509'	091°59.795'	289	5NVS ↓	270	135	10	4.3	3.8	1013.8	94	0/10
2b	3.4	Coring	11/Aug/2017	21:07	UTC-4	71°28.493'	091°59.829'	336	5NVS ↑	270	135	10	3.8	3.6	1014.1	95	0/10
2b	3.4	Coring	11/Aug/2017	21:30	UTC-4	71°28.529'	091°59.626'	331	Gravity Core ↓	270	135	14	4.9	3.5	1013.7	89	0/10
2b	3.4	Coring	11/Aug/2017	21:34	UTC-4	71°28.527'	091°59.640'	314	Gravity Core (bottom)	270	135	14	4.9	3.5	1013.7	89	0/10
2b	3.4	Coring	11/Aug/2017	21:37	UTC-4	71°28.524'	091°59.661'	318	Gravity Core ↑	270	135	14	4.9	3.5	1013.7	89	0/10
2b	3.4	Coring	11/Aug/2017	21:48	UTC-4	71°28.519'	091°59.590'	333	Box Core ↓	270	135	14	5.5	3.5	1013.5	87	0/10
2b	3.4	Coring	11/Aug/2017	21:52	UTC-4	71°28.512'	091°59.600'	291	Box Core (bottom)	270	135	14	5.7	3.4	1013.6	85	0/10
2b	3.4	Coring	11/Aug/2017	21:56	UTC-4	71°28.512'	091°59.604'	318	Box Core ↑	270	135	14	5.7	3.4	1013.6	85	0/10
2b	3.4	Coring	11/Aug/2017	22:11	UTC-4	71°28.522'	091°59.723'	321	Gravity Core ↓	270	135	11	4.7	3.2	1013.6	90	0/10
2b	3.4	Coring	11/Aug/2017	22:15	UTC-4	71°28.518'	091°59.742'	317	Gravity Core (bottom)	270	135	11	4.7	3.2	1013.6	90	0/10
2b	3.4	Coring	11/Aug/2017	22:19	UTC-4	71°28.509'	091°59.793'	350	Gravity Core ↑	270	135	11	4.7	3.2	1013.6	90	0/10
2b	3.5	Coring	12/Aug/2017	08:11	UTC-4	70°26.183'	091°14.199'	318	Box Core ↓	224	135	10	3.8	4.1	1014,0	92	0/10
2b	3.5	Coring	12/Aug/2017	08:15	UTC-4	70°26.197'	091°14.179'	275	Box Core (bottom)	224	135	10	3.8	4.1	1014,0	92	0/10
2b	3.5	Coring	12/Aug/2017	08:19	UTC-4	70°26.204'	091°14.151'	260	Box Core ↑	225	135	10	3.8	4.1	1014,0	92	0/10
2b	3.5	Coring	12/Aug/2017	09:06	UTC-4	70°26.266'	091°14.304'	228	Piston Core ↓	223	120	10	3.4	4.2	1013.8	92	0/10
2b	3.5	Coring	12/Aug/2017	09:11	UTC-4	70°26.277'	091°14.328'	216	Piston Core (bottom)	223	120	11	3.4	4.2	1013.8	92	0/10
2b	3.5	Coring	12/Aug/2017	09:29	UTC-4	70°26.336'	091°14.445'	228	Piston Core ↑	221	120	10	3.5	4.1	1013.8	91	0/10
2b	5.11W	Coring	12/Aug/2017	18:42	UTC-4	69°57.318'	087°40.382'	182	Gravity Core ↓	183	120	15	3.0	-0.5	1015.2	85	9/10
2b	5.11W	Coring	12/Aug/2017	18:46	UTC-4	69°57.298'	087°40.363'	230	Gravity Core (bottom)	183	120	14	3.0	-0.5	1015.2	85	9/10
2b	5.11W	Coring	12/Aug/2017	18:49	UTC-4	69°57.298'	087°40.315'	256	Gravity Core ↑	183	120	15	3.0	-0.5	1015.2	85	9/10
2b	5.11W	Coring	12/Aug/2017	19:03	UTC-4	69°57.302'	087°40.034'	077	Box Core ↓	184	120	14	3.1	-0.5	1015.1	83	9/10
2b	5.11W	Coring	12/Aug/2017	19:06	UTC-4	69°57.291'	087°40.019'	119	Box Core (bottom)	184	120	13	3.1	-0.5	1015.1	83	9/10
2b	5.11W	Coring	12/Aug/2017	19:09	UTC-4	69°57.291'	087°40.009'	164	Box Core ↑	183	120	14	3.1	-0.5	1015.1	83	9/10
2b	5.11	Coring	12/Aug/2017	23:36	UTC-4	69°52.871'	086°04.311'	298	Gravity Core ↓	299	090	12	8.5	0.5	1015.1	80	9/10
2b	5.11	Coring	12/Aug/2017	23:39	UTC-4	69°52.870'	086°04.409'	005	Gravity Core (bottom)	298	090	12	8.5	0.5	1015.1	80	9/10
2b	5.11	Coring	12/Aug/2017	23:43	UTC-4	69°52.860'	086°04.508'	027	Gravity Core ↑	298	090	12	8.2	0,0	1015,0	80	9/10
2b	5.11	Coring	12/Aug/2017	23:52	UTC-4	69°52.911'	086°04.666'	194	Box Core ↓	300	090	15	7.6	-0.3	1014.9	83	9/10
2b	5.11	Coring	12/Aug/2017	23:56	UTC-4	69°52.930'	086°04.745'	280	Box Core (bottom)	297	090	12	7.6	-0.3	1014.9	83	9/10
2b	5.11	Coring	13/Aug/2017	00:01	UTC-4	69°52.914'	086°04.773'	020	Box Core ↑	294	080	10	7.8	-0.4	1014.8	81	9/10
2b	5.11	Coring	13/Aug/2017	00:14	UTC-4	69°52.949'	086°04.953'	110	Box Core ↓	293	090	13	7.6	-0.4	1014.2	84	9/10
2b	5.11	Coring	13/Aug/2017	00:18	UTC-4	69°52.961'	086°05.079'	153	Box Core (bottom)	291	090	14	8.1	-0.4	1014.7	82	9/10
2b	5.11	Coring	13/Aug/2017	00:24	UTC-4	69°52.972'	086°05.245'	204	Box Core ↑	291	090	14	8.1	-0.4	1014.7	82	9/10

2b	A15	Nutrient	13/Aug/2017	12:17	UTC-4	69°16.271'	080°36.457'	353	CTD-Rosette ↓	54	170	8	2.6	2.9	1016,0	98	1/10
2b	A15	Nutrient	13/Aug/2017	12:34	UTC-4	69°16.293'	080°36.373'	001	CTD-Rosette ↑	54	171	8.9	3.1	2.5	1016.1	98	1/10
2b	333	Basic	13/Aug/2017	15:03	UTC-4	68°46.217'	080°50.328'	271	PNF ↓	27	140	10	2.1	3.8	1015.9	99	0/10
2b	333	Basic	13/Aug/2017	15:07	UTC-4	68°46.144'	080°50.247'	270	PNF ↑	27	140	10	2.1	3.8	1015.9	99	0/10
2b	333	Basic	13/Aug/2017	15:08	UTC-4	68°46.129'	080°50.232'	271	Secchi Disk ↓	27	140	10	2.1	3.8	1015.9	99	0/10
2b	333	Basic	13/Aug/2017	15:09	UTC-4	68°46.091'	080°50.205'	280	Secchi Disk ↑	28	130	12	1.9	3.8	1015.9	99	0/10
2b	333	Basic	13/Aug/2017	15:13	UTC-4	68°46.043'	080°50.381'	239	CTD-Rosette ↓	28	130	12	1.9	3.8	1015.9	99	0/10
2b	333	Basic	13/Aug/2017	15:30	UTC-4	68°45.825'	080°50.468'	008	CTD-Rosette ↑	26	148	9.4	3.1	3.8	1016.1	99	0/10
2b	333	Basic	13/Aug/2017	15:38	UTC-4	68°45.846'	080°50.441'	356	DSN ↓	26	145	9.4	3.3	3.8	1016.1	98	0/10
2b	333	Basic	13/Aug/2017	15:45	UTC-4	68°45.906'	080°50.514'	315	DSN ↑	27	164	10.4	3.3	3.8	1016.1	98	0/10
2b	333	Basic	13/Aug/2017	16:10	UTC-4	68°46.425'	080°50.688'	351	5NVS ↓	26	150	10	2.9	3.8	1015.9	97	0/10
2b	333	Basic	13/Aug/2017	16:16	UTC-4	68°46.349'	080°50.664'	059	5NVS ↑	26	150	12	2.9	3.8	1015.9	97	0/10
2b	333	Basic	13/Aug/2017	16:30	UTC-4	68°45.980'	080°50.734'	175	Manta Net ↓	27	140	13	2.4	3.7	1015.8	97	0/10
2b	333	Basic	13/Aug/2017	16:51	UTC-4	68°45.282'	080°50.402'	178	Manta Net ↑	28	160	13	2.3	3.7	1015.8	98	0/10
