Cruise Report
USCGC Healy HLY2202/AWS2022
Synoptic Arctic Survey Cruise
September 4 – October 24, 2022
Dutch Harbor, AK-North Pole-Dutch Harbor, AK

Carin Ashjian (WHOI), Co-Chief Scientist and
Jackie Grebmeier (UMCES), Co-Chief Scientist

-U.S. Coast Guard photo by Deborah Held Cordone, Auxiliary Public Affairs Specialist 1

Prepared by Carin Ashjian and the HLY2202 Science Team
Contact Information: Carin Ashjian
Woods Hole Oceanographic Institution
Woods Hole, MA 02543
cashjian@whoi.edu

Acknowledgements

The science party gratefully acknowledges the invaluable contributions of *USCGC Healy* Captain Kenneth Boda and Healy officers and crew. The science party acknowledges also the critical assistance and the teamwork of the NSF funded shipboard technician group (Brendon Mendenhall, Emily Shimada, Mason Schettig, and Maxwell Hughes) and of the NSF funded OSU Marine Sediment Sampling Group (MARSSAM) coring technician Michael "T.R." Tepper-Rasmussen. The outstanding efforts also of USCG C5I technicians Sarah Kaye and Brian Nuttall in operating the science network and maintaining our contact with the outside world are greatly appreciated. The NSF funded winch pool provided the HAWBOLT winch used for mooring operations.

This cruise was supported by the National Science Foundation under multiple grants (NSF/OPP-2053098, Ashjian, lead PI, 2052626, 2051642, 2052101, 2053003, 2052513, 2053110, 2053084, 2210615, 2053101, 2237847, among others) with technical support provided through the Ship-based Science Technical Support in the Arctic (STARC) Program (NSF/OPP-2222245, 2037251). The US Fish and Wildlife Service (Anchorage) supported the participation of bird observer M. Reedy. The annual turnover of the Chukchi Ecosystem Observatory moorings was supported by funding to Seth Danielson from the North Pacific Research Board.

-Photo by Lt. Lydia Ames, NOAA

Note: All data and summaries in this report are preliminary unpublished data subject to revision or correction with intellectual property reserved to the scientist contributing to the report. Data will be archived at the NSF Data Center and R2R Repository. Please contact the Chief Scientist (cashjian@whoi.edu) for additional information.

Table of Contents

Overview

The Central Arctic Ocean remains profoundly understudied, particularly with respect to carbon cycling, ecosystem alteration, and associated changes in atmospheric, ice and ocean physics that drive those biological and biogeochemical systems. The region is expected to experience continued marked changes over the coming decades, driven by ongoing climate warming. Yet, because of relatively limited understanding of fundamental characteristics and processes in the region, predicting these changes and their Pan-Arctic linkages remains difficult. The SAS is organized around three major research areas: (1) physical drivers of importance to the ecosystem and carbon cycle; (2) the ecosystem response and (3) the carbon cycle. The overarching questions are: ***"What is the present state, and what are the major ongoing transformations of the Arctic marine system?"*** The overall objective of this expedition was to quantify the present states of the physical, biological, and biogeochemical systems of the Pacific Arctic (here defined as the Chukchi Sea, Beaufort shelf/slope, Chukchi Borderlands) and Canadian Basin (i.e., the Makarov and Canada basins) during summer 2022. A key goal is to document temporal changes where possible by comparison with historical data and to quantify linkages among adjacent shelves, slopes, and deep basins on a Pan-Arctic scale. These objectives are part of the International Synoptic Arctic Survey (SAS; 2021-2022) that seeks Pan-Arctic understanding of core ocean variables on a quasi-synoptic, spatially distributed basis using coordinated, international efforts. The findings of this expedition, a US contribution to the SAS, will be a foundation and legacy for future, quasi-decadal assessments of rapid and evolving Arctic Ocean system change.

Research areas covered by the US SAS PIs covered (in brief) physical oceanography (hydrography, current), atmospheric drivers, mesozooplankton and macrobenthic distributions and ecology, water column and sediment chlorophyll, water column nutrients, water column $\delta^{18}O$, seawater carbonate chemistry, dissolved gas tracers, rates of water column photosynthesis, respiration and net community production, and water column particulate carbon and nitrogen content (Table 1). Additional projects that were able to join the effort focused on air and seawater methane content (C. Magen), marine mammal distributions (S. Moore), seabird distributions (E. Labunski and M. Reedy), seawater optical properties (K. Frey), meiobenthos (J. Silberberg), macrobenthos and sediment bacteria (C. Goethel), and near-surface POM, RNA/DNA, and eDNA (A. Martiny). Over the side sampling included CTD/Niskins, plankton nets (Bongo, Multinet, ring net), optical package, large volume pumps, benthic grabs and corers (Van Veen, MultiHaps, Multicorer), and Video Plankton Recorder. Instrumentation also was deployed in the underway science seawater system.

The science team comprised 34 people, including four STARC technicians, 2 USCG network technicians, one coring technician, six SAS PIs (Bates, Pilskaln, and Timmermans were unable to join in person), three added PIs, eight science technicians, seven graduate students, one undergraduate student, one postdoctoral investigator, and one photographer. The USGC crew included a National Ice Center ice observer and a NOAA lieutenant.

The cruise was conducted from September 4 – October 26, 2022 on the *USCG Healy,* originating and terminating in Dutch Harbor, AK. The cruise track (Figure 1) and effort focused on four major phases:

1) The annual turnaround of the Chukchi Ecosystem Observatory (3 moorings in the NE Chukchi Sea)
2) A survey along the East Hanna Shoal (EHS) transect that runs from ~40 m on the Chukchi Shelf to the north across the Chukchi shelf-break and slope into the basin and that was originally sampled in 2002-2004 as part of the Shelf Basin Interactions Program, thus providing data for comparison with which to detect change
3) Sampling along two routes extending from the Chukchi Sea to the North Pole that had been sampled during the 1994 Arctic Ocean Section (western route only) and the 2015 GEOTRACES cruises
4) A high-resolution survey across small canyons or depressions in the shelf to the NW of Hanna Shoal that are thought to be conduits for water flowing through the Central Channel of the Chukchi Sea to the basin and for water exiting the shelf after flowing through Herald Valley to the west

Table 1. SAS PIs and Scientific Contributions/Areas of Research

PI	**Areas of Research**
Ashjian	Mesozooplankton distributions and composition from nets, mesozooplankton distributions from VPR, Co-Chief Scientist
Bates	Seawater carbonate chemistry, underway measurements and air-sea CO_2 gas exchange, and net community production (using DIC)
Campbell	Mesozooplankton respiration, reproductive activity, condition, trophic (stable isotopes) and population structures, and genetics
Cooper	Water column and sediment chlorophyll content, nutrients, oxygen (stable and clumped isotopes), and DOC; sediment TOC and C/N.
Danielson	Underway CTD (UCTD), meteorological data, weather, satellite data (ice, SST, ocean color, winds), real time data visualization
Grebmeier	Macrobenthic composition, abundance, biomass; benthic respiration, nutrient and carbon flux, sediment characterization**;** Co-Chief Scientist
Juranek	Dissolved gas tracers (O_2, O_2 /Ar, $^{17}\Delta$) to track rates of photosynthesis, respiration, net community production, and deoxygenation
Pilskaln	Water column POC, PON, δ^{13}POC, δ^{15}PON, PIC & microscopic analysis of large volume-filtered suspended & sinking particles; particle size distribution and flux estimates from VPR
Timmermans	Hydrography with lowered CTD and underway science seawater system; ADCP velocities; real time data visualizations

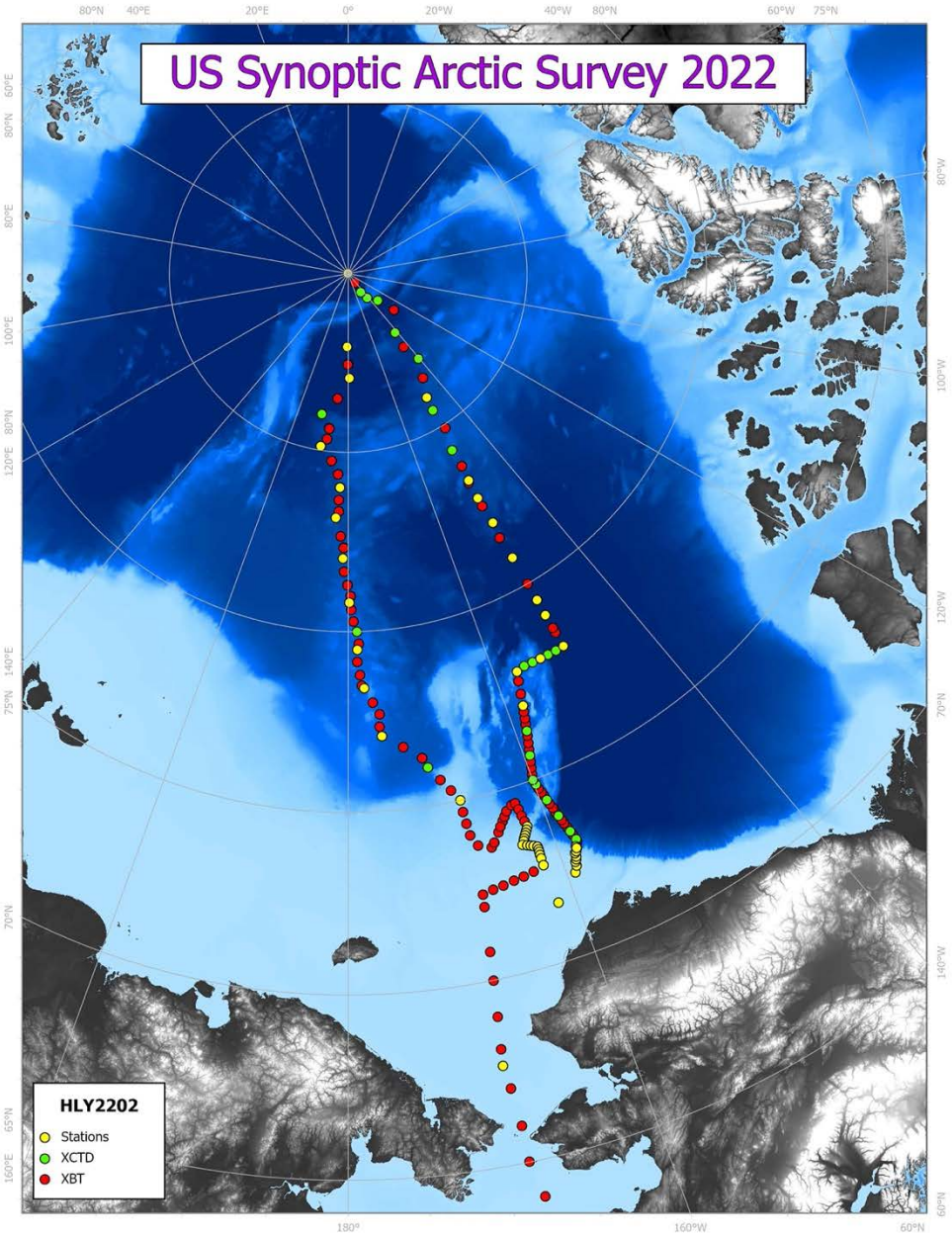


Figure 1. Locations of occupied stations (yellow) and of XCTD (green) and XBT (red) deployments from the northern Bering Sea to the North Pole (Map by Brendon Mendenhall)

Cruise Synopsis

The cruise was designed to operate under two sampling strategies: 1) 24-hour sampling during the work on the EHS line and the high-resolution survey and 2) a long-station beginning at 0730 every other day with usually one short station on the intervening day. This alternating strategy was followed to allow the ship to progress the north during the time between the long stations. Long stations could take 18+ hours so if conducted every day, there would have been only 6 hours of transit time daily and

progress along track would have been minimal. Specific latitudes along the N-S transect lines were targeted; occasionally progress by the ship would have overshot those latitudes in the interval between long stations so the bridge crew was directed to set up for the station and wait until 0730 (only a couple of hours). The goal was to conduct stations at somewhat even intervals along the lines. See Table 2 for daily activities.

Phases 1 & 2: The initial period of the cruise was devoted to transit from Dutch Harbor to the initial operation area in the northern Chukchi Sea and some USCG activities (helicopter operations, NOAA glider recovery) in the vicinity of Kotzebue Sound. Science activities were scheduled to start on Sept. 10; however, because additional personnel and a replacement instrument needed to be picked up in Utqiaġvik, AK, science activities started early with the turnaround of the CEO mooring and the southernmost station in the EHS transect. After diverting to Utqiaġik on Sept. 11, work continued along the EHS line, working 24 hours/day. The EHS line lay squarely in a persistent region of very high winds that severely impacted over-the-side activities. The CTD was lost when the propellor cut the wire at station EHS7/Stn 9 during high winds that blew the ship broadside to the waves. The weather forecast showed that high winds would persist in the region for a number of days so the decision was made to head north to the Northwind Ridge and out of the zone of high winds.

Phase 3: XCTDs and XBTs were conducted as the ship transited to the north (Figure 1). The STARC team assembled the backup CTD/sensor/Niskin systems on the backup rosette during the transit. A test deployment of the backup system was conducted on the Northwind Ridge; after the successful test, sampling resumed with station 10. Sampling proceeded northward towards the Pole from Sept. 15-30. Ice was notably heavy north of 86°N and, coupled with high winds, sampling was not possible in that band. After station 20, the ship transited north towards the Pole. Numerous leads and somewhat thin ice often hastened progress. The ship arrived at the North Pole on Sept. 30. A science station (21) was conducted over 2 days and an ice liberty was held on Oct. 2. During ice liberty, an Ice Ball buoy and the wooden "Float your Boats" were deployed. The ship transited south along the western route. Similarly to the northern transit, thick ice between 86 and 88 °N hampered progress and bad weather precluded conducting a station at 86°N. As the ship neared the southern end of the route, a location on the Chukchi Borderlands was selected as the final station on the transect because it was at the location of a moored acoustic recorder that had detected bowhead whale calls in previous years.

Phase 4: Following the work at the Borderlands, the ship transited doing a marine mammal/seabird survey until the start of the high-resolution survey across two advective pathways northwest of Hanna Shoal. The survey was conducted efficiently and safely; 16 stations (7-8 long, the remainder CTD only) were conducted over three days. Following the end survey, a station on the EHS Line (EHS6) was re-occupied. The weather forecast was for high winds to develop but luckily the sampling activities could be accomplished before wind speeds precluded safe work. The ship then turned to the west to survey for marine mammals and seabirds southward along the international boundary line. A final station (Stn. 50) was conducted at DBO3.8; the westernmost station along DBO line 3 that was within US waters. The plan was to transit through Bering Strait during daylight

hours and go south to Dutch Harbor along a route that lay to the west of Saint Lawrence Island, recovering a moored sediment trap on the way. However, a major storm was forecast for the Bering Sea so that plan was abandoned and the Healy transited south on the eastern "highway" at highest possible speed (19+ knots), reaching Dutch Harbor on Monday, October 24 (three days early).

Dutch Harbor: The science party stayed on board until Healy departed on Thursday October 27. All science gear was packed and stowed in the cargo hold (or helicopter hanger) by Wednesday October 26. The storm materialized on Tuesday-Wednesday, with sustained high winds and intermittent gusts as high as 60 knots. The ship was blown away from the dock by the gusts repeatedly during the Wednesday morning, requiring vigilance and re-adjustments of mooring lines by the Deck crew and assistance from a tug. A second major storm was forecast for Friday October 28. Rather than remain at the dock during these high winds, Healy departed prior to the storm. The successive days of storms and cancelled flights created a backlog of travelers trying to fly out of Dutch. At the request of the chief scientists, the NSF provided a chartered flight (arranged by Batelle) to assist in the science party leaving Dutch Harbor.

The cruise was very successful. Fifty-one stations (#s 0-50) were conducted both at the broad-scale (Phase 3) and at high-resolution (Phases 2 and 4). Given the time required for the long stations, this was almost as many stations as could fit into the available time, since time was required to transit as well as to sample. Multiple different types of gear were deployed (Table 3). A typical long station sequence would include a CTD cast, optics cast, VPR cast, Bongo tow, Multinet tow, 4-hour pump deployment, and Multicorer (or multiple Van Veen Grabs and Multicorer when at depths shallower than 200 m). The Healy was an excellent platform and her crew provided outstanding support. The deck crew was particularly helpful and together with the scientists conducted deployments efficiently and safely. The high-resolution survey conducted at the end of the cruise (Phase 4) was an excellent demonstration of how the crew and science party worked together as a team.

The weather had a substantial influence on the cruise activities. The persistent east winds experienced at the start of the cruise (EHS Line) contributed to the loss of the CTD at the 1000-m depth station and resulted in abandoning sampling along the remainder of the line. High winds coupled with heavy ice at around 86°N on both the northward and southward transits to/from the Pole resulted in there being some latitudes with no station (but note, XBTs and XCTDs insured an outstanding hydrographic record). The Bering Sea storms modified the ending strategy of the cruise. These modifications were unavoidable and "the price of doing business" in the Arctic Ocean and Bering Sea during the fall.

Table 2. Synopsis of Daily Activities

Date	Event	Date	Event
4-Sep-22	Left Dutch Harbor	30-Sep-22	Transit; North Pole; Stn 21
5-Sep-22	Transit - Bering Sea	1-Oct-22	Stn 21 cont.; North Pole
6-Sep-22	Transit - Bering Sea/Strait	2-Oct-22	Ice liberty North Pole; transit
7-Sep-22	Helo OPS, Kotzebue Sound. NOAA glider recovery	3-Oct-22	Transit; XBT/XCTD
8-Sep-22	Transit; CEO Mooring recoveries	4-Oct-22	Stn 22 at ~88°N
9-Sep-22	CEO Mooring Deployments; Stn 0	5-Oct-22	Short Stn 23 at 87°N
10-Sep-22	Transit, Stn 1 at EHS1; Transit	6-Oct-22	Transit, bad weather
11-Sep-22	Pick up 2 personnel and instrument at Utqiaġvik	7-Oct-22	Short Stn 24; bad weather
12-Sep-22	Stn 2 (EHS2) - Stn 5 (EHS4)	8-Oct-22	Stn 25 at 84°N
13-Sep-22	Stn 6 (EHS5) - Stn 8 (EHS6)	9-Oct-22	Short Stn 26 at ~83°N
14-Sep-22	Stn 9 (EHS 7) - CTD lost, stn aborted; Transit N doing XBTs and XCTDs	10-Oct-22	Stn 27
15-Sep-22	Continue Transit; Stn 10 - Northwind Ridge	11-Oct-22	Short Stn. 28 at ~80.8°N
16-Sep-22	Stn 11-12; Northwind Ridge	12-Oct-22	Stn 29 at ~79°N
17-Sep-22	Stn 13; Canada Basin on 150°W	13-Oct-22	Short Stn 30 at 78.4°N: Polar Bear/ Black Guillemot
18-Sep-22	Stn 14-15; Start of Ice	14-Oct-22	Stn 31 at ~77°N
19-Sep-22	Stn 16; in ice	15-Oct-22	Left ice; Stn 32; Borderlands
20-Sep-22	9/16" wire re-spooling; Transit	16-Oct-22	Marine Mammal/Seabird Survey; Borderlands
21-Sep-22	Stn 17; 82°N	17-Oct-22	Stn 33-35; Short Term Survey
22-Sep-22	Stn 18 (short); 82.75°N	18-Oct-22	Stn 36-41; Short Term Survey
23-Sep-22	Stn 19; 83.3°N	19-Oct-22	Stn 42-48;, Short Term Survey
24-Sep-22	Bad weather; Transit	20-Oct-22	Stn 49; EHS6
25-Sep-22	Bad weather; Transit	21-Oct-22	Transit/Mammal and Seabird Survey
26-Sep-22	Stn 20	22-Oct-22	Transit; Stn 50; DBO3.8
27-Sep-22	Transit	23-Oct-22	Transit
28-Sep-22	Transit	24-Oct-22	Transit
29-Sep-22	Transit	25-Oct-22	Transit; Arrive Dutch Harbor

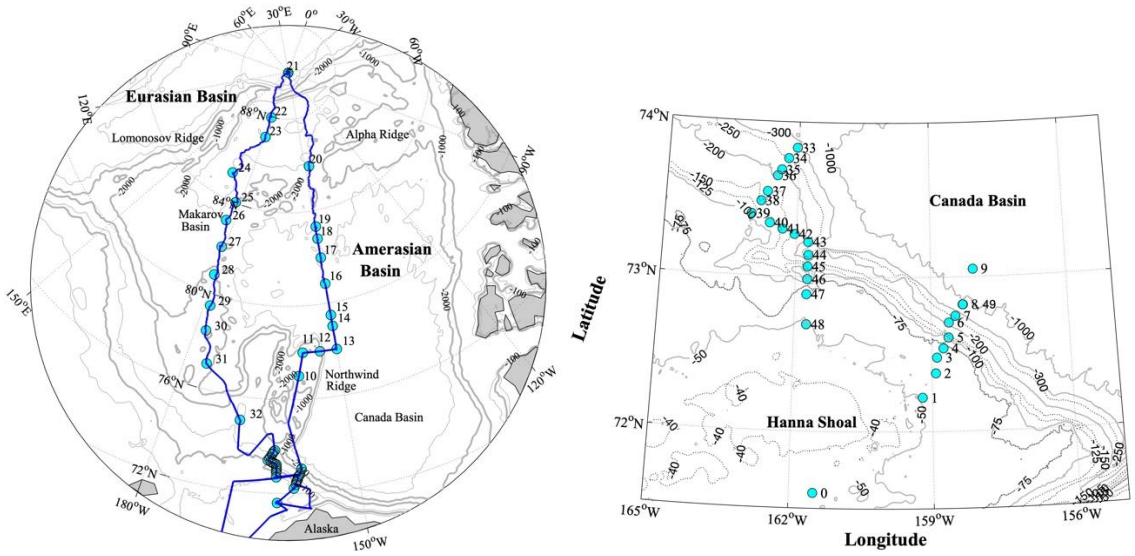


Figure 2. Station locations with station numbers. (Left) Northern Chukchi Sea to the North Pole. The blue line shows the track of the ship. (Right) Chukchi Sea shelf break and slope, Hanna Shoal, and Canada Basin.

Table. 3. Summary numbers of different types of sampling activities.

Instrument/Gear	# of Deployments
CTD Casts	54
XBT Launches	122*
XCTD Launches	24
Bongo Net Tows	32
Multinet Tows	16
Ring Net Tows	2
MultiHAPS Corers	21
Van Veen Grabs	53
Multicorers	20
Pumps	16
Optics Package Casts	37
Video Plankton Recorder Casts	34
Mooring Recoveries	3
Mooring Deployments	3
Drifter (Ice Ball) Deployments	2

*No useable data from 14 sondes

Sea Ice – Overview Observations

Sea ice was first encountered on September 18 (Day 15) (Figure 3). The transition from no ice to almost complete ice cover was very abrupt (a similar transition was seen on the transit south when the ship left the ice on October 15). Ice cover was variable. Bridge observations show ice cover ranging from ~6/10 to 10/10. Much of the open ice area was composed of leads. It was surprising how many leads were present, even approaching the North Pole.

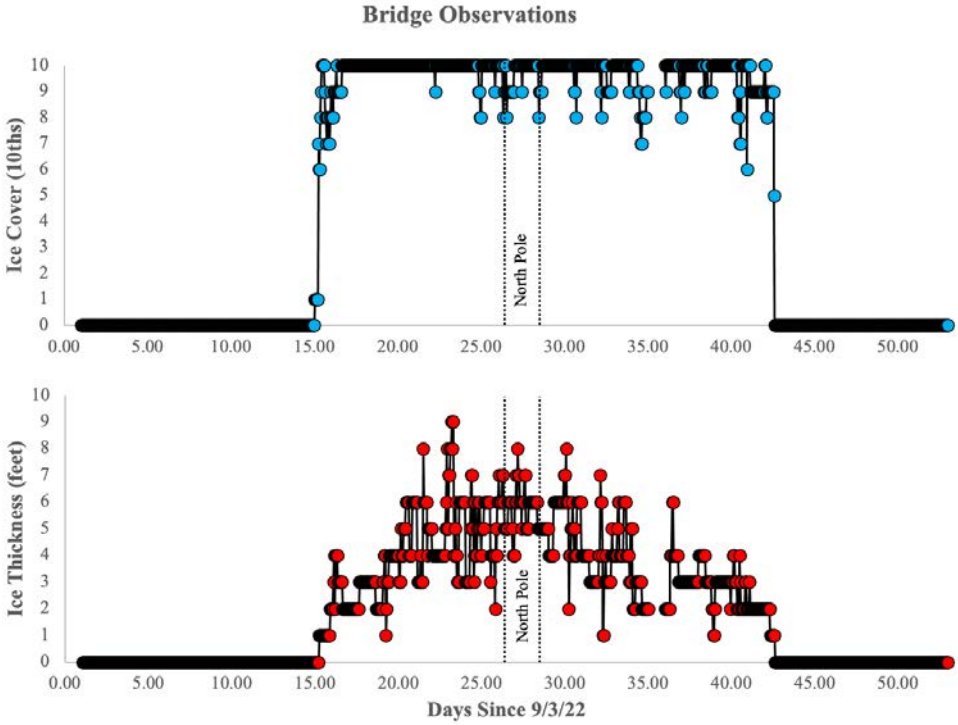


Figure 3. Sea ice cover (upper) and thickness (lower) from the Healy bridge logs. Data recorded every hour. Day 1 = Sept. 4.

Figure 4. Sea ice 15 nm from the North Pole (left) and at ~87°N on Oct. 5 (right). Both images from aloft con cameras.

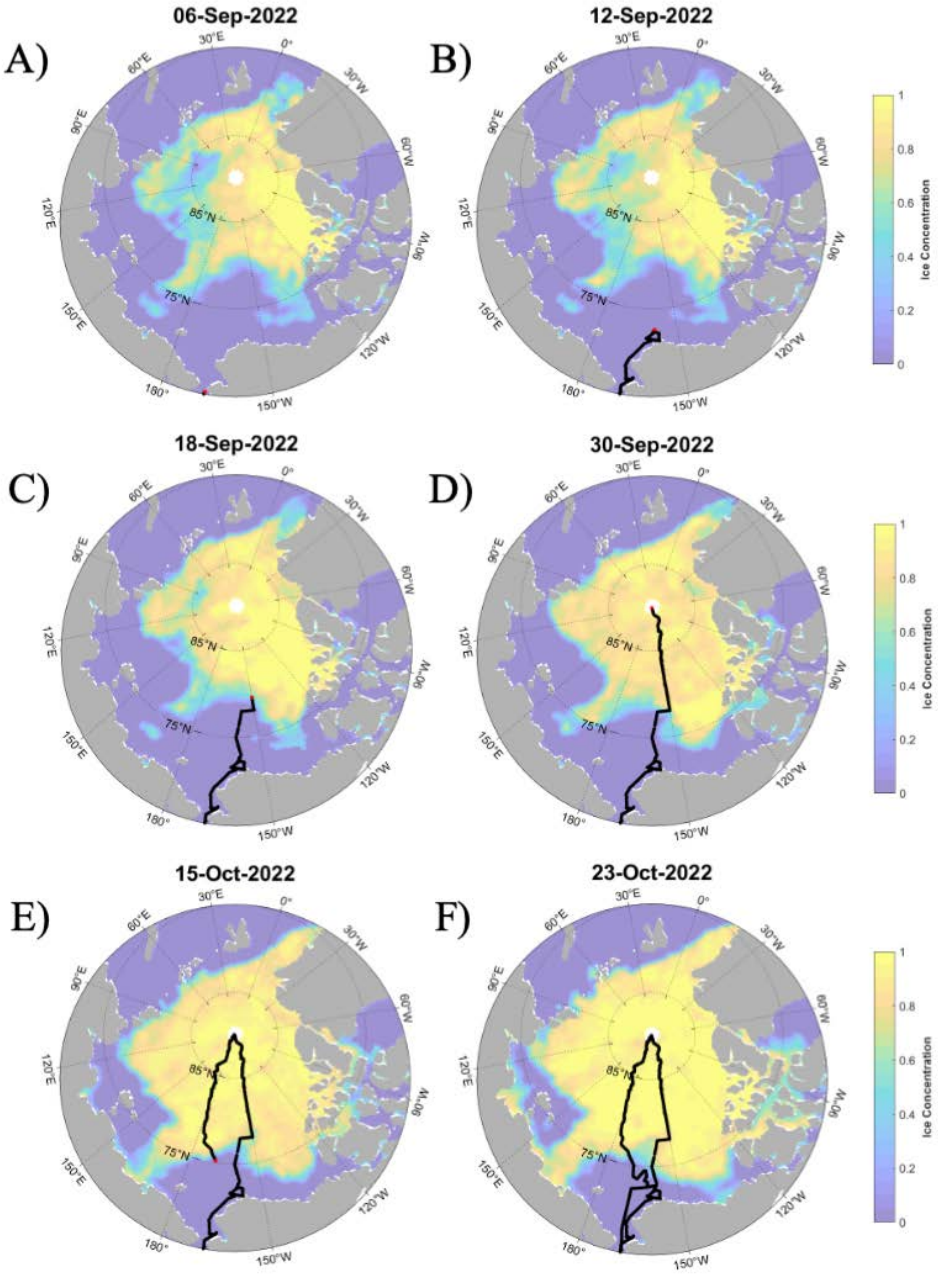


Figure 5. MSRE satellite imagery showing sea ice concentration (tenths) for selected dates of the cruise. The complete record is reported in the physical oceanography section.

A large portion of the southern Beaufort Sea, Northwind Ridge, and Chukchi Cap was ice free at the start of the cruise. The ship encountered the heaviest ice at about 85-86°N on the northern transect. After that, multiple leads facilitated progress both north and south on the return transect (Figure 6). Ice cover expanded to the south, particularly

during October, so that the ship exited the ice on Oct 15 in the Borderlands Region. The Chukchi Sea was ice free at all times during the cruise.

Figure 6. Images showing thin sea ice and leads, some expansive, encountered at different dates/latitudes.

Challenges

No cruise is without challenges. For this cruise, the challenges primarily stemmed from environmental conditions such as weather and air temperature. During the first week of the cruise, when working in the northern Chukchi and over the Chukchi Sea shelf break, winds were strong and persistent from the east over multiple days. Strong winds also created problems when operating in the heavy ice as it was very difficult to impossible to maintain an opening in the ice through which to deploy gear, particularly the pumps (4-hour pumping period) and the instruments that sample all the way to the sea floor (CTD, Multicore). As noted above, severe weather in the Bering Sea at the end of the cruise precluded the last planned sampling activities in the Northern Bering Sea. Difficulties also were encountered using the winches. Specific challenges included:

- Sept. 12: The brake for the 9/16” winch failed to release. The engineers were able to fix the problem.
- Sept. 13: CTD wire caught on a bolt during deployment and kinked; termination required.

- Sept. 14: The wire for the CTD was cut by the starboard screw when the ship lost heading in heavy winds and seas at station; the CTD was lost at ~840 m bottom depth. The STARC team immediately started assembling the backup CTD.
- The pressure sensor for the backup CTD was not correct.
- Cold temperatures threatened to freeze sensors on the CTD so a blanket was used during deployment and recovery to cover the sensors.
- Sept. 20: The wire on the 9/16" winch was not wrapping smoothly. During a deployment of the wire to 4000 m with a weight on the end of the wire, a piece of ice caught the wire, dragging it away from the ship. It was impossible to retrieve the weight because it could not be coaxed through the ice under which it was caught. It was noted that the wraps on the drum were not wrapped smoothly much deeper in the layers than could possibly be spooled out in 4000 m. Work scheduled for the 9/16" winch was moved to the 0.68" wire/winch. It was noted then that the 0.68" wire would impact the corner of the mount of one of the cameras mounted on the underside of the helo deck. This problem was mitigated by cutting off the edge of the mount so that the wire no longer would reach it.
- Any hoses left on the deck not running would freeze. Some of the pipes feeding auxiliary seawater, science seawater, and freshwater to the deck were external to the house and susceptible to freezing. Hose/pipe freezing was mitigated by a) making sure water was running through hoses at all times that they were on deck, b) turning off water feeds inside the house and draining hoses and external pipes when not being used, and c) bringing hoses inside the house for storage when not being used. The over-the-side discharge for the science seawater system occasionally also froze.
- The science seawater piping occasionally filled with sea ice slush, blocking flow. Fortunately, this did not happen too often.
- Water pressure in the ambient seawater hose on the stern was insufficient to wash the nets and could not be increased because pressure would then be too high for the science seawater system sensor suite
- Connectivity to the VSAT satellite was lost at ~80°N because satellite coverage did not extend that far north. Communication was then accomplished using an Iridium satellite service. All personnel (USCG and science) used the same link. Messages were limited in size and access to external websites (and email servers) was possible only under special circumstances. Transfer of ice and weather imagery continued using the Iridium system.
- The shipboard AutoSals didn't remain stable enough to run salinity samples on board. The instruments were located in the biochem lab and the air and sample temperatures could not be kept consistent enough to achieve the needed stability. After considerable effort and testing, it was decided to bring samples back to shore to run them there after the cruise.

Cruise Narrative

Written from the Chief Scientist's perspective.

September 2

The science party arrived at Healy at 0900 to start setting up for the cruise. Although progress was slow at times, much of the gear was brought up from the hold and unpacked in the labs. The science party returned to the hotel by 1700.

September 3

Science party arrived at around 0900 with luggage to move aboard. At 0930, crane operations commenced to move the Multicorer, mooring tripod, VPR, and Multinet from the helo deck to the main deck and to move equipment brought up from the hold from the starboard A-Frame area to the aft deck since the cradle for the AMOS buoy precluded moving gear by pallet. Lab and deck setup continued all afternoon. By evening, the labs were in excellent shape with most gear tied down.

September 4

All hands aboard by 1000.

We cast off the lines at ~ 1400 under partly sunny skies. The transit out of Dutch Harbor was notable in the sighting of many humpback whales and birds, fin whales, and orcas. After setting sail, an abandon ship drill was held. The schedule for the first week of the cruise started shaping up. The ship is headed to Kotzebue to conduct helicopter ops on Wednesday morning, September 7. Then a wayward glider (Occulus, NOAA) will be collected. Drills will be taking place at multiple ties during the week. Friday is being held open. The BOSUN plans to meet with the mooring group and the pump group to discuss deck operations. The goal is to arrive at the CEO mooring site on Saturday September 10.

September 5

The day dawned foggy with low seas. We continued to proceed to the north, usually at 15 knots. There was testing of the cycloconverters during the day during which time the ship varied speed. BOSN met with the Danielson mooring group and the Pilskaln/Drysdale pump group to discuss procedures for their operations. The Oscar Dyson passed by us, heading south, in the morning. In late afternoon/early evening we passed by Nunivak Island, making a turn to head to the eastern end of St. Lawrence Island. Various preparations in labs continued.

September 6

During the night we reached the latitude of Saint Lawrence Island. We continued to the north during the day, pausing in the region of King Island to conduct training for ship maneuvering for a man overboard. At ~1900 we resumed our transit to the north, crossing through Bering Strait at ~2000. We will continue towards Kotzebue Sound where we will conduct flight operations at 0820 for helicopter training and transfer two GE contractors who had been working on the cycloconverters to shore. The Danielson group continued preparing the moorings to be deployed on Sept. 10 at the CEO.

September 7

We arrived just off of Kotzebue Sound sometime during the night. Helo ops commenced at 820 and lasted until ~1200. Multiple types of operations were conducted, including the very cool in-flight fuel transfer. The two engineers from GE who had been aboard to trouble shoot the cyclos transferred off during the last flight. We then proceeded to the west to recover NOAA's OCULUS glider. The glider was recovered at ~1530. Next stop is Utqiaġvik to pick up a couple of CG personnel. That is scheduled for tomorrow evening.

September 8

A bit foggy to start then sunny, with low seas. Passing Ledyard Bay in the morning en route to Utqiaġvik. In early afternoon, we noted that the Alaska Airlines plane that was to take the two CG personnel to Utqiaġvik had been cancelled. Because the weather forecast was for increasing winds and seas, we re-routed to the CEO mooring site to recover moorings while the seas were lower and more favorable for small boat work. We commenced work with a brief on the bridge at 1800. All three moorings were successfully recovered by ~2030. The plan is to remain in this area to deploy three moorings and conduct additional sampling as part of Station 0. Sampling will include CTD/optics, ring net, van veen grabs (5), and multiHAPS (3).

September 9

A page at 1246 AM alerted the ship to northern lights off the bow. The morning dawned cloudy but soon turned into a clear, beautiful day albeit windy (winds 20+ kts). Science brief on the bridge at 0800 to review mooring deployments (3), CTD, and optics sampling. The mooring deployments took the entire morning but were all successful. The science team joined quarters/muster at 1215 in the helo hanger. At 1230, the second science brief reviewed the ring net sampling and the benthic (Van Veen grabs, mHaps core) sampling. Sampling commenced shortly thereafter. There were a few hiccups and slow starts because this was the first time many had conducted these operations. However, a successful ring net tow was conducted on the second try (the w/o readout wasn't working on the first). Five Van Veen grabs were next done. The mHaps sampling took quite a bit longer and were finally finished around 8 PM. The winds had continued throughout the day and the seas were building. In addition, it was difficult for the ship to hold position since the winds were sufficiently high to really blow her around.

While the sampling was taking place, Laurie Juranek and Seth Danielson identified a means to get a borrowed titrator from Fairbanks to Utqiaġvik in time to be picked up on Sunday (along with two additional personnel for the ship). If all goes well, the titrator will arrive in Utqiaġvik on Saturday as checked baggage for Jennifer Danielson (who will immediately fly back to Anchorage/Fairbanks). UIC Science will collect the titrator and transfer it to the personnel staying at the Top of the World Hotel who will bring it to the small boat for transfer to Healy.

Because the weather forecast remains very windy until Sunday, precluding small boat operations at Utqiaġvik, it was decided to transit to the west to the EHS line and conduct Station 1 at EHS1 on Saturday afternoon, leaving Saturday morning as holiday routine. After the sampling is concluded, we will transit back to Utqiaġvik to hopefully pick up the personnel and instrument (if all goes well, knock on wood).

September 10

Arrived at EHS1 during the night and are hanging waiting for the start of science ops after noon. Weather cloudy and foggy. Winds remain in the 20s, although the seas were lower than yesterday. Started Station #1 at EHS1 at around noon. This was the first deployment of the VPR and of the Bongo nets. Things went well. We are all beginning to get used to working with each other. The deck crew is very helpful. The optics cast again took a bit of time and we will have to be careful with it when the weather is windy, such as today. The mHAPS was again problematic although enough cores were obtained after an extra cast or two. The station was completed by around 1715. The ship then departed to sail to the CEO site again so that Seth Danielson and Peter Shipton could talk with their moorings. After that, the ship will sail to Utqiaġvik to hopefully pick up the two additional personnel as well as the oxygen titrator from UAF (which made it to Utqiaġvik) tomorrow morning. A small number of CG personnel have been isolated due to testing positive for COVID-19. Science party advised to start wearing masks and the CG has distributed a lot of hand sanitizer, especially for use after using the ladders and handrails.

September 11

We arrived 3 miles off of Utqiaġvik before 8 AM. Weather was somewhat foggy and cloudy. Winds from the east in the 20s but the waves and swell on the Chukchi Side were quite low. The small boat was launched just after 8 and went in to near NAPA in Browerville. No boat ramp but the boat beached and picked up two passengers and the 44# black pelican case containing the O_2 titrator. All were back on board shortly after 9 and we departed to the EHS line. A number of people enjoyed the brief hours of cell phone access. In early afternoon, we sailed past the *R/V Mirai* that was working near the mouth of Barrow Canyon. Bowheads were observed feeding in Barrow Canyon. This afternoon, the first ukulele lessons were held in the Science Conference Room. After dinner, there was Sunday Sundae in the mess deck. Science meeting held at 1945 in the SCR to review the next few days of activities. Weather forecast is for 20-25 knot winds from the east for the week, with a potential gale on Wednesday.