2b	333	Basic	13/Aug/2017	17:03	UTC-4	68°46.416'	080°50.652'	354	Plankton Net ↓	26	136	13	2.6	3.8	1015.7	97	0/10
2b	333	Basic	13/Aug/2017	17:05	UTC-4	68°46.421'	080°50.653'	010	Plankton Net ↑	26	144	14	2.6	3.8	1015.7	97	0/10
2b	333	Basic	13/Aug/2017	17:13	UTC-4	68°46.412'	080°50.689'	349	Plankton Net ↓	26	136	14	3.5	3.7	1015.5	94	0/10
2b	333	Basic	13/Aug/2017	17:16	UTC-4	68°46.403'	080°50.711'	355	Plankton Net ↑	26	136	14	3.5	3.7	1015.5	94	0/10
2b	333	Basic	13/Aug/2017	17:27	UTC-4	68°46.370'	080°50.840'	387	Box Core ↓	27	130	6	3.7	4.1	1015.2	91	0/10
2b	333	Basic	13/Aug/2017	17:28	UTC-4	68°46.374'	080°50.846'	005	Box Core (bottom)	27	130	6	4.1	3.7	1015.2	91	0/10
2b	333	Basic	13/Aug/2017	17:29	UTC-4	68°46.376'	080°50.857'	339	Box Core ↑	26	135	14	3.6	3.7	1015.1	93	0/10
2b	333	Basic	13/Aug/2017	17:43	UTC-4	68°46.524'	080°50.926'	337	Box Core ↓	27	130	15	4.0	3.7	1015,0	92	0/10
2b	333	Basic	13/Aug/2017	17:44	UTC-4	68°46.522'	080°50.927'	335	Box Core (bottom) (Didn't work)	27	130	15	4.0	3.7	1015,0	92	0/10
2b	333	Basic	13/Aug/2017	17:45	UTC-4	68°46.518'	080°50.930'	337	Box Core ↑	27	130	14	4.0	3.7	1015,0	92	0/10
2b	333	Basic	13/Aug/2017	17:48	UTC-4	68°46.510'	080°50.944'	346	Box Core ↓	27	130	15	4.0	3.7	1015,0	92	0/10
2b	333	Basic	13/Aug/2017						Box Core (bottom) (Didn't work)								0/10
2b	333	Basic	13/Aug/2017	17:50	UTC-4	68°46.505'	080°50.980'	344	Box Core ↑	27	140	15	6.5	3.7	1014.9	81	0/10
2b	333	Basic	13/Aug/2017	18:09	UTC-4	68°46.515'	080°50.956'	308	Box Core ↓	27	140	12	3.0	3.7	1014.7	85	0/10
2b	333	Basic	13/Aug/2017	18:10	UTC-4	68°46.519'	080°50.951'	304	Box Core (bottom)	27	140	12	3.0	3.7	1014.6	95	0/10
2b	333	Basic	13/Aug/2017	18:11	UTC-4	68°46.528'	080°50.956'	318	Box Core ↑	27	140	12	3.0	3.7	1014.6	95	0/10
2b	333	Basic	13/Aug/2017	18:20	UTC-4	68°46.547'	080°50.929'	301	Agassiz Trawl ↓	27	140	14	2.9	3.7	1014.6	95	0/10
2b	333	Basic	13/Aug/2017	18:26	UTC-4	68°46.651'	080°51.318'	258	Agassiz Trawl ↑	27	140	14	2.9	3.7	1014.5	96	0/10
2b	333	Basic	13/Aug/2017	18:40	UTC-4	68°46.471'	080°50.523'	352	Beam Trawl ↓	26	160	12	3.5	3.7	1014.4	93	0/10
2b	333	Basic	13/Aug/2017	19:06	UTC-4	68°47.254'	080°51.860'	335	Beam Trawl ↑	26	140	12	2.8	3.7	1014.4	96	0/10
2b	3.10-2	Coring	14/Aug/2017	01:52	UTC-4	68°52.754'	078°09.759'	321	Box Core ↓	52	194	11.9	1.5	-0.2	1013.7	99	5/10
2b	3.10-2	Coring	14/Aug/2017	01:54	UTC-4	68°52.738'	078°09.753'	313	Box Core (bottom)	52	194	11.9	1.5	-0.2	1013.7	99	5/10
2b	3.10-2	Coring	14/Aug/2017	01:56	UTC-4	68°52.726'	078°09.753'	310	Box Core ↑	52	194	11.9	1.5	-0.2	1013.7	99	5/10
2b	3.10-2	Coring	14/Aug/2017	02:08	UTC-4	68°52.777'	078°09.567'	083	Gravity Core ↓	51	192	11.2	1.6	-0.4	1013.6	99	5/10
2b	3.10-2	Coring	14/Aug/2017	02:10	UTC-4	68°52.765'	078°09.861'	074	Gravity Core (bottom)	51	192	11.2	1.6	-0.4	1013.6	99	5/10
2b	3.10-2	Coring	14/Aug/2017	02:12	UTC-4	68°52.751'	078°09.852'	070	Gravity Core ↑	51	192	11.2	1.6	-0.4	1013.6	99	5/10
2b	3.10	Coring	14/Aug/2017	12:04	UTC-4	67°47.844'	080°50.820'	010	Box Core ↓	97	176	24.2	3.5	3.5	1009.7	96	0/10
2b	3.10	Coring	14/Aug/2017	12:07	UTC-4	67°47.844'	080°50.816'	003	Box Core (bottom)	96	176	24.2	3.5	3.5	1009.7	96	0/10
2b	3.10	Coring	14/Aug/2017	12:10	UTC-4	67°47.838'	080°50.782'	008	Box Core ↑	96	176	24.2	3.5	3.5	1009.7	96	0/10
2b	A8	Nutrient	15/Aug/2017	03:16	UTC-4	65°27.043'	083°15.454'	104	CTD-Rosette ↓	101	250	9.8	11.1	1.4	1008.9	76	3/10
2b	A8	Nutrient	15/Aug/2017	03:54	UTC-4	65°27.124'	083°15.497'	117	CTD-Rosette ↑	99	251	11.2	10.4	1.5	1008.3	82	3/10
2b	1.1	Coring	15/Aug/2017	10:04	UTC-4	65°09.304'	081°21.269'	334	Box Core ↓	419	180	14	3.7	1.8	1009.3	95	1/10
2b	1.1	Coring	15/Aug/2017	10:10	UTC-4	65°09.308'	081°21.235'	305	Box Core (bottom)	418	180	14	3.7	1.8	1009.3	95	1/10
2b	1.1	Coring	15/Aug/2017	10:18	UTC-4	65°09.303'	081°21.248'	309	Box Core ↑	418	180	14	3.7	1.8	1009.3	95	1/10
2b	1.1	Coring	15/Aug/2017	11:05	UTC-4	65°09.347'	081°21.323'	298	Piston Core ↓	418	190	12	3.5	2.1	1008.9	98	1/10
2b	1.1	Coring	15/Aug/2017	11:14	UTC-4	65°09.319'	081°21.305'	327	Piston Core (bottom)	418	200	11	3.5	2.2	1009,0	98	1/10
2b	1.1	Coring	15/Aug/2017	11:24	UTC-4	65°09.331'	081°21.321'	336	Piston Core ↑	418	220	9	3.3	2.2	1009.1	98	1/10
2b	1.1	Coring	15/Aug/2017	13:00	UTC-4	65°11.707'	081°23.081'	044	Piston Core ↓	409							
2b	1.1	Coring	15/Aug/2017	13:17	UTC-4	65°11.708'	081°23.093'	044	Piston Core (bottom)	409							
2b	1.1	Coring	15/Aug/2017	13:40	UTC-4	65°11.717'	081°23.112'	044	Piston Core ↑	409	255	3	6.0	2.3	1009.4	94	1/10
2b	A1	Nutrient	15/Aug/2017	22:20	UTC-4	63°42.428'	079°50.479'	333	CTD-Rosette ↓	180	210	16	4.2	1.5	1011.4	99	1/10
2b	A1	Nutrient	15/Aug/2017	23:00	UTC-4	63°41.618'	079°50.030'	084	CTD-Rosette ↑	169	210	15	4.3	1.4	1011.8	99	1/10
2b	A2	Nutrient	16/Aug/2017	00:42	UTC-4	63°37.978'	079°15.308'	326	CTD-Rosette ↓	157	224	14	4.0	2,0	1011.5	99	1/10
2b	A2	Nutrient	16/Aug/2017	01:18	UTC-4	63°37.956'	079°15.299'	326	CTD-Rosette ↑	158	217	15.6	3.8	1.8	1011.5	99	1/10
2b	A3	Nutrient	16/Aug/2017	02:50	UTC-4	63°33.149'	078°43.289'	084	CTD-Rosette ↓	256	221	14.5	5.9	3.8	1011.2	99	0/10
2b	A3	Nutrient	16/Aug/2017	03:39	UTC-4	63°33.087'	078°43.009'	125	CTD-Rosette ↑	257	233	14.4	5.8	3.6	1011.3	99	0/10
Leg 4																	
4	356	Nutrient	07/Oct/2017	03:44	UTC-4	60°38.358'	064°42.418'	250	CTD-Rosette ↓	342	290	16	-0.5	1.8	989.5	95	0/10