September 12

Morning dawned gray with 20-25 knot winds. Seas weren't too bad, but they did build during the day. We started at station EHS2 / Station 2 right after the science brief at 0800. The first three stations were CTD/Optics and VPR only. At these stations, we started trying to figure out how to deploy the optics at the same time as the CTD. The BOSUN decided we should wait until the CTD is at 15 m on the upcast and then deploy the optics package so as to minimize the chances of tangling it and also to put the optics package in the water during the upcast of the CTD. The first three stations (2-4) went along rather quickly and we arrived at station 5 at 1230, the CTD went into the water at 1245. Things seemed to be going along well. First Multinet took a little while but that was expected. VPR and Bongos went well. Then we started the benthic work which for some reason was just plagued with delays. Between repositioning and winch faults, everything was taking longer than expected. At about 1840, white smoke was detected in the winch room and the general alarm soon was sounded. All science reported to their muster station (SCR) and were accounted for. There also was a smell of brakes in the main lab, coming from the winch room. After some time, the situation was secured and personnel were released from their muster stations. There was about 105 m of wire out with the mHAPS core on the end. From the tension, it was clear that the mHAPS is hitting the bottom as the ship jogs in place.

Personnel were working on identifying the problem and repairing the winch so as to be able to recover the mHAPS core. The problem was the brake on the 9/16" winch; it is actuated by air and it wasn't releasing. To recover the mHAPS, the brake was switched to something else and implemented by Clive working from his laptop. The mHAPS was recovered around 9 PM. MST2 Makenzi Austin did a great job driving the winch and a-frame. Turns out there were two intact cores in the mHAPS! TR is analyzing the camera footage to see what was going. It isn't clear if the 9/16" winch can be repaired so we may need to switch to a different deployment strategy. The pumps can go on either the 0.322 or the 0.68 wires. Science was suspended until tomorrow. Engineers will work on the winches. Principals will meet at 0800 in the Captains Cabin to discuss a plan.

September 13

Another windy day (25-30 kt) with seas building. The engineers were repaired the 9/16" winch overnight. Prior to using it, the winch brake system was tested using weights on the back deck. The winch operated well enough to use. Station 6 (at EHS5) was started mid-day (1200). Unfortunately, the CTD wire caught on a bolt on the rosette during deployment, kinking the wire. While the CTD was being re-terminated, the remainder of the events at Station 6 were conducted. Because of the heave of the ship, deployment of the Multinet was cancelled. Also, optical casts were cancelled because of the bad weather. The VPR, Bongo Nets, Van Veen Grabs, and multi-HAPS corer all were deployed. These events took about 4 hours, during which time the CTD was re-terminated so Station 6 was concluded with the CTD cast. At station 7 (EHS6), a short station (CTD and VPR only) the VPR was deployed first to minimize the need to re-arrange wires below decks. Seas were quite rough and the ship had trouble maintaining heading into the wind during this cast; the VPR tapped the fantail on recovery. In a likely unrelated incident, the VPR data cartridge USB gave an error message during download but still downloaded successfully. It was decided to not use the VPR until consultation with SeaScan in Falmouth. Because of the weather, the planned deployment of the pumps at the upcoming station 9 was cancelled. Station 8 started with a CTD followed by a Bongo net tow and multi-HAPS deployments. Again, it was difficult to keep the ship heading into the wind but the last two HAPS deployments went beautifully.

September 14

Station 8 finished up just after midnight and the ship transited to Station 9. During the CTD cast, while the CTD was at ~0840 m depth, the ship caught the wind and turned sideways so that she was lying in the trough. The CTD wire was all over the place and the ship was unable to regain control of the heading. At ~0330, the CTD wire was severed, presumably by the starboard screw, and the CTD was lost. After some discussion and considering that the horrible weather is to continue until at least Monday, it was decided to head north along the line to waypoint 14 then to cut over to waypoint 21 which is at the southern end of the Chukchi Cap transect. XCTDs and XBTs were to be deployed enroute. Dragging for the lost CTD was not seen as being profitable or a good use of time, given the horrible weather and the difficulty in locating such a small item. Mason and Max immediately started assembling the spare CTD.

The weather moderated moving north, especially after entering a band of ice. Seas calmed substantially as well. Multiple options for obtaining spare CTD parts were explored, including meeting up with Canadian research vessels and the Sikuliaq. There was no completely satisfactory solution identified at that time. Dragging for the CTD again was discussed but the

BOSUN was clear that, given the weather conditions, this would not be a good use of time. However, the site could be re-visited upon the return from the Pole.

During the day, re-assembly and testing of the backup CTD continued. The wire was re-terminated. A spare pylon was located (in addition to the very old one that was on the spare rosette). The spare rosette was taken out of the upper hold through the hatch using the large crane (luckily seas and winds permitted this). The plan is to complete assembly of the CTD, then run some tests with the hopes of conducting a long station on September 15. Meantime, the ship continues to transit northwards with instructions to not go further north than waypoint 28 which is located on the Chukchi Cap so that the station can be conducted on the Cap. CTD testing could occur during the evening but not later than 2200.

September 15

We arrived at waypoint 27 (Stn 10) by morning. The first order of business was to test the CTD. The initial test showed most systems working but there were a few problems. The STARC team wanted to work on it for 30-60 minutes and then do another cast. We debated if to proceed with the VPR for that station and decided to wait since doing the VPR would have required repositioning the ship (30 minutes) plus the cast (30 minutes) and if they were ready in 30 minutes, then the CTD team would have to wait (plus the ship would have to reposition 2x). The CTD was deployed again after repairs and did a cast; there were some problems noted (the pressure sensor seems off, the altimeter didn't work). We then proceeded to conduct the Multinet cast. Another CTD was conducted with a Microcat attached to the rosette to get an idea of whether the pressure sensor was far off and if it was a constant. We then proceeded to continue with the station. The VPR and Bongo nets went well. The pumps were deployed for the first time around 1800. Deployment went well. Recovery was at 2300 and went less well but the pumps were recovered successfully. The first Multicorer deployment started after the pumps came back on board and went very well; 8 good cores. Work was finished up at ~0300 AM and the ship departed for Waypoint 30.

September 16

The day dawned cold and sunny. Station 10 had ended just after 0300 so the ship hustled to get to waypoint 30 in time for an 0800 CTD cast. (Stn. 11). It took a while to set up the ship for the CTD cast. The decks were icy and we discovered that there was only a handful of salt on board to de-ice the decks. This will be a problem moving forward. Winds are high (25-30 kts), picking up through the day. The CTD cast was successful. Seth had looked at the relationship between the Microcat pressure and the CTD pressure and hypothesized that there was a typo in the Seabird calibration sheet for the CTD pressure sensor so he and STARC changed it in the calibration file for the pressure sensor. Also, Emily re-built the cable for the altimeter. The pressure was much more realistic for the CTD after the change and the altimeter readings, although it was not deployed anywhere near the seafloor, were as expected for a properly functioning altimeter. Success! After the CTD, there was about 30-45 minutes of repositioning before the VPR cast.

Station 12 (short station, CTD and VPR) was conducted starting around 1600.

Today is field day and the ship is abuzz with cleaning activities in the afternoon. Winds are sustained in the 20s. I am concerned about the upcoming CTD/VPR station and the long station tomorrow.

September 17

Science started at 0730 with a full water column CTD cast (3800+ m) (Stn 13). The cast took about 3 hours and was not deployed all the way to the bottom because of the extreme wire angle. Evolutions proceeded more efficiently today. Everyone is getting used to the cadence and the sequence of activities. The pumps were delayed a bit because the start time was set quite late after they reached depth (the ship was ready earlier than anticipated). However, the Multicorer went in at about 22:20. Hopefully as stations progress we can become even more efficient.

We are now off of the Chukchi Cap/Northwind Ridge and working over the abyssal plain of the Canada Basin. There is still no ice, even at 78N (150W), which is quite shocking. Ice maps and analysis show that we should enter the MIZ shortly after leaving this station in the early morning tomorrow and then enter pack ice within the next day.

Discussions are ongoing for a CG C130 to drop a couple of barrels of mission required parts for the CTD. This would happen on Sept. 23.

September 18

After the Multicorer was recovered (7 good cores!) and secured, we turned to the north along 150°W. The ship made good time over night. The CTD team dropped a couple of XBTs to fill in gaps as we transited. We did a short station at 0730 and then another at 1530. The air temperature has become much colder and we are now solidly in the MIZ. New ice is forming in leads between small floes. Much of the day was foggy; however, the fog lifted in the evening and we had an amazing sunset. The ship made very good time, transiting at least 80 miles overnight.

September 19

Clear and cold (mid-teens F). We are now completely in ice. Much of it is very light, ice forming between floes. Many frost flowers. We started to set up for station at 0730, a bit later than we should have since we would like to put the CTD in at 0730. The CTD went in 45 minutes later at 0820. There was little/no horizontal movement of the ship and the CTD was deployed to ~30 m off of the bottom. The station is progressing nicely. We have not heard yet about a potential drop of CTD sensors by C130; it could be that the big storm in the Bering has occupied the CG sufficiently that they cannot entertain this request.

The pumps were deployed successfully; the whole operation takes about 5.5 hours. During the Multinet tow, the winch operator lost control of the winch. Luckily she hit the emergency stop. In trying to figure out the problem and getting the winch going again, it was discovered that the air pressure to one of the brakes was off. However, this is not the really problem. Clive, the GE engineer, is working on figuring out the problem.

The Multicorer went in at ~ 10 PM. After reaching bottom, the winch was not wrapping wire correctly on the drum. It took about 5 hours to retrieve the cores.

September 20

The morning started with the retrieval of the Muticore (see above). The Multicorer was finally on board at around 6 AM with 8 successful cores. The benthic team processed the cores and cleaned the deck so that the ship could depart station at ~0650 AM.

The 9/16” wire needs to be spooled out and re-wound to eliminate the problem with the bad wraps. After sailing for about an hour, it was decided to stop and do this at the present location since the ETOPO topography shows the bottom depth becoming shallower ahead as the track goes up over a ridge. This is taking place at ~81 3.54N and 150 3.354W.

After about 3800 m of wire was spooled out, it was noted that there were several wraps below that still had problems. While the wire was fully deployed, ice filled in behind the stern, carrying the wire away from the ship. After several hours of trying to free the wire and recover it, about 50 m had to be cut and the end abandoned (along with 2 weights). The bad wraps are still deep in the core of the wire on the drum and really the wire can no longer be used. The decision was made to switch the coring operation (at least) to the 0.68" wire. Initially it was thought that all operations could be switched to that wire, including the Multinet, but then we found that the pump clamps would not fit on that wire and that it would damage the electrical termination to pass it through the block so the 0.68" will be used for the corer and likely the rest of the operations will take place on the 0.322 wire. The ship was underway to the north at about 1630. The ice is more compressed here but the ship is still making good speed (~4 knots). Tomorrow is another long station. An additional activity will be to test the 0.68" wire by spooling it out with some weights attached.

September 21

Another prolonged sunrise. Overall, today is cloudy. Air temperatures are warmer, 16-18 F, than the last few days. The ship was set up for the CTD at 0730 and the long station (Stn 17) started promptly. After the CTD was on board, repositioning took about 1.3 hours before the Bongos could go in. After the extensive repositioning period, the ship settled in to a location for the remainder of the station. Bongos were deployed on the 0.322 wire, as were all other gear except for the Multicorer. The STARC team had put a termination on the 0.68" wire for the Multicorer deployment. However, when testing of the wire/termination was taking place, it was noted that when the wire was under tension and until the A-Frame was fully extended, the wire would hit the mount for the fantail camera which was mounted directly in line with the block on the A-frame and the block from which the wire came out of the ship. After some discussion, it was decided to proceed north and to do the testing and a Multicorer deployment tomorrow afternoon following the planned CTD cast. This will allow time for a plan to be developed and implemented.

September 22 (Equinox)

Cold weather returned again today, with air temperatures 13-15F. Luckily the wind has abated. The sea ice has become a bit thicker, with more large, older floes. We had planned to do a CTD at 1200 but it actually took place a little bit later because the bridge wanted to be sure to have a good stable parking place for both the CTD and the Multicorer. The plan was to re-arrange the blocks on the aft A-Frame so that the 0.68" wire ran between the block and the house a bit more to the starboard and avoided the camera bracket. The blocks were re-arranged during the CTD cast (Stn 18). After that, testing of the 0.68" began again. Unfortunately, it was quickly discovered that the 0.68" wire still hit the camera bracket very slightly when the A-Frame was extended outward. The bosun lay in the helo deck net and reached out with a Sawzall to cut off the offending edge. Then, the wire cleared OK. After that, there was testing with railroad wheels and then the wheels were deployed to a couple of hundred meters to test the level winding. All checked out OK and the Multicorer was deployed. During the cast, it was noted that there was a substantial discrepancy between the wire out reported by the winch and reality: The Multicorer is equipped with a pinger. To get to the bottom, more wire had to be paid out than the bottom depth but in reality, there was less wire payed out. Regardless, the coring was completely successful

with 8 good cores. We got underway again at around 2100. The plan is to do a long station tomorrow.

September 23

Warmer this morning, almost 19°F at the bridge. Low winds. But still cloudy. Arrived at Waypoint 52 in time to set up for a long station (Stn 19) to start at 0730. CTD went into the water on time! After the CTD, it took some time to reposition for work off of the stern so the Bongos didn't go into the water until noon, pushing the length of the station back in time.

During the day, the lead PIs conferred and decided to skip doing a short station on Sept. 24. This will allow further northward transit. Also, because the ice conditions have become heavier, the distance between stations is getting smaller. A long station is still planned for Sept. 25.

Ice analysis Mike Fine discussed the upcoming change in winds to be from the north which should loosen the ice pack for the next 48-72 hours.

September 24

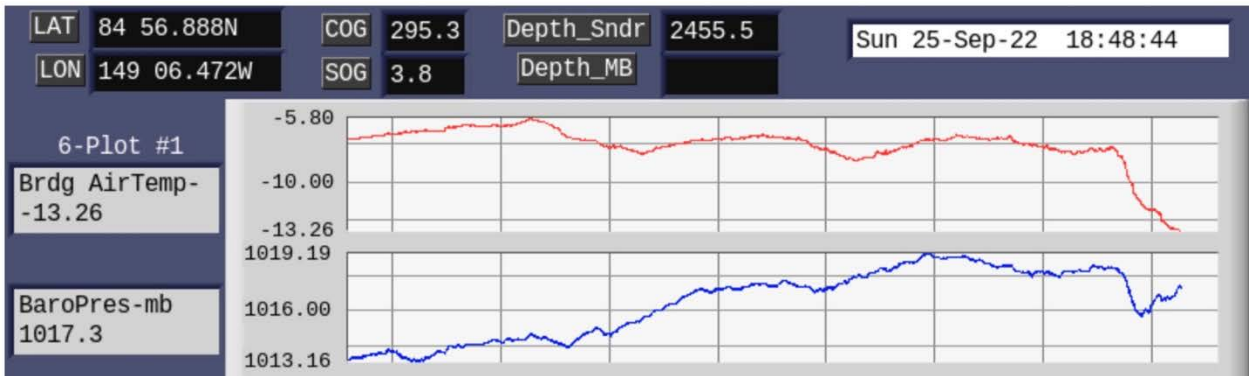
Winds at 30 knots+ and blowing snow this morning. The Multicorer deployment at the end of Station 19 was a near disaster due to ice and was cancelled. It was proposed by Jackie that the Multicorer sampling be moved to the days of the short stations so that the event would take place during daylight when better visibility would aid in ice management. This seems like a good idea. At ~0940 the weather decks were secured due to bad weather. The ice is much heavier here (N of ~83° 20'N) and little distance was achieved between the Multicorer attempt and morning. Occasionally leads are encountered that permits some distance to be achieved. Poor visibility impedes the ability to see ahead. Some leads and thinner ice were found in the afternoon. The strong winds from the north are pushing the ice, and us, south. The north winds also are loosening the pressure on the pack ice.

During the afternoon and evening, some progress was made as visibility improved and more newly frozen leads and in fact lakes were found. The weather forecast for tomorrow is once again high winds from the north. It was decided a) to not do a long station tomorrow and b) to convene at 9 AM to discuss whether to do a short + (CTD/OPTICS/MULTICORE) station if we can find a suitable location. One strategy, as long as these winds persist, is to continue to strike for the Pole to achieve that goal and have a more relaxed opportunity for science.

OPS did a calculation and said we have 9 more science days (9x24 hours) if we want to get back to Dutch in time. This is a conservative calculation but is very useful.

September 25

We made good distance overnight as the north wind has relieved the pressure on the ice and many leads are opening up. Since leaving our abortive station 19, we have made 100 miles to the north. The weather continues to be foul, although the sun came out this morning at around 1000. Winds are 30 knots and air temperatures are 10F. There was a big drop in air temperature (and continuing to drop) as we passed from cloudy to clear and sunny. The visibility is much improved with the clear skies.



Air temperature and barometric pressure from the STARC Met Display.

Because of the high winds, we decided to skip a station today as it would be difficult to maintain an ice-free sampling hole and continue to work our way to the north.

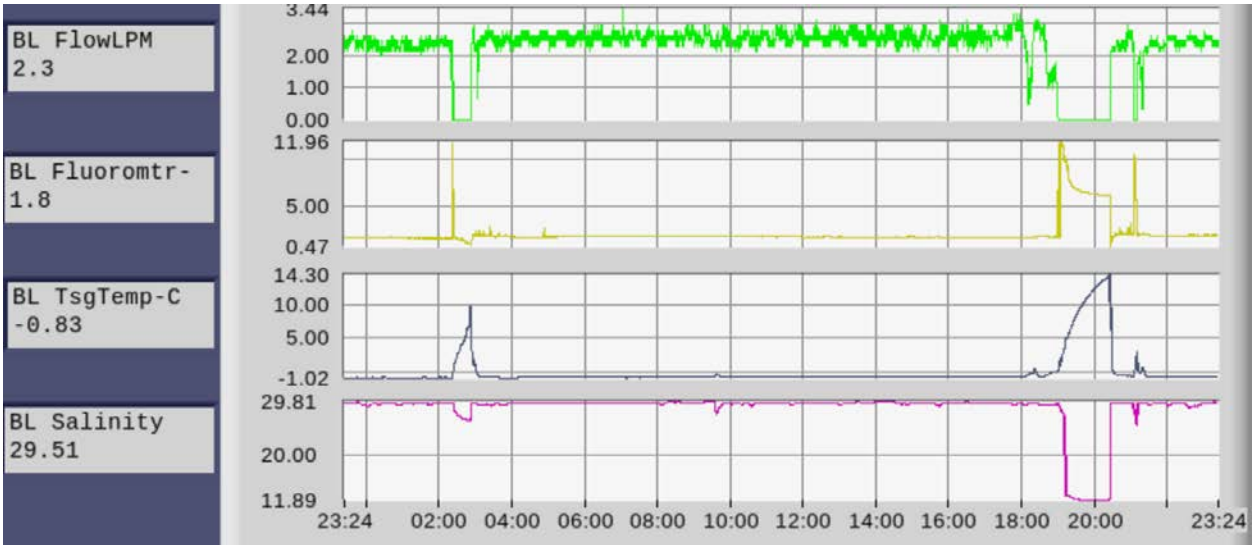
We continued to claw our way northwards during the day. We reached 85N at around 1400. The ice north of that has many fewer leads and more ridges. Progress is slow.

We meet tomorrow at 9 AM to decide whether to do a short plus station.

September 26

A big ridge encountered overnight required at least 2 hours of backing and ramming to vanquish. We met at 9 AM and decided to keep on pushing to see if we could get further north, with an aim to re-assess at 1215. At that time, we hadn't gone far enough to want to conduct a station, since we had done an XCTD at 0830 and had only traveled about 9 miles.

The science seawater system got clogged with slush at about 11 AM (1900 GMT). There is a bit of snow on the ice and that must be contributing to the system ingesting slush as well as ice and having trouble staying clear. See chart below. Also, last night at about 1815 local black water was released without science being notified so the science seawater system took up some of the waste. Hopefully this will not happen again.



We met again at 1215 and decided to push onwards, hoping to get some more distance. During the afternoon, we encountered a series of small leads that greatly hastened the forward motion. Also, some of the ice floes seemed quite thin (relatively) and the ship was able to transit through them with little/no backing and ramming. The ship also was running on four main generators. We re-assessed at 1600 and determined that if we found a suitable spot and could park by 1900, we would conduct a short plus station (CTD, Optics, Multicorer). At around 1620, we came upon a series of leads/ponds, some with light ice and thought this would be suitable. A station is planned for 1730.

Meantime, Emily Shimada found two fish at two different times clogging the science seawater system. Sue Moore and Marty Reedy and the Aloft Con crew reported seeing a spotted seal. And Carin Ashjian saw some arctic cod in a crack that the ship crossed with her starboard side, likely the source of the fish in the seawater system. This is at 85° 54'N.

At the evening meeting, we heard that a very strong low was moving into our area that would impact our weather, shifting winds from north to south and bringing snow. At this point, a Bongo net was added to the planned short station.

The station (Stn 20) was underway at 1745 with successful CTD and optics casts. Following those events, a Bongo tow was done from the stern. The wind started to pick up during these activities and was blowing quite a bit (20 kt) across the side of the ship during the retrieval of the Bongo net. The ship tried to clear ice from the stern and re-adjust position for 1.5 hours so that a Multicorer could be done. Finally, the ship moved to rest against a different floe. Brash ice still was filling in behind the ship that had to be cleared using slow turns of the props. The Multicorer finally was deployed, with some trepidation because the parking spot really didn't leave any options for moving if the winds shifted. Then it was found that the pinger was not working (either not functioning or not turned on). The wire was tending up and down nicely but only 15 m of wire were out. The Multicorer was retrieved. After discussion, it was mutually decided that it was too risky to deploy and we left the station to head north.

September 27

The day dawned very foggy. Visibility was obscured overnight, with snow. The ship had not made much progress north during the night. The ship worked through a large floe during the morning but entered a region of thinner ice and was able to pick up some distance in the afternoon. At around 1900, the ship came into a region of many small leads and was able to make good progress to the north, hopefully continuing into the night.

The second night of science talks took place at 1900, with talks by Annika Margevich and Savannah Sandy.

Next planned stations are at 90°N.

September 28

Again, the day dawned foggy with winds from the south at 10-15 knots. Progress had been slow overnight and continued through the morning but in the afternoon a series of leads were used to advance progress to the north so that about a degree/60 miles was covered in 24 hours. Some of the leads were very large, ponds. Unfortunately most were oriented NE-SW so that to maintain northward progress, traverses across more solid ice were necessary. There were considerable sections of the track where the ice was thin enough that the ship could traverse at 4 knots or so without backing and ramming. Polar bear tracks were seen mid-day. Light continues to be present throughout the day. Sunrise and sunshine were seen mid-day, although the sun only

skirted the horizon and didn't rise above the low-lying clouds. However, light is present, although dim, for about 24 hours.

September 29

We did reach 88 degrees early this morning. Going was tough overnight. We are now at 88° 13' N and we lose good satellite (Radarsat) coverage at 88° 30'. Ice continues to be a mix of heavy floes and leads and ponds. Most large leads/ponds are oriented NE-SW, which is not particularly helpful for getting north but does permit a kind of hopping (go NE then jump across heavier ice to the next NE oriented lead). Weather cloudy. The sun might not rise above the horizon today (although we wouldn't even see it if it did with the weather). At around noon, we ended up in a long lead that was oriented ~N-S and were able to transit at 11 knots. Progress in the last 24 hours has been impressive.

At about 1800, we reached 89°N. We could reach 90°N sometime tomorrow. Excitement on the ship is high. Many people joined in the cup coloring party in the science conference room.

The ice became thicker, with few leads, at about 89° 11' or so. Fog set in as well, so visibility was poor (although the ice radar is working).

September 30

A clear morning and cold (-1.3F). We are at 88° 33' N. The Pole is not easily giving up its secrets. We hope to start our station sometime today, with a CTD (3.5 hours), after arriving at the Pole.

We were close to the Pole after lunch. The excitement on the ship is palpable. Everyone is eager to reach the Pole. We arrived around 1400. The bridge was very crowded as we approached 90°N. Finally, we came within 0.01 of a mile…as close as we could get and still stop the ship. The Captain announced that the Healy had arrived at the North Pole. Everyone was crowded around the GPSs. People took photos, inside and outside of the bridge. There were a series of flags that were flown just briefly as mementos of the Pole ("this flag flew at the pole"). Eventually, after some time, we started to set up for a station (Stn 21). The CTD went into the water at around 1630 and took about 2.5 hours. The cast depth was over 4000 m and many Styrofoam cups (and a Styrofoam head) were shrunk on the cast. We then followed with the Multinet, VPR, and Bongos. Tomorrow the station will continue with the pumps, followed by ice liberty and the deployment of the "float your boats". And then we will end up our north pole station with a Multicorer cast.

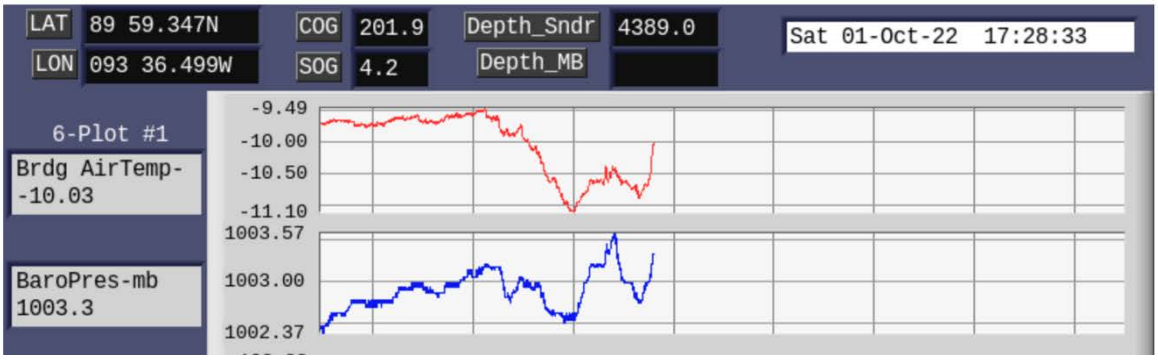
The cold (it was -2°F this morning and warmed up to the low teens by evening) is taking its toll on the ship. One of the black water vents froze (vapor froze inside). The drains for the sinks into which the science seawater flows in the labs (wet lab) froze and the SSW had to be shut down for a while so that the drains could be unfrozen (otherwise the SSW would go into the black water; not good).

October 1

During the sampling and the night we drifted further towards the Eurasian side of the pole. We started to move back to the American-Canadian side to conduct station work and ice liberty at ~0430. However, the ice was not co-operative and we were nowhere near the station location by 0730. After using four mains for a bit, we were able to start making progress towards our sampling site. The plan has now changed from that of yesterday: We will transit to a location 5 nm to the south of the Pole on the American-Canadian side (~150°W) and do the pump and

Multicorer deployments. This should take much of the day and evening. We will plan to do ice liberty tomorrow morning and then start the transit back to the south.

Weather today is cloudy with snow before 0800. The air temperature is 14°F. The barometric pressure is all over the place. Temperature is somewhat tracking pressure.



We arrived at the station location (~5 miles south of the Pole on the American-Canadian side) at ~1030 and deployed the pumps at ~1145 (recovered around 1545). The Multicorer was deployed after the pumps and was recovered between 2100 and 2200 with 8 intact cores. Although we moved off-site for the Multicorer cast, our records kept the Stn 21 designation. The ship then moved to position in a floe for ice liberty.

October 2

Winds were low and air temperatures in the single digits. Ice liberty was held from 10-12 during which time the wooden "Float your Boats" and one ice ball were deployed. Quarters were held at 1215 on the flight deck, with presentation of Arctic service medals to four coast guard personnel and a Cutterman's ceremony. The ship's complement then disembarked to the ice for two advancements and the group photos. All were on board by 1330 and the ship departed the North Pole, heading south along the most favorable route to conduct a station at ~88°N.

-Photo by Carin Ashjian

The wooden boats laid out to read "90° N". The ice ball is in the center of the degree symbol.

October 3

Transiting from the North Pole to ~88°N by the best possible route through available leads. There was quite a bit of ice at the start of the transit but later in the day we entered a region of expansive leads that were covered only by a very thin layer of newly formed ice. Transiting became quite easy, with ship speeds of up to 9 knots. The 0.680" wire needed to be re-terminated because the termination used was very stiff and when the wire is loose while the Multicorer is on the bottom (and the weight of the wire is pushing downwards), a bend in the wire developed just next to the end of the termination. STARC is putting on a different type of termination to see if this improves the situation

October 4

Overnight we arrived at a location at 87° 57N and the ship set up for the CTD at station 22. The light is still very strange, with the lightest part of the day in the early morning hours (ship time, we are presently at 180°W or E). Air temperature was very cold, just around 0°F. The CTD went in at about 0740 over ~3900 m of water. The station proceeded very well, with efficient transitions between events except for the recovery of the CTD. One of the tracks on which the CTD platform slides to move the CTD from the deck into the starboard staging area came un-attached so that the CTD could not be moved. This required about 30 minutes to fix during which time the CTD remained on deck in extremely cold temperatures. A blanket was put on the instruments and warm saline water was flushed through the T-S sensors, however it is possible that some of the sensors were damaged. Also, the water froze in the bottles, likely compromising the gas samples. During the day, the air temperature dropped so that by the time the multinet was came on board (2200 local, 0600 GMT), it was ~-10°F. The rest of the station proceeded without significant incident. A new termination for the 0.680 cable from which the Multicorer is deployed needed to be tested prior to deploying the Multicorer. This didn't take much time.

October 5

The first part of the day was spent finishing up the Multicorer at station 22. The ship got underway sometime after 0330. The way south lies through an amazing network of connected leads. The ship was able to transit at up to 13 knots during the morning. A photo of the aloft con camera at 0852 shows one such lead.

A “test” cast of the CTD had been scheduled for 1300. We then decided it would be good to do the cast at 87°N since we might as well get data if we go to the effort of making the hole and deploying the CTD (as long as the CTD is working). It seemed that we were coming up on 87°N very quickly but then encountered heavier ice conditions so slowed. In the end, we stopped to work just before 1300 and just north of 87°N. The CTD was deployed and the pumps were not working. After a few minutes at 20 m, we decided to send the CTD much deeper to the warmer water below in hopes of defrosting the pumps. The CTD was sent to 200 m. Just as we were about to give up and recover the instrument from 200 m, the pumps started working. So we brought the CTD to the surface and conducted a cast to 1000 m (Station 23). The sensors all were working, even the oxygen sensor. Air temperatures were in the single digits. Recovery took a while; the deck department is strategizing methods to speed up the process. So the CTD likely froze again. The plan was to transit to 86°N to conduct a long station but the weather forecast is dire.

The outflow for the sea ice separator system froze, lots of pressure on the pumps. Also a geyser in the biochem lab. The science seawater system is secured until the outflow can be unfrozen.

October 6

Winds were blowing 30 kts at 0700; gusts into the 40 kts has been noted overnight. Air temperature was in the 20s. The ship set up for a station but after considering the winds and the ice, we decided that it was too windy to safely do the work. Transit south continued. At about 0915 we noted that the winds had dropped considerably (along with the air temperatures!) so we looked for a location to set up and see if we could do some of our station work. However, we were unable to find a spot where we could keep the ice away from the starboard side (CTD hole). In addition, it was uncertain if the winds would pick up suddenly again to high levels, imperiling equipment deployed to deep depths (because the ship could run over the cable). We elected to not conduct the station.

Sometime in the early morning hours the walk-in freezer and refrigerator failed. People with samples were notified; they put cold packs into their coolers. Engineering worked on it and was able to get cooling going again by ~0800. Disaster averted.

Heat tape on the outflow for the science seawater system allowed the system to be operational again. However, now the drain for the portside system is clogged. The biolab system is up and running but the portside is still down.

Transiting south. The number of leads picked up considerably in the afternoon so we are able to make better time. The weather forecast for tomorrow is pretty awful, winds 20-25 kts with gusts to 30. We are planning to look for a spot to conduct a station and confer at 0700 regarding whether to do one or not. Also are not planning to go south of 85°N, since we would really like some samples/data from this region.

October 7

We had hoped to do a long station today but the weather did not cooperate. Winds were around 30 knots at 0700 but the ship had set up really nicely against a floe. There was a nice spot for the CTD. We decided to do a cast to 500 m, with shorter bottle soaks to minimize the time in the water (Station 24). None of the activities that required sending something deep would be feasible because the wind could increase rapidly and we didn’t want to have a huge amount of wire out. Also, the wind was blowing across the fantail and it was just too strong to think of

deploying the nets. It was snowing and the air temperatures were in the single digits. After a successful CTD cast, we kept moving south.

We were in a 70-mile long lead leading to the south and made good time. It became clear that we would reach 84°N before Oct. 8 and before the winds had died enough to work. The PIs met and decided to hove to at 84°N in hopes of conducting a long station on Oct. 8, since we wanted data from that far north. Unfortunately, this would take out time for activities later on in the cruise but we thought it was worth the sacrifice. We also decided that we would after that transit south at best speed, stopping every other day for a long station. In lieu of following our track line we would head to 75°N, 168°W (Chukchi Borderland, acoustic recorder) to conduct a long station (starting whenever we arrived). After that, we would head south and do a high spatial resolution line across Hanna Canyon. The trick is going to be estimating transit times and station times so that we don't run out of time (end October 22 at the end of our line).

October 8

After hoving to overnight, we awoke to diminished winds (20 kts) and warmer temperatures (22°F). We decided we could proceed with the station (Station 25). Because the pumps should be in the water during daylight, and because at this longitude the middle of the day occurs at our local time of 1600, we conducted the CTD followed by the Multinet followed by the pumps. The winch control for the 0.322" wire was not working properly (speed and payout approximately half of what it should read) after some maintenance so there was an hour delay before the Multinet cast. All other operations proceeded efficiently, with very quick turnovers in between events. After the Multicorer is on board, we will proceed south. If we make sufficient distance, we may do a short station (CTD/optics) mid-afternoon (1500).

October 9

Underway from Station 25 after Multicorer at maybe midnight? We made almost 30 miles by 615 the next day. Continued to move south. We had made 40 mile by 1230 so decided we would look for a spot to do a short station (CTD and Optics). Winds about 15 kt and air temperature about 16F.

Setting up for the short station (Stn 26) started at around 1300. The CTD went in the water for a 700 m cast at about 1500. The optics cast lasted until about 1618 and then we resumed our track south. This station was conducted just to the north of 83°N.

The region has multiple leads and first year ice that yields easily to the ship. At this longitude (177E), the sun is at its highest at 1600. Transit speed has been averaging about 4 knots in the N-S direction (the ship may actually go faster but the route also has not been straight so 4 knots N-S is a good estimator of southerly progress).

After the station, we proceeded towards the south, planning to do a long station starting at 0730 tomorrow morning.

October 10

We started setting up for a station at 0500 but just about then engineering needed to pump so we had to relocate 5 nm away from the 0500 location. The station (Stn 27) started with the CTD going in at 0745. Because of the shallower depth and of our efficiency, we were able to get the Multicorer into the water before 2000 and out by 2200. The ice ball also was deployed at this location. After processing the cores on deck for an hour, we left the station heading south.

October 11

We made good distance overnight. The ice is thinning and Healy can often just drive through it, rather than having to go around through leads. However, we are taking advantage of leads as we go south. We conducted a short station (Stn 28 at 1200, 80.8°N) and then started to transit south again. We are following a "straight" line from waypoint 100 to a station on the Chukchi Borderlands at 75°N, 168°W and hope to do two more long stations before reaching that location. After the Borderlands station, we will go south to a high spatial-resolution survey across the Herald Outflow/Hanna Canyon features.

The sun actually was visible to day and sun sights were conducted by John W and the celestial navigation students at Local Apparent Noon. A lovely "day".

Plan is to transit overnight stopping at 79°N to conduct a long station starting at 0730.

October 12

Long station (Stn 29) a bit north of 79°N. Station went well and was completed by ~2200. After wrapping up the benthic processing on deck, we proceeded towards the south.

October 13

Continued to transit to the southeast, conducting a short station (Stn 30) starting at 1200. During the CTD cast, a young female polar bear approached the ship and circled around (still quite far away) from the starboard side past the bow to the port side, eventually going off to our left. She was quite curious and perhaps was drawn by the smell of the ribs that we had had for lunch. Everyone very much enjoyed the bear. A black guillemot also was spotted swimming in the open water around the CTD wire during the CTD cast.

Our plan now is to conduct a long station tomorrow at no further south than 77°N and then to transit to the location on the Borderlands where there is a mooring with an acoustic recorder. We will conduct a station there and then transit to the south to the start of a high spatial resolution survey in the Hanna Canyon/Herald Valley outflow region. We will take Sunday as a day of rest prior to starting an intense four days of round-the-clock sampling on Monday morning at 730. Following the end of the survey, we will move to Station EHS6 where we will complete our scientific work.

October 14

A beautiful, mostly clear day, with sunny skies (once the sun rose) and temperatures around 8-10°F and barometric pressure up. Station 31 started promptly at 0730 and proceeded efficiently and smoothly, with the Multicorer coming out between 2000 and 2100. A small chlorophyll maximum was observed on the CTD, reflecting a small fall bloom. Multiple diatoms were collected in the 53 μm Bongo Net and the pump filters were black with particulate (pumping time will be reduced to 2 hours for the remaining stations). STARC and the deck crew conducted a wire payout calibration for the 0.680 wire while the benthic team was finishing up with the core processing on deck. John was able to do some star sights as well a sun sight. We got underway to our station on the Borderlands at about 2120.

October 15

It took longer to get through the ice than we had anticipated so we didn't arrive at the ice edge until 13:30, still about 60 miles away from the station. Once we had cleared the ice edge we proceeded at 15 knots to the Borderlands station (Stn 32), arriving just before 1700. The depth is

about 165 m so events at the station are proceeding rather quickly (the Bongo/VPR combination took about 30 minutes). We are using the 0.332 wire for the Van Veen grabs and it is working nicely. The station concluded before midnight. The plan is to survey for marine mammals and birds tomorrow and then to start the high spatial resolution sampling at 0730 on Monday morning.

Marty saw some shearwaters today.

October 16

Another lovely day. Winds are 15-20 kts and seas are low. Air temperature is 28°F. Northern lights were out last night at around 0100. Today we are surveying along a track identified by Marty and Sue together with the Captain. Marty saw seven spectacled eiders and has been seeing black guillemots. Sue Moore and Leonard Sussman gave the science talk.

October 17

Winds were in the high teens – low 20s in the morning, with air temperatures in the high 20s. Seas were low but there was a swell. When setting up for the first station of the survey, it was found that the bow thruster was set to be controlled from the aloft-con rather than the bridge and it could not be switched. After trying several repairs, and standing by with the CTD, we started the sampling plan from the stern (VPR, Bongo, Multinet, Multicorer). Because of the swell, there was quite a bit of pitching so the stern was heaving. However, we were able to conduct all the stern sampling with the exception of the pumps. We were about to move off to the next location in the survey at which stern sampling would take place when control of the bow thruster was restored to the bridge and we were able to conduct the CTD at this location. Unfortunately, there was still too much swell to conduct the pump sampling. We then commenced moving along the line and reached station HC3 at around 20:45 to wrap up the day's sampling.

October 18

Overnight, HC4 and HC5 were sampled. Winds from the east at around 18 knots and air temperature holding at 22F. Station HC5 had such soft mud that the M-Core penetrated almost too deep. The ADCP is showing a lot of flow to the west; CTD showing Atlantic water at depth. Also, the IBCAO depths are off and the stations have been in deeper water than estimated from interpolation from IBCAO 3. Depth at Station HC6 (155 m) is approximately correct. The winds subsided at Station HC9 that it was possible to put in a single pump (because it was shallow) to pump for 1.5 hours. Work continued through the day. The winds picked up in evening and there were some intense snow squalls. So far though the ship is able to hold position while work continues off of the stern. As of 10 PM, sampling at HC9 was nearing completion.

October 19

The high-resolution survey continued. The weather is supposed to get very bad tomorrow so we are planning to finish the survey and go as fast as possible to station EHS6. Sampling there will be in a different order so that priority sampling takes place first. Priority is CTD, Bongo, Multicorer, Pumps. If weather permits, Multinet and VPR.