4	356	Nutrient	07/Oct/2017	04:28	UTC-4	60°48.257'	064°41.171'	253	CTD-Rosette ↑	341	215	15	-0.8	1.7	989.8	97	0/10
4	354	Nutrient	07/Oct/2017	05:15	UTC-4	60°58.062'	064°49.298'	198	CTD-Rosette ↓	587	290	13	-0.8	1.1	990.7	90	0/10
4	354	Nutrient	07/Oct/2017	07:12	UTC-4	60°57.544'	064°53.630'	203	CTD-Rosette ↑	636	284	12	-0.3	1,0	991.4	89	0/10
4	DFO-1	Mooring	07/Oct/2017	16:02	UTC-4	60°27.677'	061°15.846'	092	Mooring Deployment ↓	499	290	27	0.2	1.8	997.2	83	0/10
4	DFO-1	Mooring	07/Oct/2017	16:40	UTC-4	60°27.562'	061°15.350'	086	CTD-Rosette ↓	541	330	30	0.3	1.7	998.6	82	0/10
4	DFO-1	Mooring	07/Oct/2017	17:40	UTC-4	60°26.278'	061°14.467'	165	CTD-Rosette ↑	570	300	25	2.5	1.9	999.9	83	0/10
4	DFO-1	Mooring	07/Oct/2017	18:12	UTC-4	60°27.231'	061°15.566'	119	5NVS ↓	516	300	19	2.3	2,0	1000.2	79	0/10

4	DFO-1	Mooring	07/Oct/2017	18:44	UTC-4	60°26.658'	061°15.664'	115	5NVS ↑	491	290	23	0.3	2,0	998.1	83	0/10
4	DFO-1	Mooring	07/Oct/2017	19:22	UTC-4	60°27.323'	061°15.630'	127	Box Core ↓	517	280	24	0.0	2.1	1000.9	87	0/10
4	DFO-1	Mooring	07/Oct/2017	19:34	UTC-4	60°27.219'	061°15.726'	091	Box Core (bottom)	507	290	24	2.6	2.1	1001.2	77	0/10
4	DFO-1	Mooring	07/Oct/2017	19:49	UTC-4	60°27.055'	061°15.856'	143	Box Core ↑	491	290	25	1.0	2.2	999.1	83	0/10
4	DFO-1	Mooring	07/Oct/2017	20:40	UTC-4	60°27.954'	061°15.719'	146	Beam Trawl ↓	490	280	21	1.7	2.3	1002,0	80	0/10
4	DFO-1	Mooring	07/Oct/2017	21:10	UTC-4	60°27.543'	061°15.381'	112	Beam Trawl (bottom)	661	280	22	-0.3	2.4	1002.2	91	0/10
4	DFO-1	Mooring	07/Oct/2017	22:55	UTC-4	60°26.205'	061°10.324'	077	Beam Trawl ↑	476	280	25	0.0	2.5	1002.1	85	0/10

Leg	Cast	Station	Start Date UTC	Time UTC	Latitude N	Longitude W	Bottom depth (m)	Cast depth (dbar)	Comments	Rosette Type	Init
Leg 1											
1	001	Test	1 juin 2017	18:01	51°18,924	056°57,977	110	100	Bottle 8, replaced with spare bottle	Test	RS
1	002	NFLD	8 juin 2017	16:41	50°8,208	055°16,356	131	123		CTD	RS
Leg 2a											
2a	001	732	7 juillet 2017	23:51	55°23,275	077°59,525	114	105		Short Basic	CB
2a	002	736	8 juillet 2017	22:03	58°25,544	078°18,221	85	76	Problem with CTD	Short Basic	CB
2a	003	736	8 juillet 2017	22:22	58°25,668	078°17,952	85	50	append previous cast	Short Basic	CB
2a	004	736	8 juillet 2017	22:35	58°25,734	078°17,934	85	30	append previous cast	Short Basic	CB
2a	005	720	9 juillet 2017	16:45	60°41,764	078°33,860	85	75	Nothing to report.	Short Basic	RS
2a	006	694	10 juillet 2017	09:10	62°30,766	078°29,333	96	86	Nothing to report.	Short Basic	CB
2a	007	688	10 juillet 2017	21:00	62°22,018	074°39,716	103	93	Nothing to report.	Short Basic	RS
2a	008	684	11 juillet 2017	09:09	61°47,208	071°54,743	103	93	Nothing to report.	Short Basic	cb
2a	009	682	11 juillet 2017	19:31	61°02,514	069°42,984	101	90	Nothing to report.	Short Basic	RS
2a	010	676	12 juillet 2017	04:19	60°07,568	069°03,884	111	103	Nothing to report.	Short Basic	cb
2a	011	670	12 juillet 2017	14:37	58°59,779	067°56,132	128	120	Nothing to report.	Short Basic	cb
Leg 2b											
2b	012	OF-B2	14 juillet 2017	10:27	63°0,095	067°19,804	416	405	Nothing to report.	HiBio	cb.cg
2b	013	A16	15 juillet 2017	15:03	63°38,360	068°37,574	142	133	Problem with matlab	Basic	cg
2b	014	A16	15 juillet 2017	17:37	63°38,363	068°37,445	137	128	Nothing to report.	Basic	cb
2b	015	Bell11	15 juillet 2017	22:22	63°21,659	068°10,789	111	100	Nothing to report.	HiBio	cg
2b	016	OF-B14	16 juillet 2017	09:31	62°23,070	066°1,830	411	395		HiBio	
2b	017	BB1	18 juillet 2017	05:50	66°51,664	059°3,474	1048	1034		Nutrient	cg
2b	018	180	18 juillet 2017	16:42	67°24,678	061°26,874	543	533	Re-installed ISUS and PAR	Basic	cb
2b	019	180	18 juillet 2017	20:29	67°25,564	061°23,308	710	691		Basic	cb
2b	020	Diskofan	19 juillet 2017	04:45	67°58,052	059°30,199	911	896	Became more than ROV	ROV	cg
2b	021	FloatStn2	20 juillet 2017	06:58	69°33,204	060°46,133	1710	1676		PDT `Deep`	cb
2b	022	FloatStn2	20 juillet 2017	11:44	69°38,653	060°44,687	1672	978	Bottle #8 did not fire ; O2	Float	cb
2b	023	176	21 juillet 2017	03:01	69°36,781	065°23,490	284	272	Rien a signaler	Basic	cg
2b	024	176	21 juillet 2017	05:17	69°36,193	065°23,628	285	274	Rien a signaler	Basic	cg
2b	025	BB3	22 juillet 2017	03:00	71°24,893	068°36,785	1265	1257	Nothing to Report	Nutrient	cb
2b	026	BB2	22 juillet 2017	13:48	72°46,108	067°0,271	2373	1677	Nothing to Report	Basic	cb
2b	027	BB2	22 juillet 2017	19:08	72°45,836	066°59,369	2375	792	Nothing to Report	Basic	cg
2b	028	BB2	23 juillet 2017	03:37	72°45,850	066°59,458	1672	989	Bottles leaked	Float	cg
2b	029	BA06	23 juillet 2017	22:55	75°39,840	070°25,690	531	518	Nothing to Report	Mooring	cg
2b	030	BA05	24 juillet 2017	01:41	75°48,310	070°12,319	539	524	2 fichiers sur le cast adcp	Mooring	cm.cg
2b	031	101	24 juillet 2017	12:26	76°22,980	077°24,280	362	343	Rien a signaler	Full-1	cm
2b	032	101	24 juillet 2017	16:40	76°23,110	077°24,310	353	341	pas de LADCP	Full-2	cm-cg
2b	033	102	24 juillet 2017	22:10	76°22,303	076°59,959	256	245	avec LADCP	CTD	cm
2b	034	103	24 juillet 2017	23:24	76°20,778	076°35,680	151	139	Rien a signaler	Nutrients	cm
2b	035	104	25 juillet 2017	00:53	76°20,668	076°10,381	189	119	cast cancelled	CTD	cg
2b	036	104	25 juillet 2017	01:13	76°20,788	076°10,463	182	168	Rien a signaler	CTD	cg