October 20

Arrived at EHS around 3AM. Winds were around 20 knots but still workable. During the CTD cast, the cyclos tripped and we had a dark ship (no power). No power to shafts or bow thruster (or winches) with the CTD at 50 m. Luckily, the ship held her heading. Power was restored and the CTD cast continued (it had been on the up cast). After that, we successfully followed the order of sampling described above, finishing with an optics cast that was completed at about 1230.

The ship then moved off for our transit south. The plan is to head west to the international boundary and then run down that line to the DBO 3.8 location where we will conduct a station. This area is not surveyed all that often but might be a good place to spot marine mammals and birds. After sampling at DBO 3.8, we will survey for Rebecca Woodgate's mooring and then head through Bering Strait during daylight hours. We might run to Dutch via the western side of St. Lawrence Island. Also considering picking up a mooring with a sediment trap at M8 (the Dyson was unable to retrieve the mooring because of mechanical failure). Winds are picking up in the afternoon evening (and seas). Healy rides great.

October 21

Transiting from the northern Chukchi Sea. We reached the international boundary in the early morning hours and turned to transit south. Unfortunately, this put us broadside to the prevailing waves and wind so that the ride became a bit rocky. Winds were in the high 20s to 30 throughout much of the day with air temperatures rising about freezing for the first time in weeks. By mid-afternoon we had transited far enough to the south to be out of the strongest influence of the pressure gradient/winds so the seas subsided a bit and the ride became very comfortable. The sun set as a large orange ball only partially visible through the clouds. More birds are being observed. Also, 6 walrus were seen, including a couple of pups.

October 22

Conducted the last station at the western end of the within-US DBO 3 line (DBO 3.8), starting at 10 AM. A nice day, with fair seas and warm air temperatures (36F). After the station, we transited south just to the east of the international boundary line, doing marine mammal and seabird surveys. The benthic and zooplankton groups washed gear with fresh water on the back deck.

Things can change in a hurry, especially when driven by the weather. A couple of major lows are going to barrel across the Bering Sea and Gulf of Alaska. The weather will be very bad in Dutch Harbor, so bad that Healy would not be able to get in to port. The Captain, XO, and OPS called a meeting of the department heads (including myself and Jackie) to discuss. The new plan is for Healy to make for Dutch Harbor as fast as possible and by the most direct route (no mooring recovery, no route to the west of Saint Lawrence Island) to get in to Dutch before the storm hits on Tuesday. At the moment, Healy is anticipating departing Dutch on Friday Oct. 28 rather than on Oct. 29. Of course, all of this may change. It is unclear if there will be any flights in/out of Dutch during the week. The science party is welcome to stay on board until Juneau. Also advised to try to fly out stand by if there are any flights. The situation is very up in the air. However, at the moment, we are making for Dutch Harbor, hoping to arrive on Monday evening or, if not then, on Tuesday morning.

We also drove over Rebecca Woodgate's mooring (A2) to see if we could see it on the multibeam. We were not sure that we could.

October 23

Continued transit to Dutch. Packing of science gear took up much of the day. A group of scientists, STARC techs, and crew put together a fantastic haunted house in the helo hanger for Healyween. Then there was a costume contest on the mess deck during ice cream. Emily Shimada won as a fly with John Wigglesworth as a ViPeR and Emily Lewis as a Jedi/Sith as runner ups.

October 24

Underway to Dutch Harbor at 18.4 knots throughout the day. Arrived at Dutch Harbor and docked at ~1700. So ends the cruise.

Individual Science Component Reports

Physical Oceanography

Seth Danielson (sldanielson@alaska.edu), Savannah Sandy (ssandy2@alaska.edu), Peter Shipton (pshipton@alaska.edu) - University of Alaska Fairbanks
Annika Margevich (annika.margevich@yale.edu) - Yale University

The physical oceanography component of the US SAS cruise ran the CTD casts, conducted XBT and XCTD deployments between CTD stations, parsed out underway meteorological, ADCP, and seafloor bathymetry data, and made graphical summaries of these in near-real time. We also deployed and recovered moorings at the Chukchi Ecosystem Observatory (CEO) site on the NE Chukchi Sea continental shelf. At latitudes above 80 N, the NIC-supplied SAR imagery was unavailable, so we also downloaded and plotted the NASA team near-real-time passive microwave sea ice concentration data.

Physical Hydrography

We conducted 54 CTD casts on the cruise, including 41 casts in which Niskin bottles were tripped and water sampled for biological and biogeochemical components (Fig. 7). Two of the 54 casts were test casts following the assembly of the backup CTD. Water samples from the Niskin bottles were collected for dissolved oxygen, dissolved inorganic carbon, dissolved methane, major macronutrients (nitrate, nitrite, phosphate, silicate and ammonium), 18O, chlorophyll a and other pigments. Phytoplankton and microzooplankton species were preserved with Lugol's solution. Sensors on the CTD included pressure, dual temperature and conductivity probes, photosynthetic available radiation (PAR), chlorophyll-a fluorescence and colored dissolved organic matter (CDOM). For the first 10 casts of the cruise, we also had a transmissometer and optical backscatter sensor.

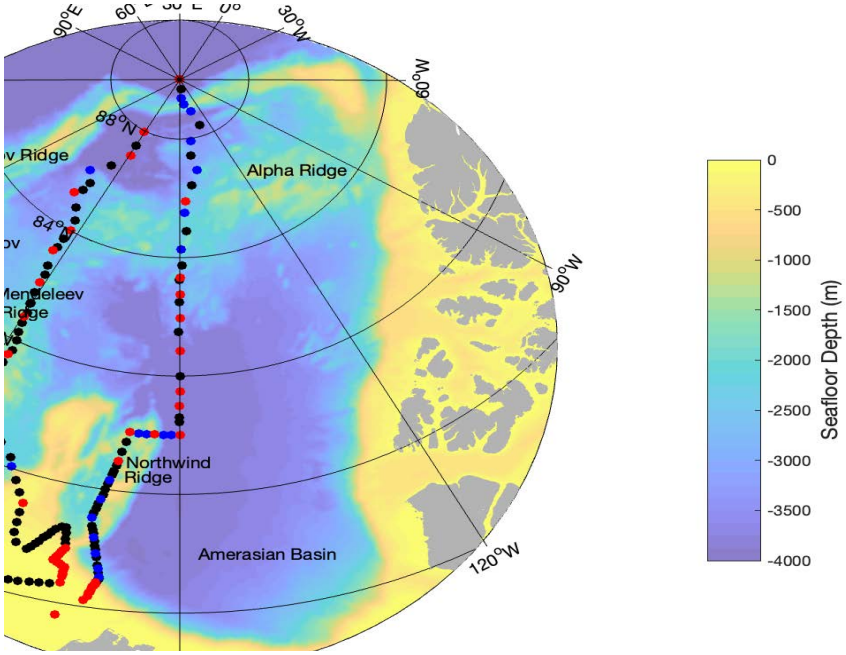


Figure 7. Locations of CTD, XCTD and XBT stations on cruise HLY2202.

Despite the Arctic conditions with air temperatures that often fell between -20 and -5 °C, we only had one instance of the CTD pumps freezing up and causing a delay in the cast. In this one case, we lowered the CTD to the depth of the relatively warm Atlantic water, and the pumps were able to come on after a few minutes. After this, the Healy's crew became much more efficient at the staging and deployment process by 1) leaving the CTD in starboard staging until the ship was fully on station and ready for deployment; 2) draining all water from the sensors; 3) directing electric heater blower air flow at the CTD package while staged in the hangar; 4) swiftly deploying once staged; 5) not turning on the CTD until the package was fully submerged (rather than simply waiting for just hands-off).

On the 10th CTD cast of the cruise, the Healy got turned around relative to the wind, which was blowing a stiff 25 kts - wind shifted to the port side, causing Healy to drift over the 0.322 CTD cable. The bridge spent approximately an hour trying to bring the wind back to the starboard side, but the 0.322 cable tended aft and under the ship, eventually coming in contact with the starboard propeller, which sheared the cable and caused the loss of the CTD. The STARC team had a backup CTD system on board and in about 36 hours was able to have a new system up and running. The new system lacked a transmissometer and Eco-Triplett sensor, but otherwise included all other data parameters. A chlorophyll fluorometer and CDOM fluorometer replaces two of the Eco-Triplett channels. The Coast Guard offered to mount a supply flight with a C130 from Kodiak; if it had occurred, this support would have improved the quality of the CTD data by replacing the transmissometer and by providing a fully functional pressure sensor (see narrative below for issues that arose with CTD#2).

The physics team collected salinity samples for the purpose of cross-checking and correcting the conductivity sensor calibrations. Our plan had been to run the salt samples at sea, but because the AutoSal was located in the general biochem lab, we were unable to attain a consistent enough instrumentation and sample temperature and the system never remained stable long enough to produce consistently high-quality data. After considerable testing, we changed our approach and took samples with the intention of running them on shore in a more controlled environment. Overall, conductivity cell and temperature probe performances appeared good, but with somewhat smaller offsets in salinity for CTD #2. For the cruise as a whole, the difference between the primary and secondary sensors for each of the two CTDs is shown in Table 4, with the mean offset as being less than 0.001 for both parameters. The dual sensors provides us with some confidence in the accuracy of the readings, which will be re-assessed for CTD #2 after the sensors are returned from SeaBird, Inc. following post-season calibrations.

Table 4.. Statistics of the 1-db averaged temperature and salinity data using the differenced (Δ) primary and secondary temperature and conductivity probes.

	Mean ΔT	Mean Δ|T|	Variance ΔT	Variance Δ|T|	Mean ΔS	Mean Δ|S|	Variance ΔS	Variance Δ|S|
CTD #1	2.83e-4	2.81e-3	8.83e-5	8.05e-5	7.45e-	8.17e-3	8.76e-5	7.64e-5
CTD #2	7.65e-4	1.52e-3	2.12e-5	2.01e-5	1.21e-	1.35e-3	1.51e-5	1.33e-5

.

We discovered after our first cast with CTD#2 that the pressure sensor was not fully lining up with the winch payout. The behavior appeared erratic, with a possible non-constant offset between the two. Testing and some logging of the two measures of CTD depth showed that:

1) On downcasts the CTD maintained a fairly constant offset with respect to winch wire out.
2) The downcast offset did not remain constant from one cast to the next, and varied between about 2 m and 10 m.
3) On upcasts the CTD offset had about a 10 m trend between the final depth and the surface.

The above findings seemed to hold both for relatively shallow casts (300-1000m) and for full ocean depth casts (<3500 m). Once we were in the ice, our CTD wire angle was nearly perfectly vertical so we changed our bottle trip depth levels from the CTD readout to the winch wire payout. We believe that especially in the upper 100 m of the water column, the winch wire provided a much closer and more consistent measure of CTD package depth. Note that the winch operator typically zeroed the wire when the CTD rosette frame top entered the water surface, so the CTD pressure sensor should have been reading about -2 m when the wire was zeroed. Hence, bottle targets of 20, 30, 40 m were more likely tripped at normal depth levels of 22, 32 and 42 m, respectively. To the extent that the SAS cruise data will be compared to prior (and following) data, these depth level differences may represent an important caveat that needs to be taken into consideration. If further diagnosis of the behavior of the pressure sensor is needed, we have the option of comparing winch wire out (logged as a serial feed by the Healy's science data network) to pressure depths logged by the CTD.

We brought two cases (24) expendable CTD sondes on the cruise. STARC also had a large number of XBT sondes, many of which were aging and of uncertain condition. Following the loss of CTD#1, many of these sondes were offered to the use of the science party. In the first day following the CTD loss, we used XCTDs and XBTs to continue the high-resolution shelf-slope transect (Fig. 8). Thereafter in the cruise, we used them to provide a higher resolution sampling between the CTD stations, to great effect. We generally were able to attain a 20-30 nmi spacing in the basin, and over the Bering-Chukchi shelves in our final transect of the cruise we deployed one probe every degree of latitude for a 60 nmi spacing.

Figure 8. Deployment of an XBT to collect water column temperature data.

Moorings

In support of the Chukchi Ecosystem Observatory (CEO), we recovered three moorings and deployed three moorings at the CEO site on the southern flank of Hanna Shoal. The instruments on the moorings deployed in 2020 were programmed to collect data for 2 full years as a response to COVID-19 concerns about turn-around cruise options. The CEO3t-21 mooring was designed and deployed in 2021 as a result of a COVID-cancelled turnaround cruise in September of 2021. It was intended to be a one-year mooring with no turnaround in order to continue the time series of sediment trap collections and passive acoustics records, as well as provide freshly calibrated CTD and oxygen measurements.

Mooring Recoveries

All three recovered taut line moorings were ranged on with the Healy's deck mounted transducer and each mooring's acoustic releases. When mooring position was established relative to the ship the acoustic releases were triggered and the moorings surfaced. A USCG RHIB (small boat) that was already in the water drove to the surfaced moorings and a tow line was attached to the top float or frame. The RHIB towed the mooring to the starboard side of the Healy and the ship's crane hook was clipped to the lifting bail of each mooring. For each recovery, the crane then brought the entire mooring on board in one pick.

CEO1-20 was recovered on September 8th at 19:16 (local)

This mooring consisted of a 600 kHz Acoustic Doppler Current Profiler (ADCP) and SBE37SMP (pumped CTD) at a depth of approximately 33 meters. A passive acoustic recorder (National Instruments Sound Trap) at 36 meters depth and an additional SBE37SMP attached to the acoustic releases at a depth of 43 meters. All of these sensors, except the for the sound trap, were intended to and did collect data for 2+ years.

CEO2-20 was recovered on September 8th at 19:56 (local)

CEO2-20 had a suite of instruments at 33 meters, all contained within a viny float frame. These instruments were a SUNA (nitrate sensor), an AZFP (Acoustic Zooplankton Fish Profiler), a Contros HydroC (pCO2 sensor), an SBE37SMP-ODO (pumped CTD with oxygen sensor), as well as a standalone PAR sensor and a standalone Triplet (3 channel optical sensor which measured turbidity, chlorophyll, and CDOM). The sensors in the viny frame were programed to collect data for 2 years, although the PAR sensor (Nov. 2021) and AZFP instrument (June 2022) datasets terminated early. The SUNA instrument appeared to collect data correctly for the full two years (it was still sampling on recovery) but a programming error resulted in no data being stored. A HydroBIOS 24 cup sediment trap was also on CEO2-20 at a depth of 38 meters. Due to the bottle limitations, the sediment trap was only intended to collect samples for 1 year.

CEO3t-21 was recovered on September 8th at 20:37 (local)

This mooring consisted of an SBE37SMP-ODO (CTD and oxygen) and a SeapHet (pH) at 34 meters depth. A Sound trap was mounted at a depth of 35 meters and a 24 bottle sediment trap was in line at 39 meters. An SBE37SMP was mounted to the acoustic releases at 43 meters. There were also 3 RBR thermistors to measure temperature at 37, 39, and 41 meters. All instruments on this mooring returned full datasets.

Figure 9. Recovery of moorings CEO1-20 (left), CEO2-20 (middle) and CEO3-20 (right).

Figure 10. Deployment of mooring CEO2-22.

Mooring Deployments

CEO2-22 consists of SUNA, an SBE37SMP-ODO, a PAR, a Triplet, a SeapHox(SBE37SMP-ODO and pHet), and a Sami CO2 and contained in a viny frame at a depth of 33 meters. A 24-cup sediment trap is in line at 38 meters with a Sound Trap attached to the Sediment trap's frame. The mooring was assembled on deck, picked up in one pick with the crane and quick release and deployed at **September 9th at 09:23:03 (local) at 71◦ 36.0420 'N, 161◦ 32.4510 'W**.

CEO1-22 has an SBE37SM (unpumped) attached to the top float at a depth 33 meters. A Green Eyes water sampler with 47 sample bags is in line at 37 meters deep. An SBE37 is also attached to the releases at a depth of 43 meters. CEO1-22 was assembled on deck and deployed in 1 pick on **September 9th at 10:18:41 (local) at 71◦ 36.0260 'N, 161◦ 29.9740 'W**.

CEOtripod-22 contains 3 upward looking transducers on the top platform at a height of about 1.9 meters. These transducers are a 300kHz ADCP and the 2 AZFP transducers. An SBE 37SMP is mounted on the underside of the top platform. On the middle platform, a benthic camera and lighting system are mounted on a cantilevered shelf. The bottom shelf holds the battery packs for the benthic camera and the AZFP. This tripod was fully assembled on deck. It was deployed through the A-frame by picking it from the three-point bridle using a Hawboldt winch. An acoustic release on the end of a working line was attached to the bridle. The tripod was lowered to a wire out reading on the winch display of approximately 46 meters when tension seemed to drop. The wire was then hauled in 2 meters to take up tension again and the acoustic release was then triggered; letting go of the tripod at **11:22:01(local) on September 9th at 71◦ 35.547 'N, 161◦ 31.349 'W**. We subsequently used the ship's acoustic release to query the tripod acoustic releases and found that both releases reported being in an upright orientation.

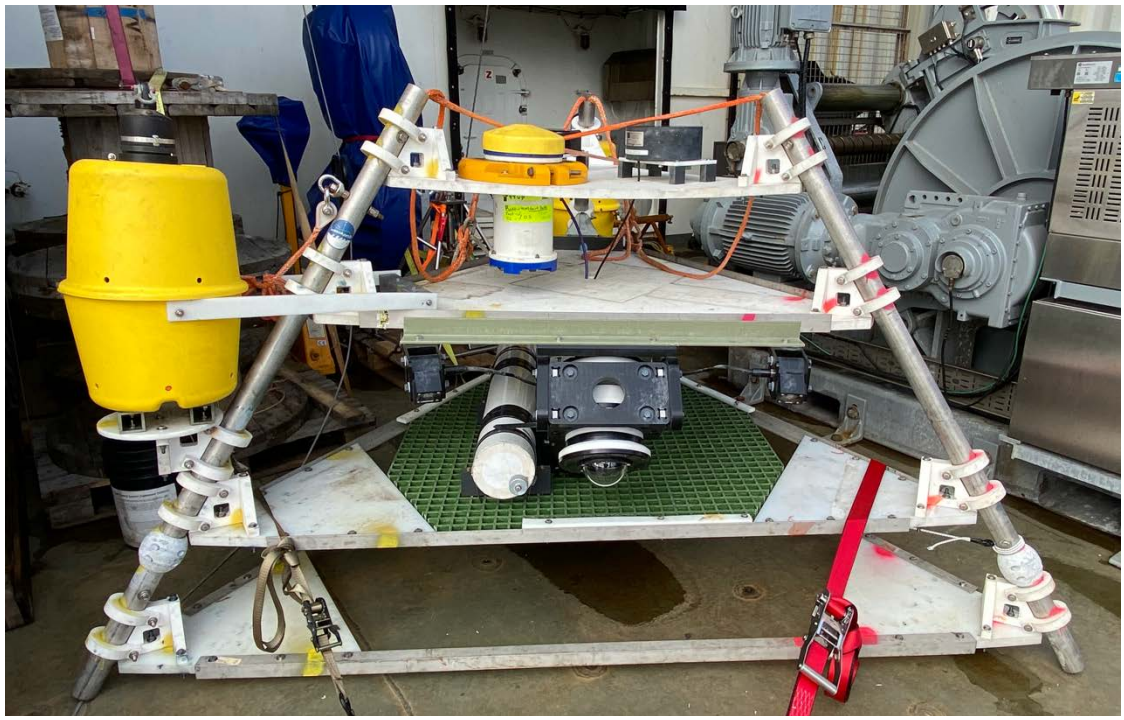


Figure 11. Chukchi Ecosystem Observatory tripod, with benthic camera, Acoustic Zooplankton Fish Profiler, Acoustic Doppler Current Profiler, Microcat CTD, and pop-up release cannisters.

Physical Hydrography

We spent time checking the underway data and processing and analyzing the station data to the degree possible as the cruise progressed. Initial graphical visualizations of the data are presented below (Fig. 12-16). Please note that some final QA/QC procedures have yet to be applied to the data.