2b	037	105	25 juillet 2017	02:18	76°19,049	075°45,625	330	319		Basic	cg
2b	038	105	25 juillet 2017	05:52	76°19,098	075°45,878	330	316	Nothing to Report	Basic	cb
2b	039	106	25 juillet 2017	09:14	76°18,397	075°21,635	377	366		CTD	cb
2b	040	107	25 juillet 2017	11:05	76°16,895	074°59,249	434	416		Nutrient	cb
2b	041	BA-06	25 juillet 2017	20:09	75°39,167	070°24,229	533	522		Mooring	cm
2b	042	BA-05	25 juillet 2017	23:15	75°48,233	070°11,635	540	531	O2 and salinity	Mooring	cm
2b	043	115	26 juillet 2017	08:51	76°19,928	071°11,826	673	659		Full	cb
2b	044	115	26 juillet 2017	13:08	76°20,234	071°13,213	661	651	salinity	Full	cm
2b	045	126	27 juillet 2017	09:52	78°19,427	074°53,604	345	297		Nutrients	cb
2b	046	127	27 juillet 2017	11:28	78°19,432	074°30,469	527	494	salinity	Nutrients	cb-cm
2b	047	129							Cast aborted,station at 048	Basic	cg
2b	048	129	27 juillet 2017	16:27	78°19,560	074°7,618	519	501		Basic	cg
2b	049	129	27 juillet 2017	19:49	78°19,433	074°4,860	544	533	O2 and salinity	Basic	cg-cm
2b	050	130	27 juillet 2017	23:22	78°19,337	073°39,742	699	679		Nutrients	cm
2b	051	131	28 juillet 2017	02:17	78°19,700	073°5,282	175	161		Nutrients	cg
2b	052	TS233	28 juillet 2017	09:57	77°46,859	076°30,148	546	534		Full	cb
2b	053	TS233	28 juillet 2017	14:01	77°45,294	076°36,355	396	382	salinity	Full	cm
2b	054	114	29 juillet 2017	09:14	76°19,556	071°47,357	611	584		CTD	cb
2b	055	113	29 juillet 2017	10:22	76°19,242	072°13,062	547	536		Nutrients	cb
2b	056	112	29 juillet 2017	12:14	76°18,956	072°43,192	560	551		CTD	cm
2b	057	111	29 juillet 2017	13:22	76°18,544	073°13,187	593	582		basic_1	cm
2b	058	111	29 juillet 2017	16:57	76°18,143	073°13,483	589	564	Salinity	basic_2	cg
2b	059	110	29 juillet 2017	20:24	76°18,170	073°37,034	541	532		Nutrients	cm
2b	060	109	29 juillet 2017	22:03	76°17,393	074°6,691	451	441		CTD	cm
2b	061	108	29 juillet 2017	23:12	76°15,840	074°36,142	448	438		Basic	cm-cg
2b	062	108	30 juillet 2017	02:05	76°15,707	074°36,251	444	431		Basic	cg

2b	063	Jones Sound	30 juillet 2017	19:47	76°5,083	081°56,485	770	761		HIBIO	cm
2b	064	323	31 juillet 2017	12:19	74°9,370	080°28,698	788	778	salinity	Full-1	cm
2b	065	323	31 juillet 2017	17:33	74°9,563	080°27,881	787	777		Full-2	cg
2b	066	ROV POND	1 août 2017	22:09	72°49,660	077°36,220	899	807	salinity	HiBio	cm
2b	067	ROV NBI	2 août 2017	10:43	73°43,646	081°6,034	369	320		HiBio	cb
2b	068	325	2 août 2017	16:11	73°49,102	080°29,773	683	675		Nutrients	cg
2b	069	324	2 août 2017	19:12	73°58,950	080°29,482	772	761		Nutrients	cg-cm
2b	070	300	2 août 2017	22:19	74°19,066	080°29,794	699	689		Nutrients	cm
2b	071	322	3 août 2017	01:14	74°29,399	080°33,079	659	644	2 files again for LADCP	Nutrients	cg
2b	072	301	3 août 2017	06:33	74°16,660	083°21,884	714	702	Salinity	Full	cb
2b	073	301	3 août 2017	10:13	74°16,361	083°22,765	710	694	O2	Full	cb
2b	074	301	3 août 2017	20:00	74°16,627	083°22,002	715	705	For extra bottom water/ salinity	Full	cm
2b	075	303	4 août 2017	13:21	74°22,020	089°36,192	288	279	salinity	Nutrients	cm
2b	076	304	4 août 2017	17:27	74°14,822	091°30,510	311	298		Basic	cg
2b	077	304	4 août 2017	19:17	74°14,875	091°31,986	310	298	some bottles leaked	Basic	cg-cm
2b	078	305A	5 août 2017	04:09	74°13,325	093°30,757	157	147		Nutrients	cb
2b	079	305B	5 août 2017	05:53	74°21,140	093°34,936	166	156		Basic	cb
2b	080	305C	5 août 2017	10:21	74°28,980	093°38,429	168	159		Nutrients	cb
2b	081	305D	5 août 2017	12:05	74°36,152	093°42,644	123	113	salinity	Nutrients	cm
2b	082	5,1	6 août 2017	04:15	74°29,395	099°5,437	215	205		Nutrients	cb
2b	083	QMG-M	8 août 2017	06:06	68°18,172	101°44,464	112	99	salinity	Basic	cb
2b	084	QMG-M	8 août 2017	09:08	68°18,150	101°44,244	107	97		Basic	cb
2b	085	Mooring WF1	8 août 2017	12:48	68°14,824	101°48,658	102	92		CTD	cm
2b	086	QMG-4	9 août 2017	00:31	68°29,172	103°25,751	67	56		Basic	cm
2b	087	QMG-3	9 août 2017	05:23	68°19,675	102°56,478	51	41		Basic	cb
2b	088	Mooring WF1	9 août 2017	12:09	68°14,557	101°47,704	104	94	salinity	CTD	cm
2b	089	QMG-1	9 août 2017	17:03	68°29,473	099°53,718	38	29		Basic	cg
2b	090	QMG-2	9 août 2017	22:14	68°18,367	100°48,091	92	82	salinity	Basic	cm
2b	091	312	10 août 2017	05:45	69°10,238	100°42,260	63	54		Basic	cb
2b	092	312	10 août 2017	09:22	69°10,136	100°41,837	62	53		Basic	cb
2b	093	BELLOT	11 août 2017	17:03	71°59,568	094°49,136	146	136	salinity	Basic	cg
2b	094	A15	13 août 2017	16:17	69°16,264	080°36,455	53	42	salinity	Nutrients	cg
2b	095	333	13 août 2017	19:14	68°46,033	080°50,375	26	16	salinity	Basic	cg
2b	096	A8	15 août 2017	07:17	65°27,040	083°15,469	99	90	O2	Nutrients	cb
2b	097	A1	16 août 2017	02:20	63°42,409	079°50,470	176	167		Nutrients	cg
2b	098	A2	16 août 2017	04:43	63°37,969	079°15,280	157	147		Nutrients	cb
2b	099	A3	16 août 2017	06:51	63°33,150	078°43,300	258	252		Nutrients	cb
Leg 4b											
4b	001	356	7 octobre 2017	07:46	60°48,359	064°42,410	335	326			SM
4b	002	354	7 octobre 2017	10:17	60°58,078	064°49,211	607	584			SM
4b	003	DFO-1	7 octobre 2017	20:44	60°27,462	061°15,191	541	535			SM

Leg	Name	Position	Affiliation	Network Investigator/Supervisor	Embark place	Embark date	Disembark place	Disembark date
Leg 1	Ahmed, Mohamed	PhD Student	University of Calgary	Else, Brent	Quebec City	25-mai-17	Iqaluit	11-juin-17