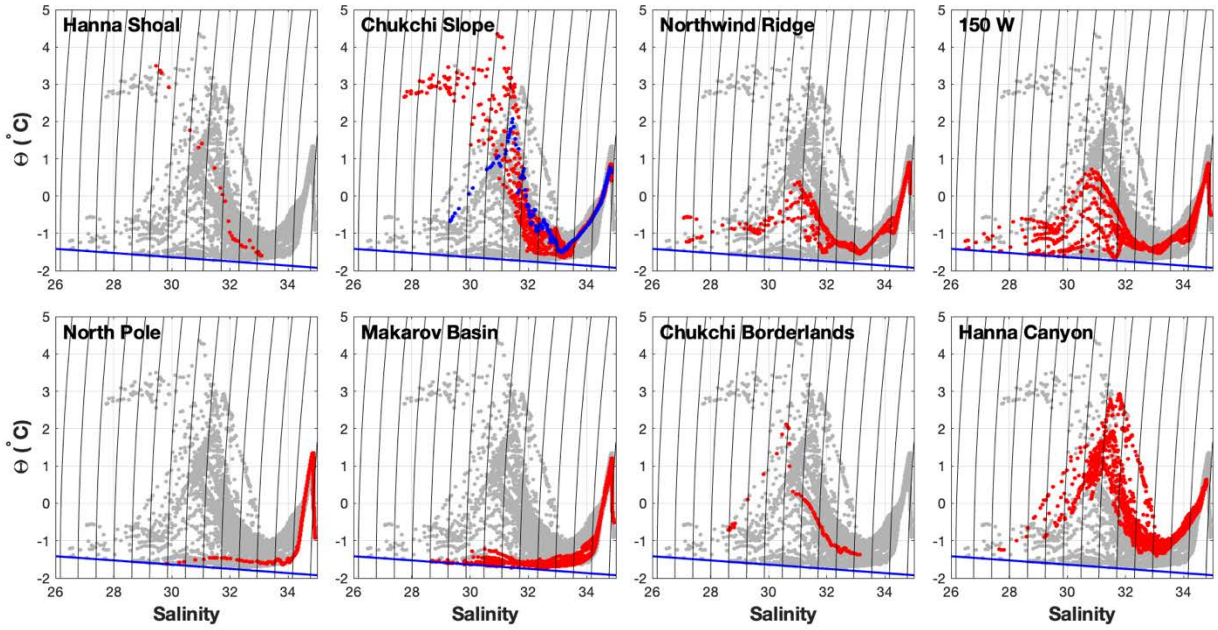


Figure 12. T/S diagrams showing the location in temperature-salinity space of the data collected in each region (red points) along with all CTD from the cruise (grey points). The blue data points shown from the Chukchi Slope denote a second occupation of station HSE6 (first occupation on September 10th, second on October 21st). The freezing point curve is plotted in all panels in blue.

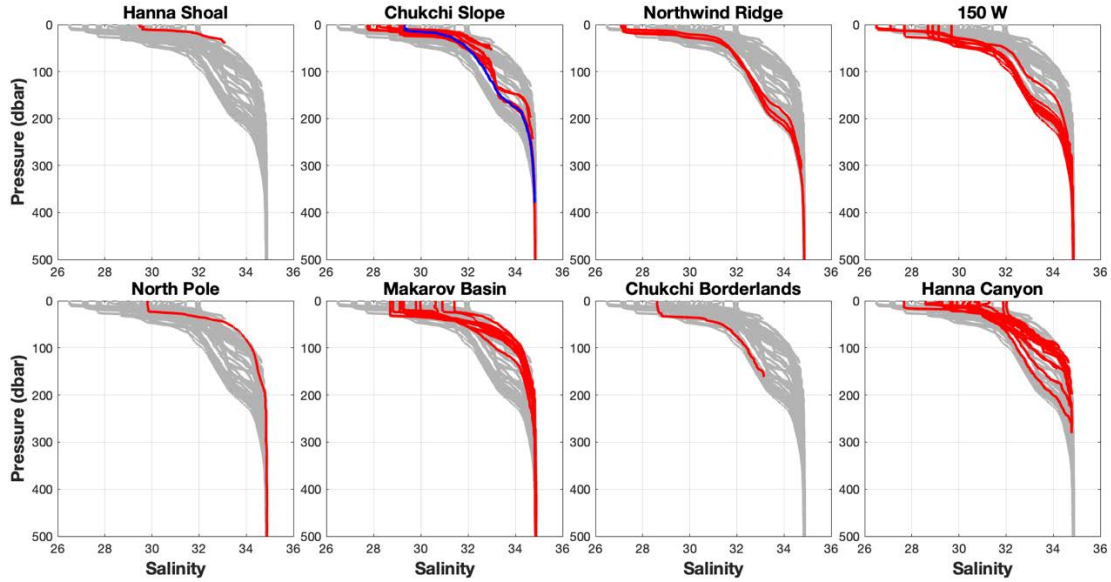


Figure 13. Salinity profiles for the upper 500 m of the water column plotted by region as shown in Figure x.

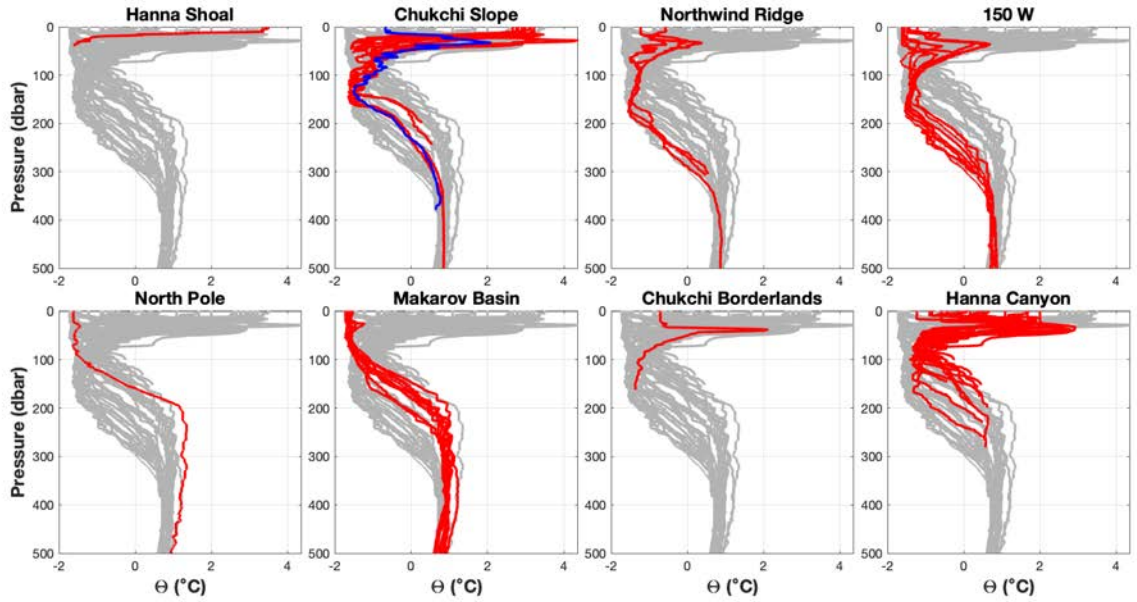
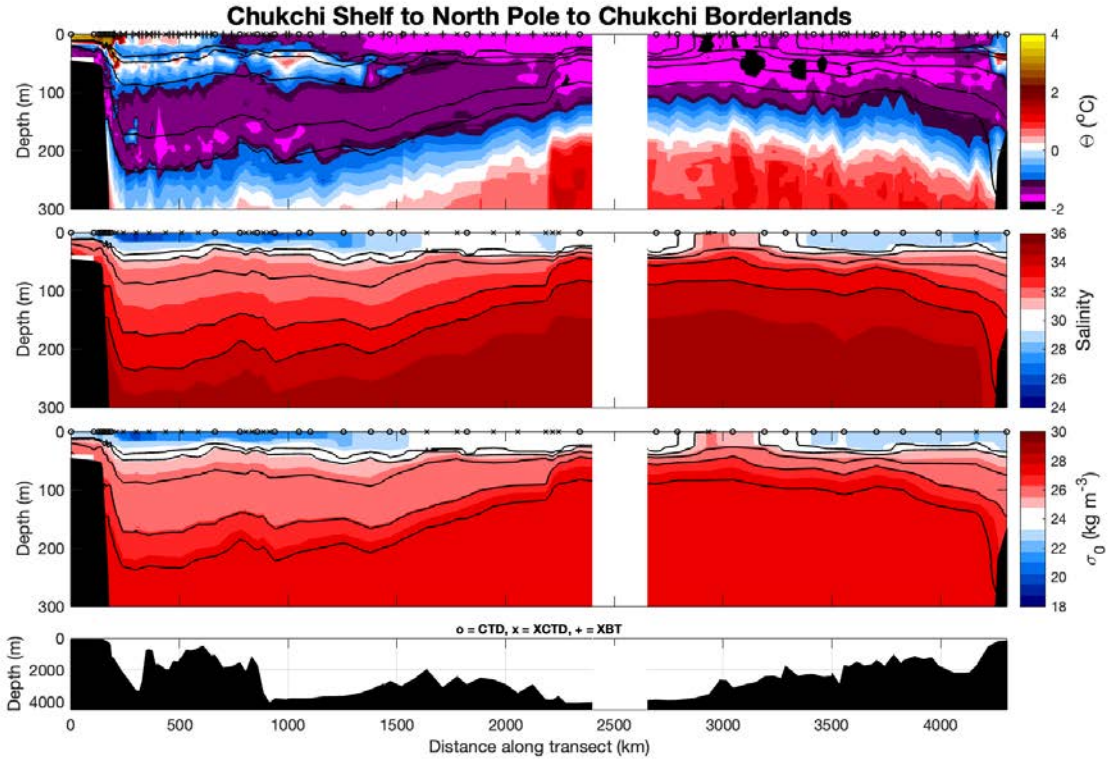
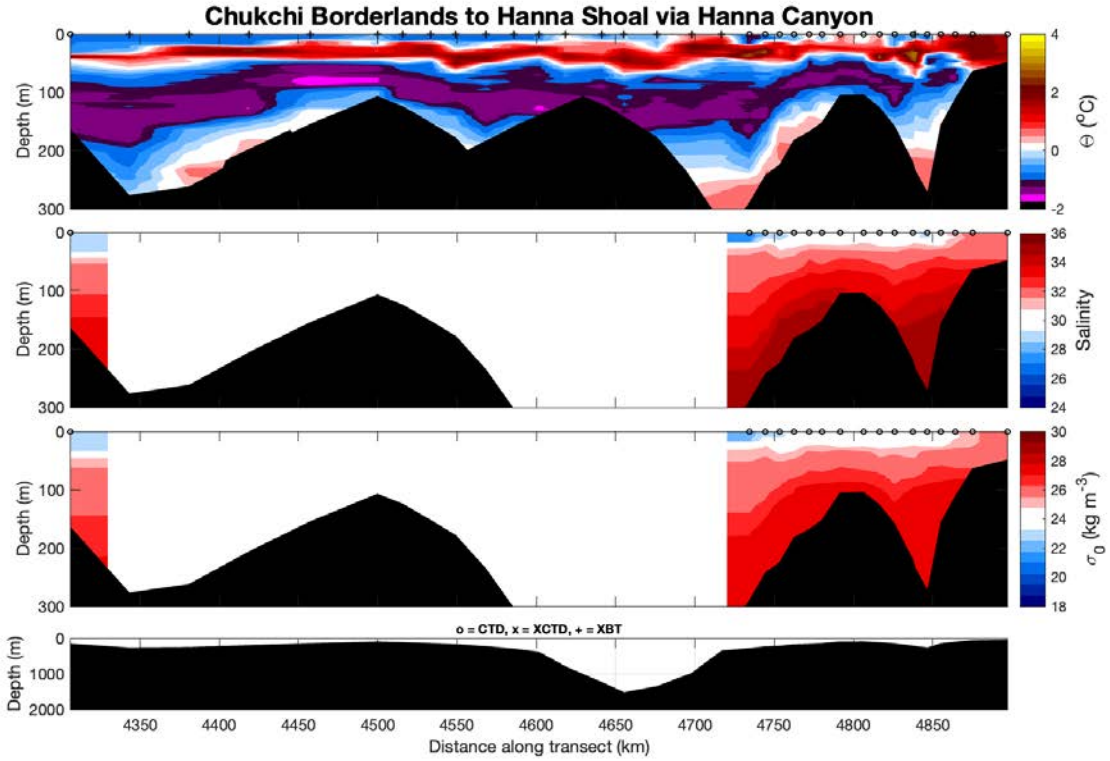
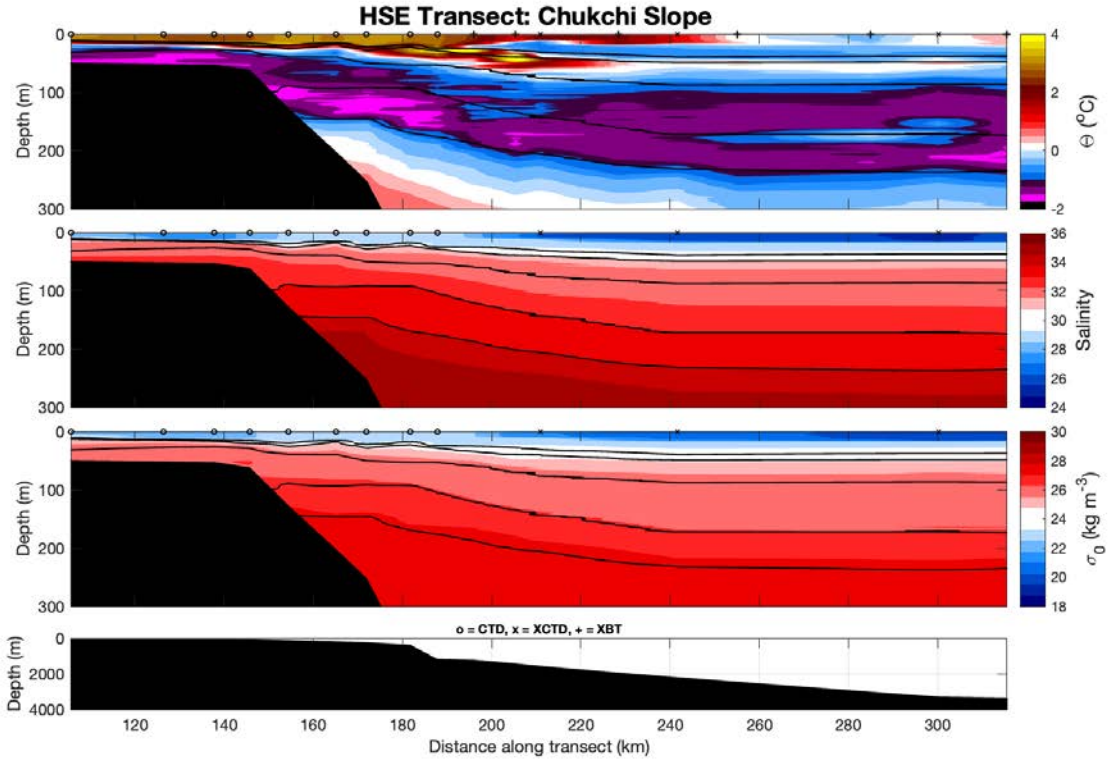
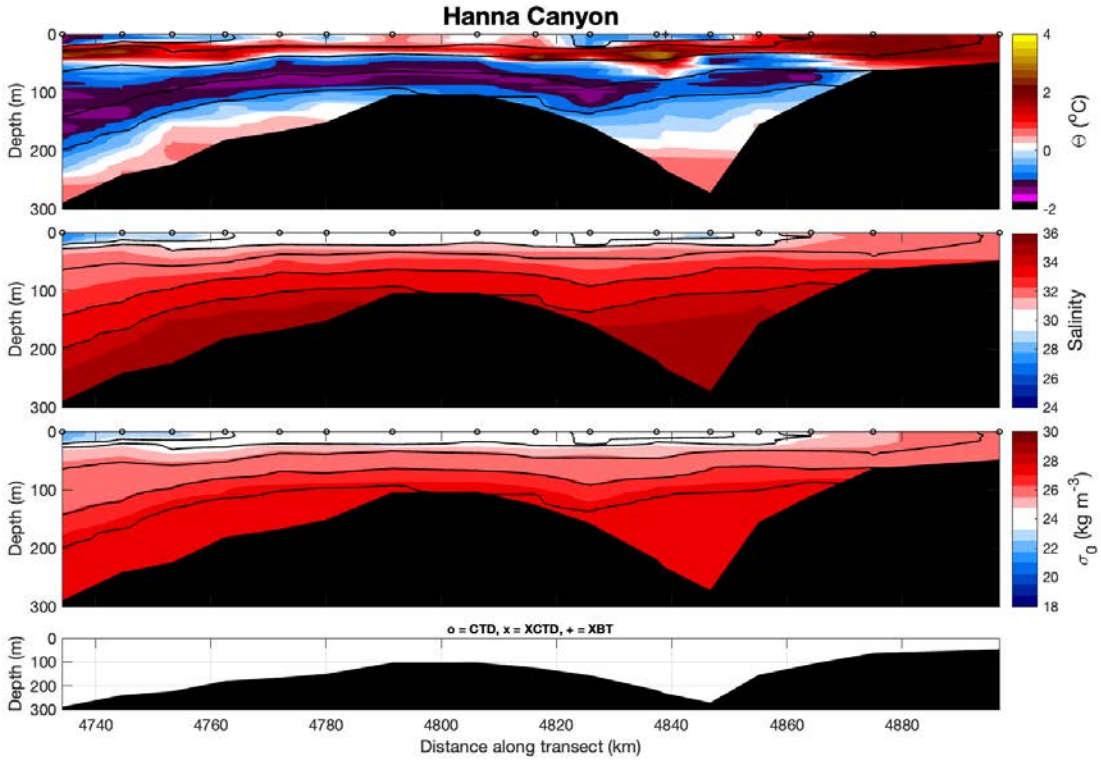


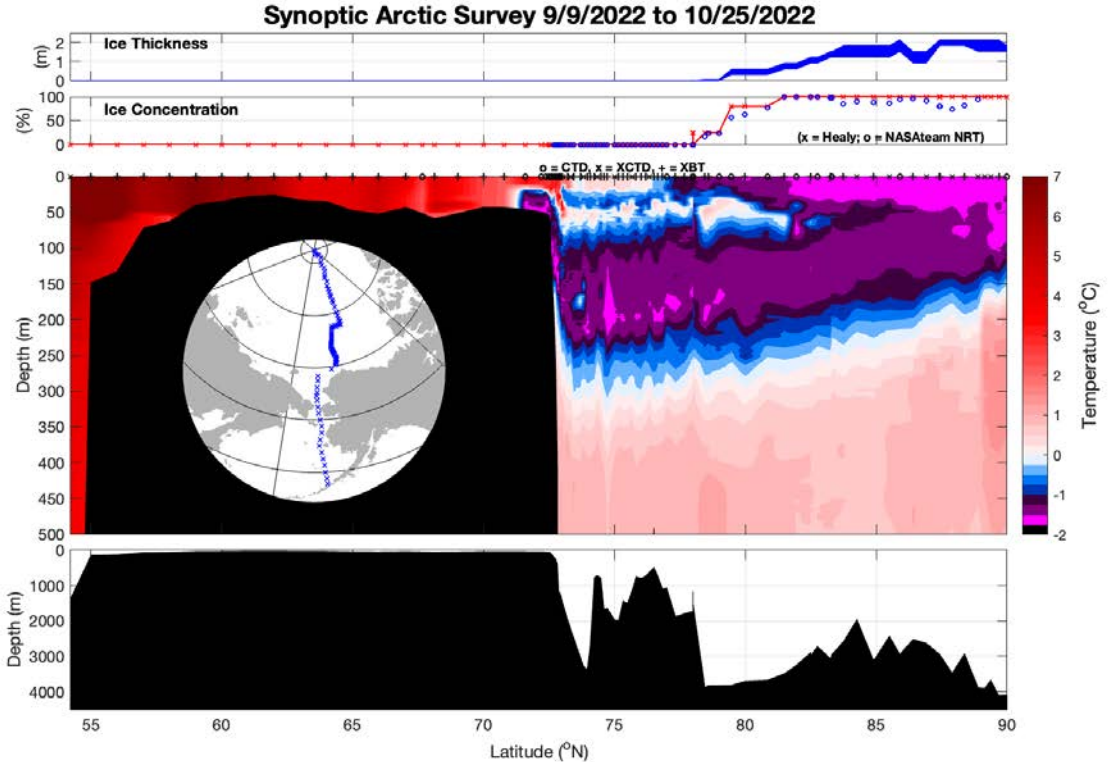
Figure 14. Potential temperature profiles for the upper 500 m of the water column plotted by region as in Figure x.