Leg 3, Leg 4a	Amidlak, Linda	Interviewer	TBD	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17
Leg 4a	Annanack, Thomas Edward	Interviewer			Kangiqsujuaq	14-sept-17	Kuujjuaq	06-oct-17
Leg 4b	Aubry, Cyril	Research Staff	Université Laval	Fortier, Louis	Kuujjuaq	06-oct-17	Quebec City	12-oct-17
Leg 1	Aubry, Cyril	Research Staff	Université Laval	Fortier, Louis	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 3, Leg 4a	Audet, Élaine	Dental Assistant	TBD	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17
Leg 3, Leg 4a	Audlaluk, Lydia	Interviewer	TBD	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17
Leg 2b	Auger, Vincent	Professional	CSSF	Archambault, P. / Edinger, E.	Iqaluit	13-juil-17	Resolute	05-août-17
Leg 1	Babb, David	Research Staff	University of Manitoba - CEOS	Barber, Dave	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 1	Barbedo de Freitas, Lucas	PhD Student	Institut des Sciences de la Mer - UQ	Bélanger, Simon	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 1	Barber, Dave	Chief Scientist	University of Manitoba - CEOS	Barber, Dave	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 1	Barber, Lucette	Professional	University of Manitoba - CEOS	Barber, Dave	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 3	Baron, Marie Christine	TBD	TBD	TBD	Kuujjuaraapik	19-août-17	Kangiqsujuaq	14-sept-17
Leg 1	Basu, Atreya	PhD Student	University of Manitoba - CEOS	Ehn, Jens	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 1	Bautista, Maria	Postdoctoral Fellow	University of Calgary	Hubert, Casey	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 2a, Leg 2b	Beasley, Christopher John	Technician	Amundsen Science	Forest, Alexandre	Kuujjuaraapik	06-juil-17	Puvirnituq	17-août-17
Leg 2b	Beaupré-Laperrière, Alexis	MSc Student	McGill University	Mucci, Al.	Resolute	05-août-17	Puvirnituq	17-août-17
Leg 3, Leg 4a, Leg	Bélanger, Lucie	Dental Assistant	TBD	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17
Leg 4b	Bernier, Jean-François	Research Staff	Université Laval	Lajeunesse, Patrick	Kuujjuaq	06-oct-17	Quebec City	12-oct-17
Leg 2b	Bernstein, Sarah	Research Staff	University of Toronto	Jantunen, Liisa	Iqaluit	13-juil-17	Puvirnituq	17-août-17
Leg 4b	Blanco-Lalonde, Justine	Personnel on-land		Health Survey	Kuujjuaq	06-oct-17	Quebec City	12-oct-17
Leg 2b	Boivin-Rioux, Aude	MSc Student	ISMER- UQAR	Gosselin, Michel	Iqaluit	13-juil-17	Puvirnituq	17-août-17
Leg 1	Brouard, Etienne	PhD Student	Université Laval	Lajeunesse, Patrick	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 3, Leg 4a	Bruneau, Suzanne	Chief Scientist	TBD	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17
Leg 2a	Bunka, Jordan	Schools on Board partipant	Schools on Board	Watts, Michelle	Kuujjuaraapik	06-juil-17	Iqaluit	13-juil-17
Leg 2a, Leg 2b	Burgers, Tonya	PhD Student	University of Manitoba - CEOS	Papakyriakou, Tim	Kuujjuaraapik	06-juil-17	Puvirnituq	17-août-17
Leg 2a	Butterworth, Brian	Postdoctoral Fellow	University of Calgary	Else, Brent	Kuujjuaraapik	06-juil-17	Iqaluit	13-juil-17
Leg 1	Butterworth, Brian	Postdoctoral Fellow	University of Calgary	Else, Brent	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 2a	Cameron-Bergeron, Kasey	MSc Student	Université Laval	Tremblay, Jean-Éric	Kuujjuaraapik	06-juil-17	Iqaluit	13-juil-17
Leg 1	Cameron-Bergeron, Kasey	MSc Student	Université Laval	Tremblay, Jean-Éric	Quebec City	25-mai-17	Iqaluit	11-juin-17
Leg 1	Campbell, Yanique	MSc Student	University of Manitoba - CEOS	Barber, Dave	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 2b	Caouette, Alexandre	BSc Student	MacEwan University	Furze, M. / Lakeman, T.	Resolute	05-août-17	Puvirnituq	17-août-17
Leg 1	Capelle, David	Postdoctoral Fellow	University of Manitoba - CEOS	Papakyriakou, Tim	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 2a, Leg 2b	Charette, Joannie	Research Staff	ISMER- UQAR	Gosselin, Michel	Kuujjuaraapik	06-juil-17	Puvirnituq	17-août-17
Leg 1	Charette, Joannie	Research Staff	Institut des Sciences de la Mer - UQ	Bélanger, Simon / Mundy C.J.	Quebec City	25-mai-17	Iqaluit	11-juin-17
Leg 2a	Chirkova, Diana	Postdoctoral Fellow	University of Manitoba - CEOS	Stern, Gary / Hubert, Casey	Kuujjuaraapik	06-juil-17	Iqaluit	13-juil-17
Leg 2a	Clark, Rhonda	Research Staff	University of Calgary	Hubert, Casey	Kuujjuaraapik	06-juil-17	Iqaluit	13-juil-17
Leg 2b	Cook, Alison	Postdoctoral Fellow	University of Ottawa/Durham Unive	Copland, Luke	Iqaluit	13-juil-17	Resolute	05-août-17
Leg 2b	Corminboeuf, Anne	MSc Student	Université Laval	Massé, Guillaume	Iqaluit	13-juil-17	Puvirnituq	17-août-17
Leg 3, Leg 4a, Leg	Côté, Suzanne	Coordinator	TBD	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17
Leg 3	Couture, Caroline	Interviewer	TBD	TBD	Puvirnituq	17-août-17	Kangiqsujuaq	14-sept-17
Leg 3, Leg 4a	Daigle, Louis-Frédéric	Interviewer	TBD	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17
Leg 1	Dalman, Laura	MSc Student	University of Manitoba - CEOS	Mundy, C. J.	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 2b	Dalton, Abigail	MSc Student	University of Ottawa	Copland, Luke	Iqaluit	13-juil-17	Resolute	05-août-17