Chukchi Borderlands to Hanna Shoal via Hanna Canyon
Depth (m)
Θ (°C)
Salinity
σ0 (kg m-3)
o = CTD, x = XCTD, + = XBT
Distance along transect (km)


HSE Transect: Chukchi Slope
Depth (m)
Θ (°C)
Salinity
σ0 (kg m-3)
o = CTD, x = XCTD, + = XBT
Distance along transect (km)


Hanna Canyon
Depth (m)
Θ (°C)
Salinity
σ0 (kg m-3)
o = CTD, x = XCTD, + = XBT
Distance along transect (km)


Synoptic Arctic Survey 9/9/2022 to 10/25/2022
Ice Thickness
(m)
Ice Concentration
(%)
(x = Healy; o = NASAteam NRT)
o = CTD, x = XCTD, + = XBT
Depth (m)
Temperature (°C)
Latitude (°N)

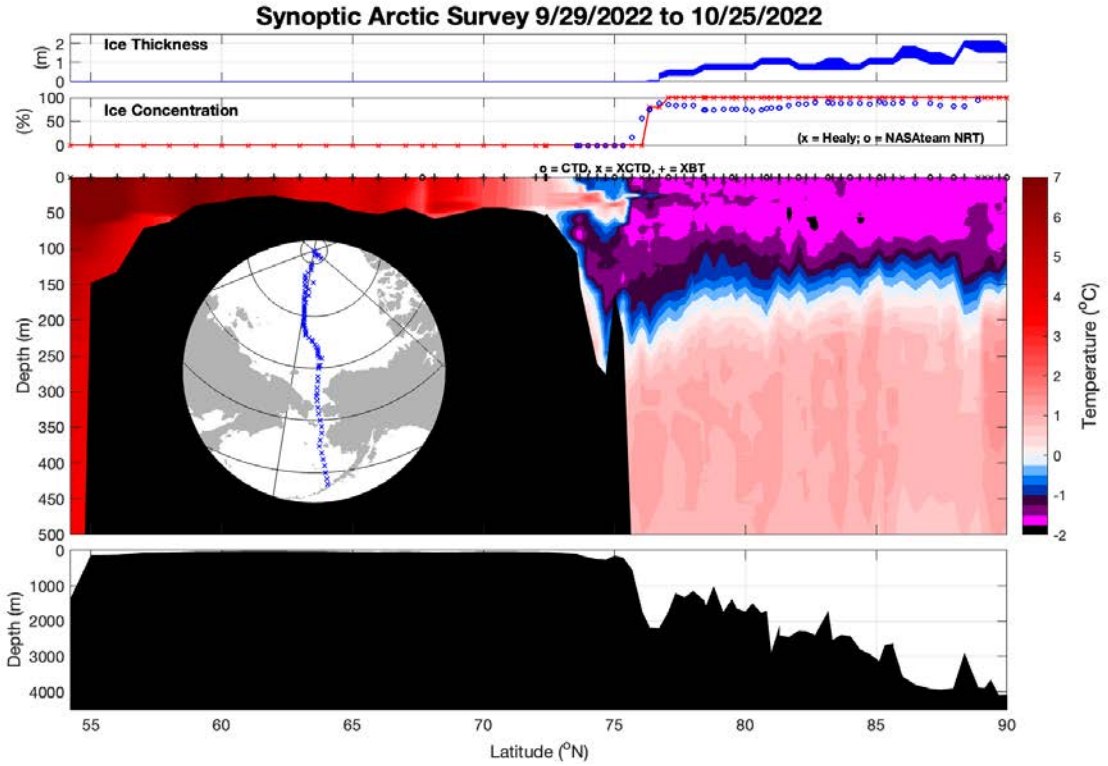
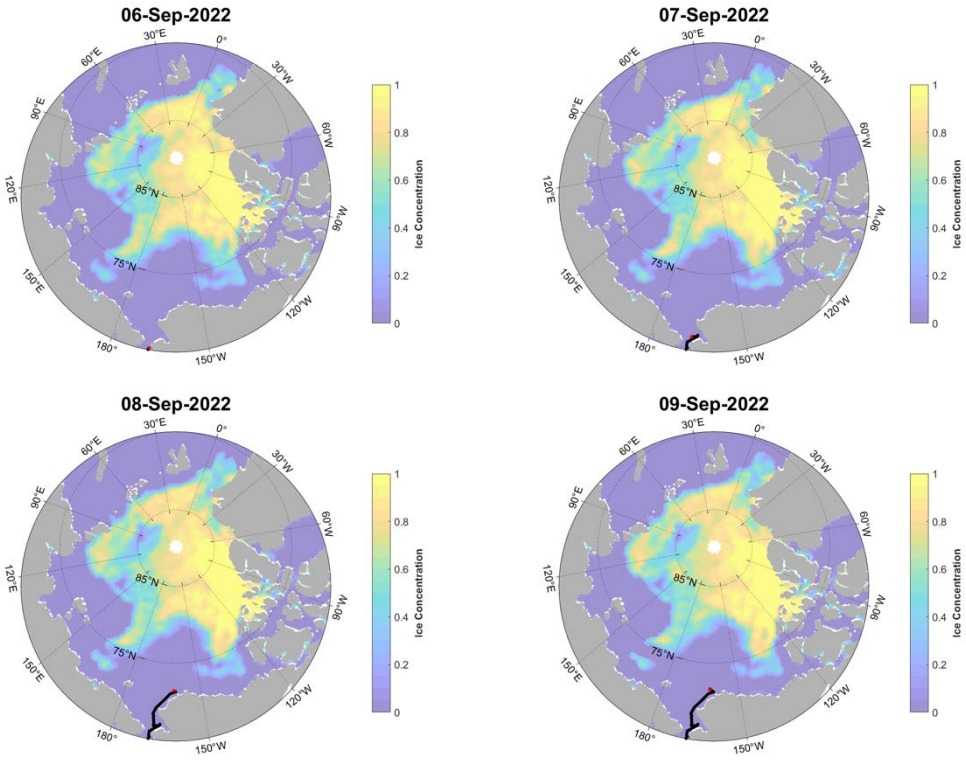
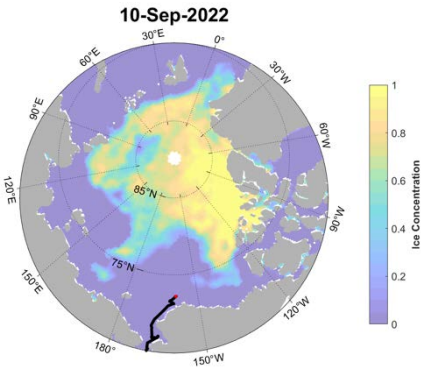
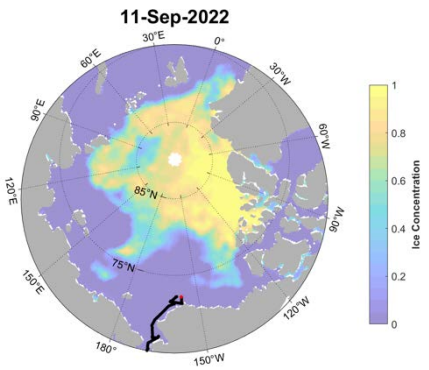
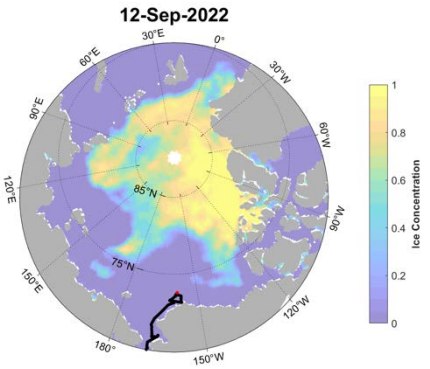


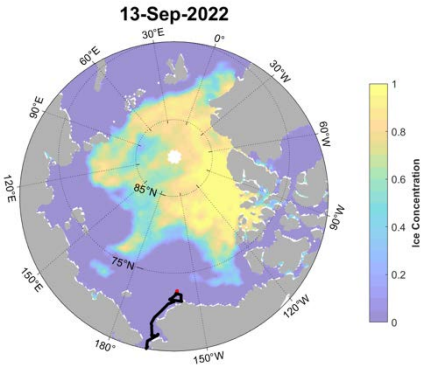
Figure 16. Temperature cross-sections between the Bering Canyon and the North Pole for the 150°W transect crossing the Northwind Ridge (top) and across the Chukchi Borderlands (bottom)