Leg 2a, Leg 2b	Darnis, Gérald	Postdoctoral Fellow	Université Laval	Fortier, Louis	Kuujjuaraapik	06-juil-17	Puvirnituq	17-août-17
Leg 4b	Davin, Sam	PhD Student	Université du Québec à Montréal	Hillaire-Marcel, Claude / Edinger, Evan	Kuujjuaq	06-oct-17	Quebec City	12-oct-17
Leg 2b	de Carufel, Valérie	Undergraduate Student	ISMER- UQAR	Nozais, Christian	Iqaluit	13-juil-17	Puvirnituq	17-août-17
Leg 2b	de Moura Neves, Barbara	Postdoctoral Fellow	Department of Fisheries and Ocean	Gilkinson, Kent	Iqaluit	13-juil-17	Resolute	05-août-17
Leg 2a	Delaigue, Louise	MSc Student	McGill University	Mucci, Al	Kuujjuaraapik	06-juil-17	Iqaluit	13-juil-17
Leg 2a, Leg 4b	Deslongchamps, Gabrièle	Research Staff	Université Laval	Tremblay, Jean-Éric	Kuujjuaraapik	06-juil-17	Iqaluit	13-juil-17
Leg 1	Deslongchamps, Gabrièle	Research Staff	Université Laval	Tremblay, Jean-Éric	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 2a, Leg 2b	Dezutter, Thibaud	Research Staff	Université Laval	Fortier, Louis	Kuujjuaraapik	06-juil-17	Puvirnituq	17-août-17
Leg 2b	Dinn, Curtis	MSc Student	University of Alberta	Leys, Sally	Iqaluit	13-juil-17	Resolute	05-août-17
Leg 3	Dion-Roy, Véronique	Interviewer	TBD	TBD	Puvirnituq	17-août-17	Kangiqsujuaq	14-sept-17
Leg 4b	Doiron, Kim	Research Staff	ISMER- UQAR	Gosselin, Michel	Kuujjuaq	06-oct-17	Quebec City	12-oct-17
Leg 3, Leg 4a	Dorval, Geneviève	Interviewer	TBD	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17
Leg 3	Doutreloux, Véronique		TBD	TBD	Puvirnituq	17-août-17	Kangiqsujuaq	14-sept-17
Leg 4b	Downey, Mark	Research Staff	Memorial University	Zedel, Len / Edinger, Evan	Kuujjuaq	06-oct-17	Quebec City	12-oct-17
Leg 3, Leg 4a	Dufresne, Philippe	Interviewer	TBD	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17
Leg 2b	Edinger, Evan	Researcher/Professor	Memorial University	Edinger, Evan	Iqaluit	13-juil-17	Resolute	05-août-17
Leg 1	Ehn, Jens	Researcher/Professor	University of Manitoba - CEOS	Ehn, Jens	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 2a	Ellefson, Emily	TBD	University of Calgary	Hubert, Casey	Kuujjuaraapik	06-juil-17	Iqaluit	13-juil-17
Leg 2b	Faye, Simon	PhD Student	ISMER- UQAR	Lajeunesse, P. / St-Onge, G. / Rochon, A.	Resolute	05-août-17	Puvirnituq	17-août-17
Leg 1	Firoozy, Nariman	Postdoctoral Fellow	University of Manitoba - CEOS	Barber, Dave	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 3, Leg 4a	Fleming, Audrey	Interviewer	TBD	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17
Leg 3, Leg 4a	Flemming, Jeannie	Interviewer	TBD	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17
Leg 4b	Forest, Alexandre	Chief Scientist	Amundsen Science	Forest, Alexandre	Kuujjuaq	06-oct-17	Quebec City	12-oct-17
Leg 3	Forest-Briand, Victoria-Emma	Interviewer	TBD	TBD	Puvirnituq	17-août-17	Kangiqsujuaq	14-sept-17
Leg 3	Fournier-Noël, Hélène	Dentist	TBD	TBD	Puvirnituq	17-août-17	Kangiqsujuaq	14-sept-17
Leg 2b	Freyria, Nastasia	PhD Student	Université Laval	Lovejoy, Connie	Iqaluit	13-juil-17	Puvirnituq	17-août-17
Leg 2b	Furze, Mark	Researcher/Professor	MacEwan University / Norwegian G	Furze, M. / Lakeman, T.	Resolute	05-août-17	Puvirnituq	17-août-17
Leg 3, Leg 4a, Leg	Gagné, Élisabeth	Nurse	TBD	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17
Leg 4a	Gagnon Beaumont, Marie-Ro	Dentist			Kangiqsujuaq	14-sept-17	Kuujjuaq	06-oct-17
Leg 2a, Leg 2b	Gagnon, Jonathan	Research Staff	Université Laval	Tremblay, Jean-Éric	Kuujjuaraapik	06-juil-17	Puvirnituq	17-août-17
Leg 4a	Gargano, Virginie	Interviewer			Kangiqsujuaq	14-sept-17	Kuujjuaq	06-oct-17
Leg 3, Leg 4a, Leg	Gauthier, Isabelle	Inhalotherapist	TBD	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17

Leg 2a, Leg 4b	Genin, François	MSc Student	ISMER- UQAR	Gosselin, Michel	Kuujjuaraapik	06-juil-17	Iqaluit	13-juil-17
Leg 3	Gingras, Gabrielle	Dentist	TBD	TBD	Puvirnituq	17-août-17	Kangiqsujuaq	14-sept-17
Leg 4b	Gjerdrum, Carina	Research Staff	Environment and Climate Change C	Cote, David	Kuujjuaq	06-oct-17	Quebec City	12-oct-17
Leg 4b	Godin, Catherine	Personnel on-land		Health Survey	Kuujjuaq	06-oct-17	Quebec City	12-oct-17
Leg 2b	Gombault, Colline	Professional	Amundsen Science	Forest, Alexandre	Iqaluit	13-juil-17	Puvirnituq	17-août-17
Leg 3, Leg 4a, Leg	Granghon, Denis	Computer Technician	TBD	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17
Leg 2b	Grant, Cindy	Research Staff	Université Laval	Archambault, Philippe	Iqaluit	13-juil-17	Puvirnituq	17-août-17
Leg 1	Guarin, Gustavo Adolfo	PhD Student	Université Laval	Archambault, Philippe	Quebec City	25-mai-17	Iqaluit	11-juin-17
Leg 2a	Guillot, Pascal	Professional	Amundsen Science	Forest, Alexandre	Kuujjuaraapik	06-juil-17	Iqaluit	13-juil-17
Leg 1	Guillot, Pascal	Professional	Amundsen Science	Forest, Alexandre	Quebec City	25-mai-17	Iqaluit	11-juin-17
Leg 4b	Hamel, Geneviève	Coordinator		Health Survey	Kuujjuaq	06-oct-17	Quebec City	12-oct-17
Leg 4b	Hamel, Jean-François	Research Staff	Memorial University	Mercier, Annie	Kuujjuaq	06-oct-17	Quebec City	12-oct-17
Leg 1	Harasyn, Madison	MSc Student	University of Manitoba - CEOS	Barber, Dave	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 4a	Hardy Morin, Ariane	Dentist			Kangiqsujuaq	14-sept-17	Kuujjuaq	06-oct-17
Leg 4b	Herder, Erin	MSc Student	Memorial University	Cote, David / Edinger, Evan	Kuujjuaq	06-oct-17	Quebec City	12-oct-17
Leg 1	Huyghe, Samantha	MSc Student	University of Manitoba - CEOS	Kuzyk, ZouZou	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 2a	Ikoe, Erik	Schools on Board partipant	Schools on Board	Watts, Michelle	Kuujjuaraapik	06-juil-17	Iqaluit	13-juil-17
Leg 3, Leg 4a	Imak, Sarah	Interviewer	TBD	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17
Leg 2a	Jacquemot, Loïc	PhD Student	Université Laval	Lovejoy, Connie	Kuujjuaraapik	06-juil-17	Iqaluit	13-juil-17
Leg 1	Jacquemot, Loïc	PhD Student	Université Laval	Lovejoy, Connie	Quebec City	25-mai-17	Iqaluit	11-juin-17
Leg 4b	Joyal, Gabriel	Research Staff	Université Laval	Lajeunesse, Patrick	Kuujjuaq	06-oct-17	Quebec City	12-oct-17
Leg 2a	Kadjuk, Anulik	Schools on Board partipant	Schools on Board	Watts, Michelle	Kuujjuaraapik	06-juil-17	Iqaluit	13-juil-17
Leg 2a	Kalenitchenko, Dimitri	Postdoctoral Fellow	Université Laval	Lovejoy, Connie	Kuujjuaraapik	06-juil-17	Iqaluit	13-juil-17
Leg 1	Kalenitchenko, Dimitri	Postdoctoral Fellow	Université Laval	Lovejoy, Connie	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 1	Labbé, Julie-Anne	BSc Student	Université Laval	Lajeunesse, Patrick	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 3, Leg 4a	Labrecque, Judith	Lab Technician	TBD	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17
Leg 3	Laflamme, Léa	Interviewer	TBD	TBD	Puvirnituq	17-août-17	Kangiqsujuaq	14-sept-17
Leg 2b	Lagunas, Jose Luis	Professional	Takuvik	Babin, Marcel	Iqaluit	13-juil-17	Resolute	05-août-17
Leg 3, Leg 4a	Larochelle, Jacinthe	Lab Technician	TBD	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17
Leg 2a, Leg 2b	Leblanc, Mathieu	PhD Student	Université Laval	Fortier, Louis	Kuujjuaraapik	06-juil-17	Puvirnituq	17-août-17
Leg 1	Lee, Janghan	Postdoctoral Fellow	Université Laval	Tremblay, Jean-Éric	Quebec City	25-mai-17	Iqaluit	11-juin-17
Leg 4a	Lejeune, Pierre	Interviewer			Kangiqsujuaq	14-sept-17	Kuujjuaq	06-oct-17
Leg 3, Leg 4a	Lemercier, Catherine	Media/Artist	TBD	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17
Leg 2b	Letaief, Sarah	MSc Student	ISMER- UQAR	Montero-Serrano, J-C.	Resolute	05-août-17	Puvirnituq	17-août-17
Leg 4a	Léveillé, Alexandre	Nurse			Kangiqsujuaq	14-sept-17	Kuujjuaq	06-oct-17
Leg 2b	Li, Alice	Media/Artist	Washington Post		Resolute	05-août-17	Puvirnituq	17-août-17
Leg 2a, Leg 2b	Linkowski, Thomas	Technician	Amundsen Science	Forest, Alexandre	Kuujjuaraapik	06-juil-17	Puvirnituq	17-août-17
Leg 2a, Leg 2b	Lizotte, Martine	Research Staff	Université Laval	Levasseur, Maurice	Kuujjuaraapik	06-juil-17	Puvirnituq	17-août-17
Leg 2b	Lockhart, Peter	Professional	CSSF	Archambault, P. / Edinger, E.	Iqaluit	13-juil-17	Resolute	05-août-17
Leg 2a	Loria, Ainsleigh	Research Staff	University of Manitoba - CEOS	Stern / Fortier / Tremblay	Kuujjuaraapik	06-juil-17	Iqaluit	13-juil-17
Leg 1	Loria, Ainsleigh	Research Staff	University of Manitoba - CEOS	Stern / Fortier / Tremblay	Quebec City	25-mai-17	Iqaluit	11-juin-17
Leg 3, Leg 4a	Lynch, Melody	Interviewer	TBD	TBD	Kuujjuaraapik	19-août-17	Kuujjuaq	06-oct-17
Leg 4a	Lyonnais, Marie-Claude	TBD			Kangiqsujuaq	14-sept-17	Kuujjuaq	06-oct-17
Leg 2a, Leg 2b	Manning, Cara	Postdoctoral Fellow	University of British Columbia	Tortell, Philippe	Kuujjuaraapik	06-juil-17	Puvirnituq	17-août-17
Leg 2b	Marec, Claudie	Professional	LOPS / Takuvik	Babin, Marcel	Iqaluit	13-juil-17	Puvirnituq	17-août-17
Leg 2a	Marteleira, Erika	Professional	Schools on Board	Watts, Michelle	Kuujjuaraapik	06-juil-17	Iqaluit	13-juil-17
Leg 1	Matthes, Lisa	MSc Student	University of Manitoba - CEOS	Mundy, C.J	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 4a, Leg 4b	McKeeman, Laura	Interviewer			Kangiqsujuaq	14-sept-17	Kuujjuaq	06-oct-17
Leg 2b	McNeill, John Patrick	TBD	University of New Brunswick	Lajeunesse, Patrick / Church, Ian	Iqaluit	13-juil-17	Puvirnituq	17-août-17
Leg 2b, Leg 4b	Meredyk, Shawn	Professional	Amundsen Science	Dumont, Dany	Iqaluit	13-juil-17	Puvirnituq	17-août-17
Leg 3	Michaud, Josée	Nurse	TBD	TBD	Puvirnituq	17-août-17	Kangiqsujuaq	14-sept-17
Leg 3, Leg 4a	Moisan, Caroline	Interviewer	TBD	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17
Leg 2b	Montero-Serrano, Jean-Carlo	Researcher/Professor	ISMER- UQAR	Lajeunesse, P. / Montero-Serrano, J-C.	Iqaluit	13-juil-17	Puvirnituq	17-août-17
Leg 2b	Mooney, Chris	Media/Artist	Washington Post		Resolute	05-août-17	Puvirnituq	17-août-17
Leg 4b	Morisset, Simon	Professional	Amundsen Science	Forest, Alexandre	Kuujjuaq	06-oct-17	Quebec City	12-oct-17
Leg 1	Morisset, Simon	Technician	Amundsen Science	Forest, Alexandre	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 1	Munson, Kathleen	Postdoctoral Fellow	University of Manitoba - CEOS	Wang, Fei	Quebec City	25-mai-17	Iqaluit	11-juin-17
Leg 2a	Murphy, Sean	MSc Student	University of Calgary	Hubert, Casey	Kuujjuaraapik	06-juil-17	Iqaluit	13-juil-17
Leg 1	Murphy, Sean	MSc Student	University of Calgary	Hubert, Casey	Quebec City	25-mai-17	Iqaluit	11-juin-17
Leg 4a	Nastapoka, Julie	Interviewer			Kangiqsujuaq	14-sept-17	Kuujjuaq	06-oct-17
Leg 2b	Nelson, Monica	BSc Student	Dalhousie	Thomas, Helmuth	Iqaluit	13-juil-17	Puvirnituq	17-août-17
Leg 2a	Noël, Amy	PhD Student	University of Calgary	Hubert, Casey	Kuujjuaraapik	06-juil-17	Iqaluit	13-juil-17
Leg 1	Noël, Amy	PhD Student	University of Calgary	Hubert, Casey	Quebec City	25-mai-17	Iqaluit	11-juin-17
Leg 2a	Nungaq, Karen	Schools on Board partipant	Schools on Board	Watts, Michelle	Kuujjuaraapik	06-juil-17	Iqaluit	13-juil-17
Leg 3, Leg 4a	Ouellet, Nathalie	Lab Technician	INSPQ	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17
Leg 1	Paetkau, Christopher	TBD	TBD	TBD	Quebec City	25-mai-17	Chesterfield Inlet	11-juin-17
Leg 1	Papakyriakou, Tim	Researcher/Professor	University of Manitoba - CEOS	Papakyriakou, Tim	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 3, Leg 4a	Paradis-Gagnon, Cassiopée	Inhalotherapist	TBD	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17
Leg 1	Peck, Chris	MSc Student	University of Manitoba - CEOS	Kuzyk, ZouZou	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 2b	Peck, Victoria	Researcher/Professor	British Antarctic Survey / University	Tremblay, Jean-Éric / Manno, Clara	Iqaluit	13-juil-17	Puvirnituq	17-août-17
Leg 3	Picard, Julie	Nurse	TBD	TBD	Puvirnituq	17-août-17	Kangiqsujuaq	14-sept-17
Leg 2b	Pienkowski, Anna	Researcher/Professor	MacEwan University / Norwegian G	Furze, M. / Lakeman, T.	Iqaluit	13-juil-17	Puvirnituq	17-août-17
Leg 2a	Pierrejean, Marie	PhD Student	Université Laval	Archambault, Philippe	Kuujjuaraapik	06-juil-17	Iqaluit	13-juil-17
Leg 1	Pierrejean, Marie	PhD Student	Université Laval	Archambault, Philippe	Quebec City	25-mai-17	Iqaluit	11-juin-17
Leg 3, Leg 4a	Poulin, Michel	Nurse	TBD	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17
Leg 2b	Rajewicz, Jill	Research Staff	Carleton University	Mueller, Derek	Iqaluit	13-juil-17	Resolute	05-août-17
Leg 4a, Leg 4b	Ricard, Sylvie	Interviewer			Kangiqsujuaq	14-sept-17	Kuujjuaq	06-oct-17

Leg 1	Ridenour, Natasha	MSc Student	University of Alberta	TBD	Chesterfield Inlet	25-mai-17	Churchill	11-juin-17
Leg 2b	Rioux, Pascal	Research Staff	ISMER- UQAR	Montero-Serrano, J-C.	Resolute	05-août-17	Puvirnituq	17-août-17
Leg 2a	Rochman, Chelsea	Researcher/Professor	University of Toronto	Jantunen, Liisa	Kuujjuaraapik	06-juil-17	Iqaluit	13-juil-17
Leg 2a	Sabean, Ryan	Technician	Amundsen Science	Forest, Alexandre	Kuujjuaraapik	06-juil-17	Iqaluit	13-juil-17
Leg 1	Sabean, Ryan	Technician	Amundsen Science	Forest, Alexandre	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 1	Schembri, Sarah	PhD Student	Université Laval	Fortier, Louis	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 2a	Schreiber, Lars	Research Staff	University of Calgary	Hubert, Casey	Kuujjuaraapik	06-juil-17	Iqaluit	13-juil-17
Leg 4b	Seiden, Jennica	Research Staff	Fisheries and Oceans Canada	Abbott, Melissa / Cote, David	Kuujjuaq	06-oct-17	Quebec City	12-oct-17
Leg 3, Leg 4a	Shipaluk, Lynda	Interviewer	TBD	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17
Leg 1	Singer, James	MSc Student	University of Manitoba - CEOS	Wang, Fei	Quebec City	25-mai-17	Iqaluit	11-juin-17
Leg 2a, Leg 2b	Smith, Alastair	Postdoctoral Fellow	University of Calgary	Hubert, Casey	Kuujjuaraapik	06-juil-17	Resolute	05-août-17
Leg 2b	St-Onge, Joanie	MSc Student	Université Laval	Levasseur, Maurice	Iqaluit	13-juil-17	Puvirnituq	17-août-17
Leg 4b	Sulpis, Olivier	PhD Student	McGill University	Mucci, Al	Kuujjuaq	06-oct-17	Quebec City	12-oct-17
Leg 3, Leg 4b	Tafforeau Muller, Sylvie	TBD	TBD	TBD	Puvirnituq	17-août-17	TBD	TBD
Leg 2b	Thaler, Mary	Professional	Université Laval	Lovejoy, Connie	Iqaluit	13-juil-17	Resolute	05-août-17
Leg 2b	Thaysen, Clara	MSc Student	University of Toronto	Jantunen, Liisa	Resolute	05-août-17	Puvirnituq	17-août-17
Leg 2a	Theriault, Nathalie	Research Staff	University of Manitoba - CEOS	Barber, David	Kuujjuaraapik	06-juil-17	Iqaluit	13-juil-17
Leg 1	Theriault, Nathalie	Research Staff	University of Manitoba - CEOS	Barber, Dave	Quebec City	25-mai-17	Churchill	11-juin-17
Leg 4a	Thibault, Évelyne	Nurse			Kangiqsujuaq	14-sept-17	Kuujjuaq	06-oct-17
Leg 2b	Thiessen, Rabecca	BSc Student	MacEwan University	Furze, M. / Lakeman, T.	Resolute	05-août-17	Puvirnituq	17-août-17
Leg 2a, Leg 2b	Tremblay, Jean-Éric	Chief Scientist	Université Laval	Tremblay, Jean-Éric	Kuujjuaraapik	06-juil-17	Resolute	05-août-17
Leg 4b	Tremblay-Fournier, Camille	Personnel on-land		Health Survey	Kuujjuaq	06-oct-17	Quebec City	12-oct-17
Leg 2a, Leg 2b	Trottier, Annie-Pier	PhD Student	Université Laval	Lajeunesse, Patrick	Kuujjuaraapik	06-juil-17	Puvirnituq	17-août-17
Leg 3, Leg 4a	Tukai, Maina	TBD	TBD	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17
Leg 3, Leg 4a	Tukkiapik Whiteley, Amelia	Interviewer	TBD	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17
Leg 3, Leg 4a	Verna, Stefan	Media/Artist	TBD	TBD	Puvirnituq	17-août-17	Kuujjuaq	06-oct-17
Leg 2b	Wang, Kang	PhD Student	University of Manitoba - CEOS	Wang, Feiyue	Iqaluit	13-juil-17	Puvirnituq	17-août-17
Leg 2a	Watts, Michelle	Professional	Schools on Board	Watts, Michelle	Kuujjuaraapik	06-juil-17	Iqaluit	13-juil-17
Leg 2b	Wohl, Charel	PhD Student	UofCalgary/PML	Else, B. / Yang, M-X.	Iqaluit	13-juil-17	Puvirnituq	17-août-17
Leg 2b	Zindorf, Mark	PhD Student	University of Calgary	Hubert, Casey	Resolute	05-août-17	Puvirnituq	17-août-17