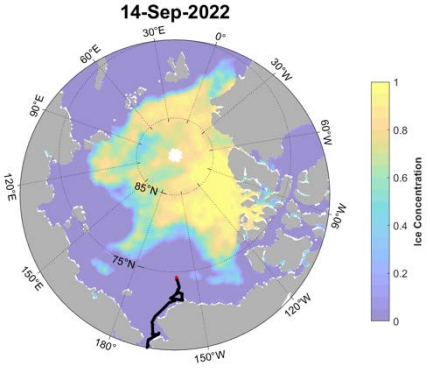


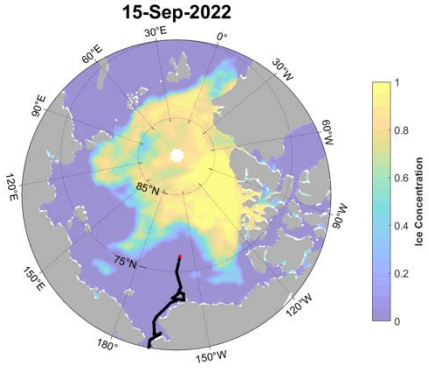

10-Sep-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

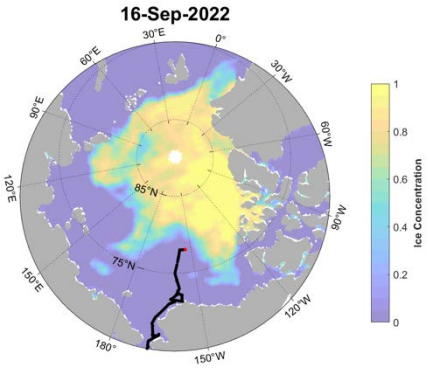

11-Sep-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

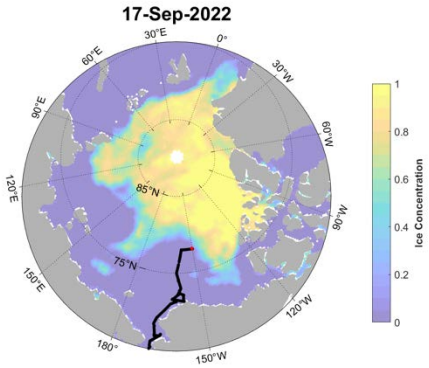

12-Sep-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

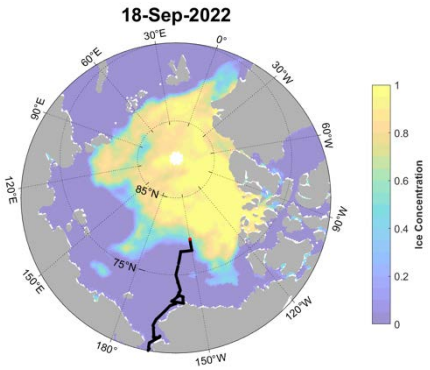

13-Sep-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

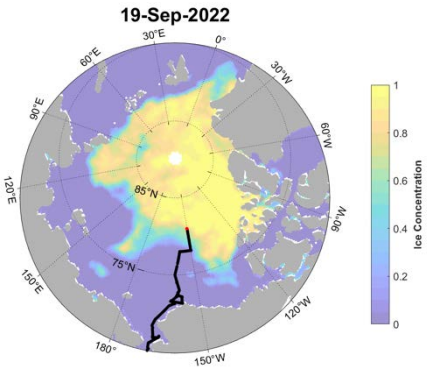

14-Sep-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

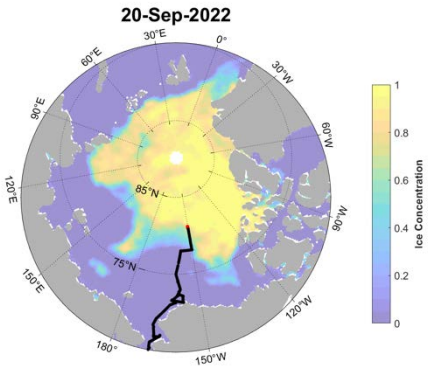

15-Sep-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

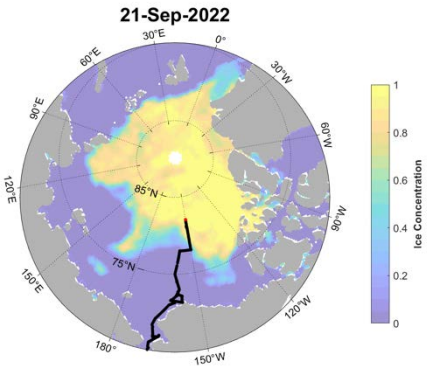

16-Sep-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

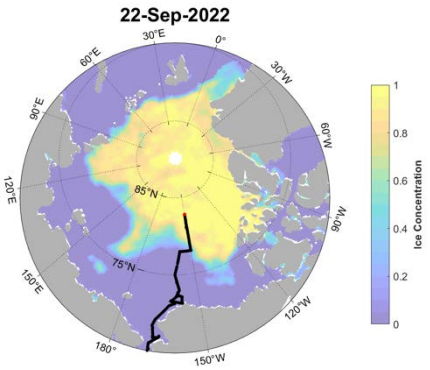

17-Sep-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

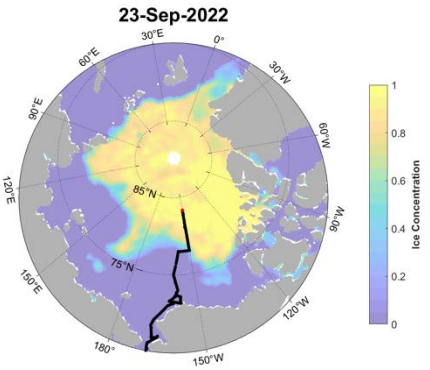

18-Sep-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

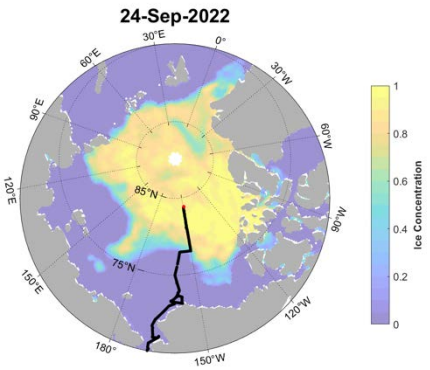

19-Sep-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

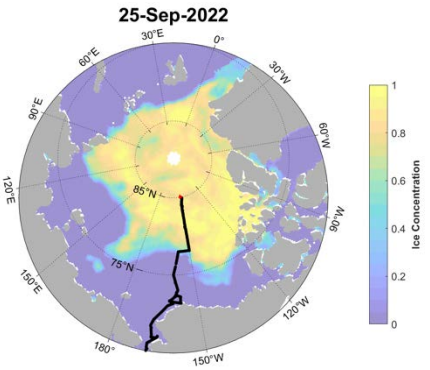

20-Sep-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

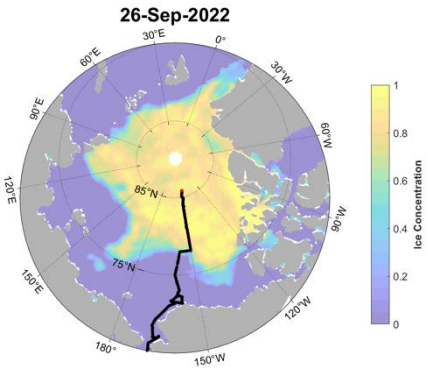

21-Sep-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

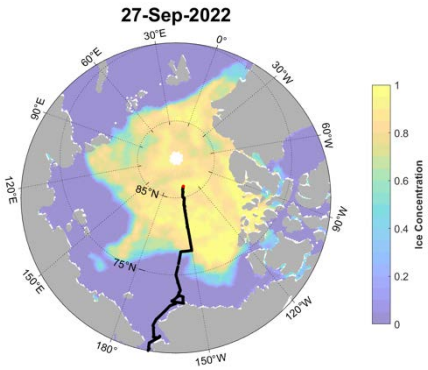

22-Sep-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

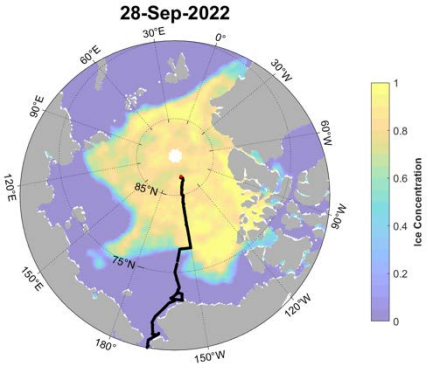

23-Sep-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

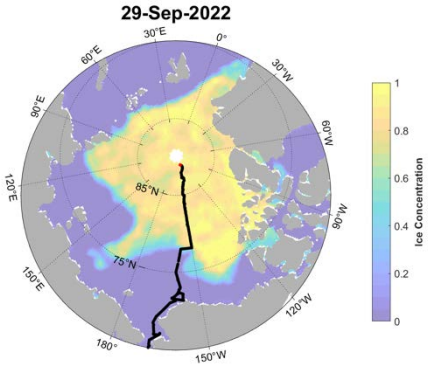

24-Sep-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

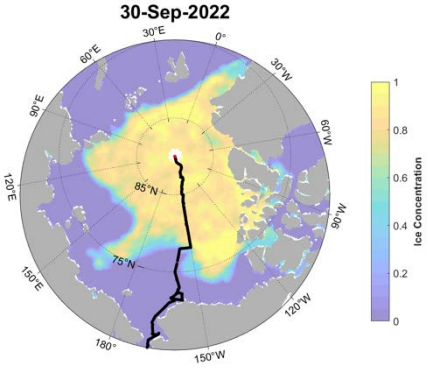

25-Sep-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

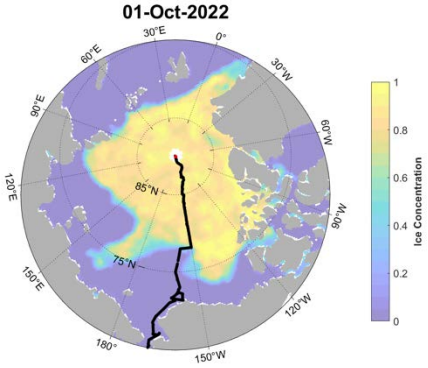

26-Sep-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

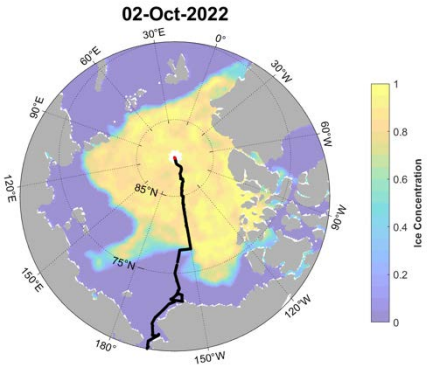

27-Sep-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

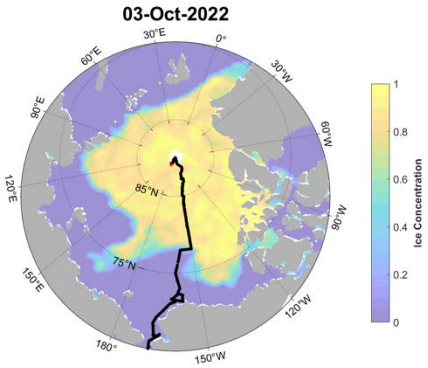

28-Sep-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

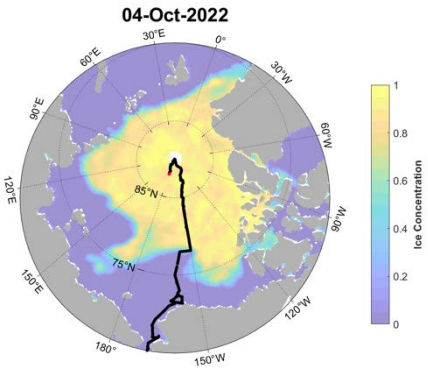

29-Sep-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

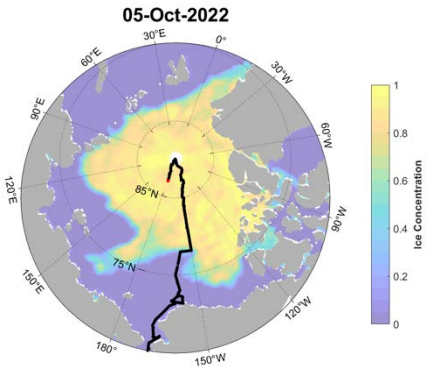

30-Sep-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

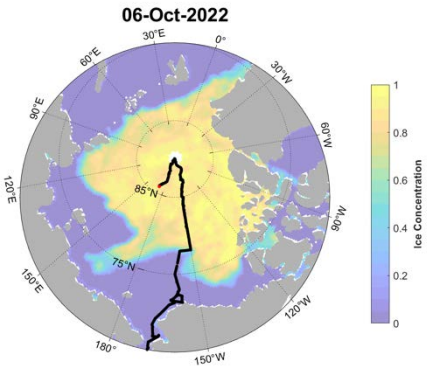

01-Oct-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

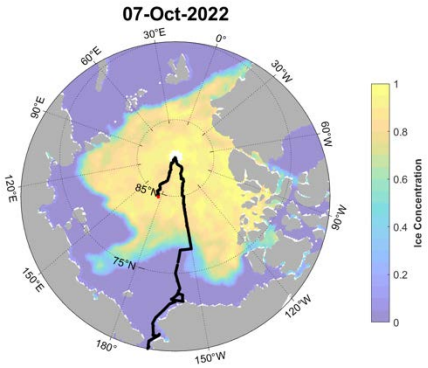

02-Oct-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

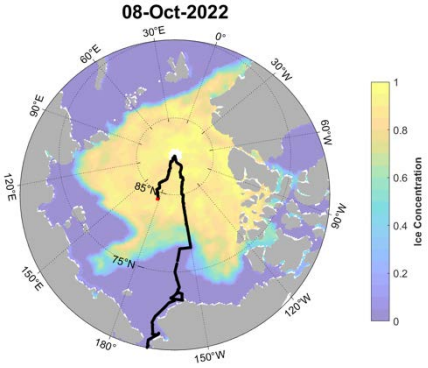

03-Oct-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

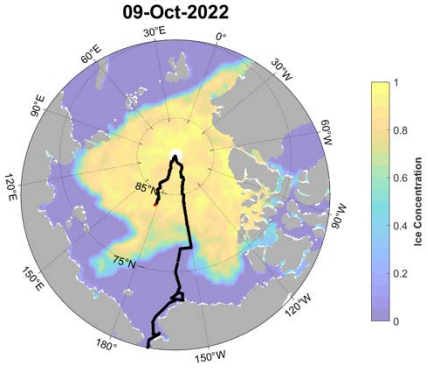

04-Oct-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

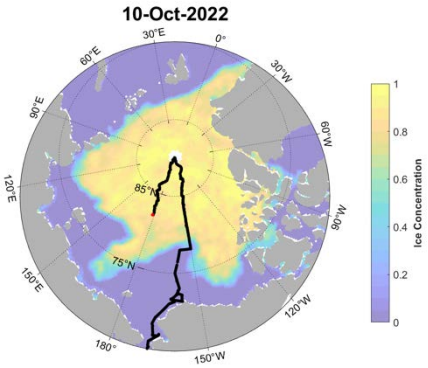

05-Oct-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

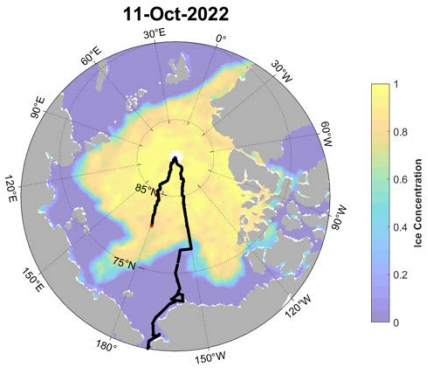

06-Oct-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

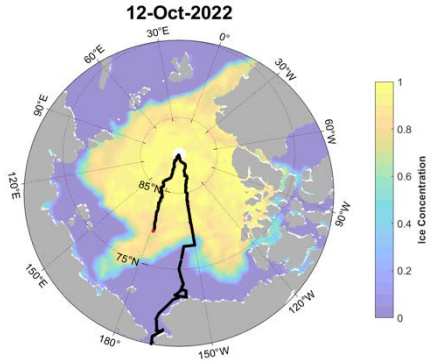

07-Oct-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

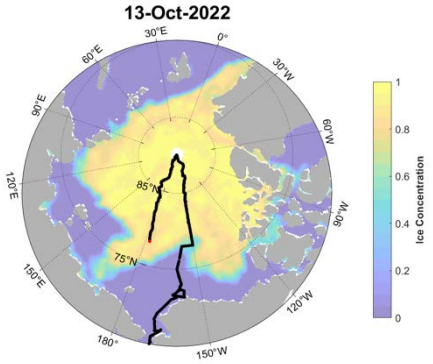

08-Oct-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

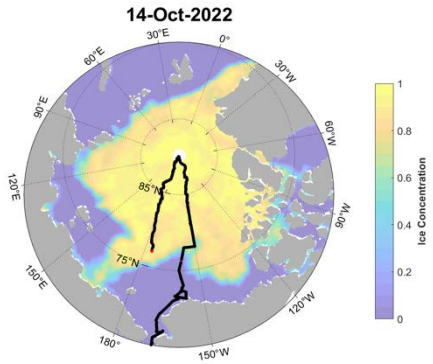

09-Oct-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

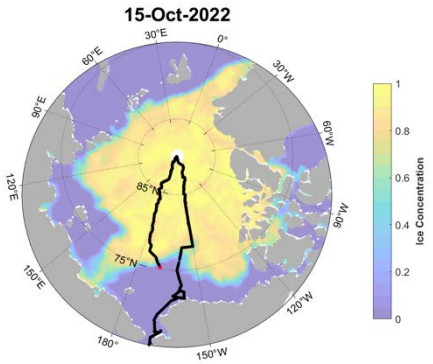

10-Oct-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

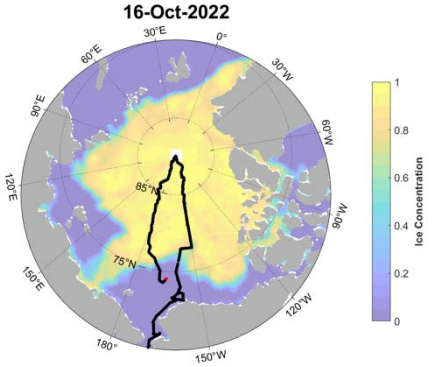

11-Oct-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

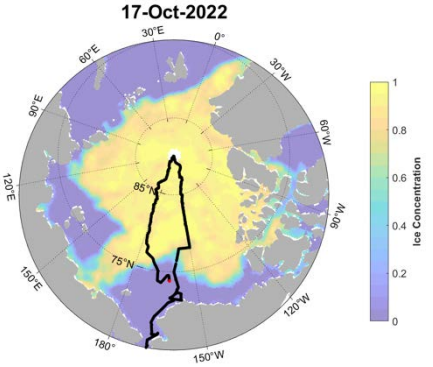

12-Oct-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

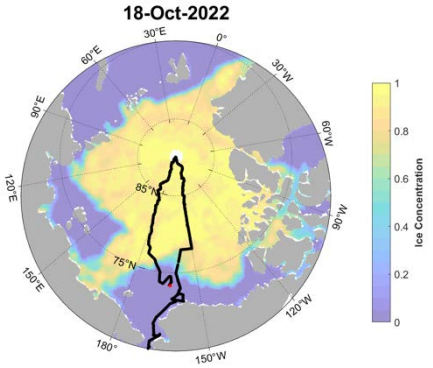

13-Oct-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

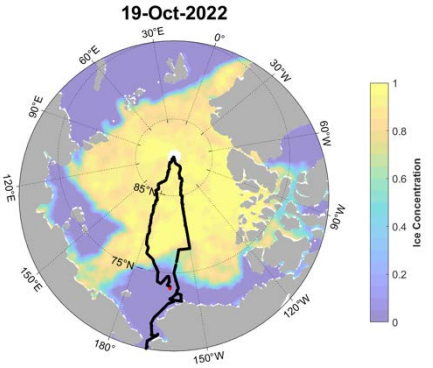

14-Oct-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0


15-Oct-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0


16-Oct-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0


17-Oct-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0


18-Oct-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0


19-Oct-2022
30°E
0°
30°W
60°E
60°W
90°E
90°W
120°E
120°W
150°E
150°W
180°
85°N
75°N
Ice Concentration
1
0.8
0.6
0.4
0.2
0

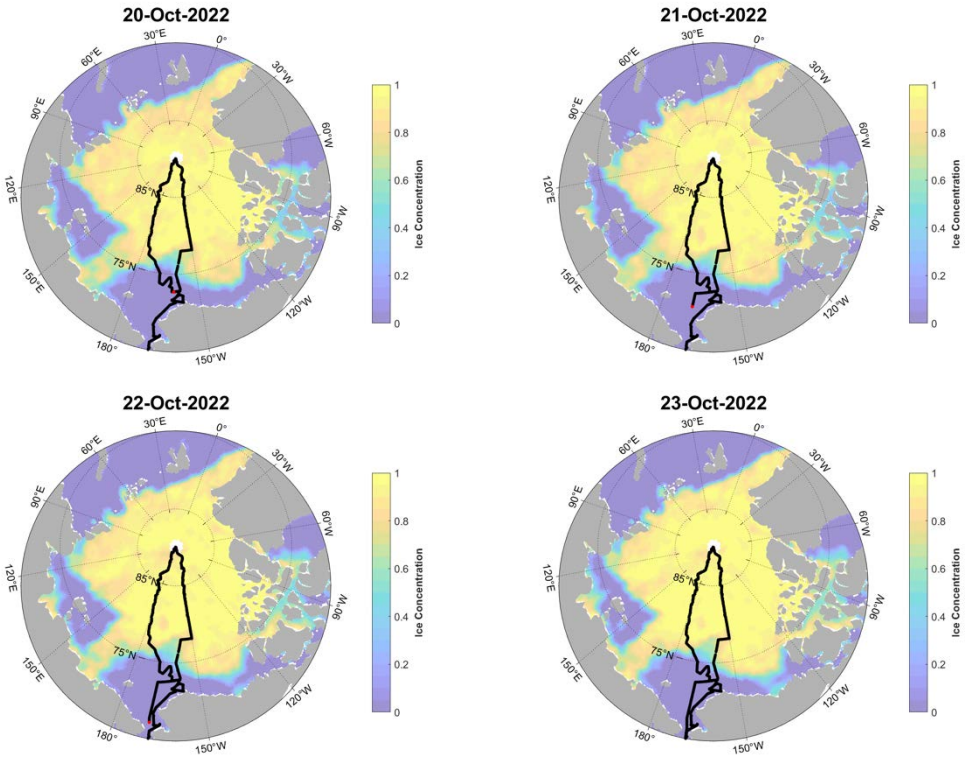


Figure 17. Satellite imagery showing sea ice concentration for each day of the cruise on which the ship was in the ice. (Imagery from MRSE Satellite).

CEO mooring

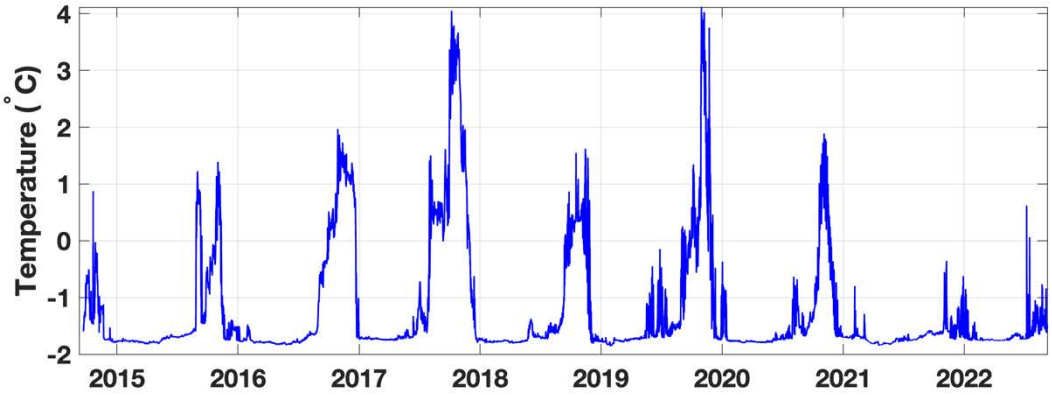
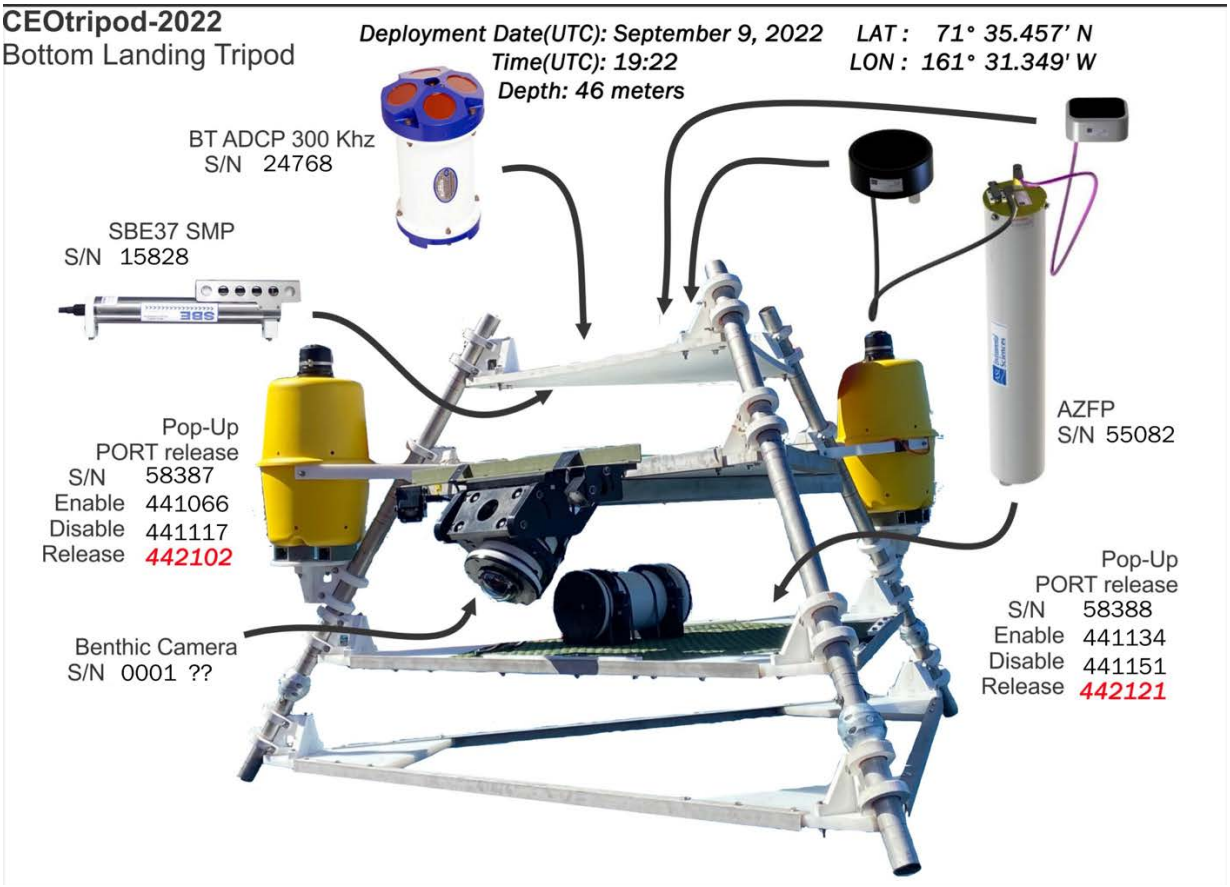


Figure 18. Near-bottom temperature at the Chukchi Ecosystem Observatory. The 2022 recovery added two years of data to the CEO data record.

Deployed Moorings



Chukchi Ecosystem Observatory, CEM2-22

Latitude **71° 36.0420' N** Longitude **161° 32.4510' W**

Deployment Date UTC **September 9, 2022** Deployment TimeGMT- **17:23**

Height (Top)
-12 m

33 meters below surface

Xeos Locator Beacon	SN **300234064975390**
SUNA V2:NO3	SN **801**
SBE-37SMPODO (T/S/P)	SN **21695**
-ECO-PAR SN **546**	ECO-Triplet SN **1592**
SeapHOx (P/T/S/pH/Ox)	SN 37-**21101**/pHet-**2105**
SaMI CO2	SN **C22u**

2.54 meters 3/8" line

S-L-S

-7.44 m

Sediment Trap SN **1230119**
SoundTrap SN **7172**

S-L-S

1.74 meters 3/8" line

S-L-S
2 Ton Swivel

-3.05 m

Acoustic Releases:
Dual Push-Off Release Transponders

SN#1	**59877**	**SN#2**	**59878**
Enable	**515416**	**Enable**	**515450**
Disable	**515435**	**Disable**	**515473**
Release	***532026***	**Release**	***532043***

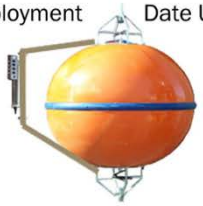
Anchor at depth of 46 meters

Chukchi Ecosystem Observatory, CEM1-22

Latitude 71° 36.026' N Longitude 161° 29.974' W

Deployment Date UTC: **September 9, 2020** Deployment Time: **18:18**

Height (Top) -12.00 m



33 meters below surface

33" Flotation Technologies ADCP buoy

Xeos Locator Beacon **SN 300234063212650**

MicroCAT 37SMP (C,T,P) **SN 4901**

S-L-S

2.1 meters 3/8" line

-8.21 m

Green Eyes Water Sampler **SN 3011**

3.16 meters 3/8" line

S-L-S

2 ton Swivel

-3.02 m

MicroCAT 37SMP (C,T,P) **SN 1429**

Acoustic Releases: **Dual Push-Off Release Transponders**

SN#1	**36425**	**SN#2**	**36427**
Enable	**414047**	**Enable**	**414153**
Disable	**414064**	**Disable**	**414170**
Release	**431564**	**Release**	**431625**

Anchor at depth of 46 meters

Video Plankton Recorder (ViPeR)

Carin Ashjian (cashjian@whoi.edu), John Wigglesworth (jcwiggs11@gmail.com) – Woods Hole Oceanographic Institution

The Digital Autonomous Video Plankton Recorder (DAVPR) was used to describe high-spatial resolution, vertical distributions of plankton and particles and to aid in an assessment of vertical particle distribution and carbon content. The DAVPR is a self-contained, underwater video microscope system that provides *in-situ* images of plankton and particles. The magnification used was setting S0 (smallest field of view) to be able to detect and image marine snow particles. The VPR was deployed off the stern, initially from the 9/16" wire and then later from the 0.322" wire. The instrument was kept inside the heated aft staging area and wheeled out to the fantail for each cast (Fig. 19). Casts were done to ~10 m off the bottom at stations 300 m deep or less and to 300 m at deeper stations (Fig. 20). A total of 31 successful DAVPR casts out of 32 deployments casts were obtained (for one deployment, the battery died and data were not collected)

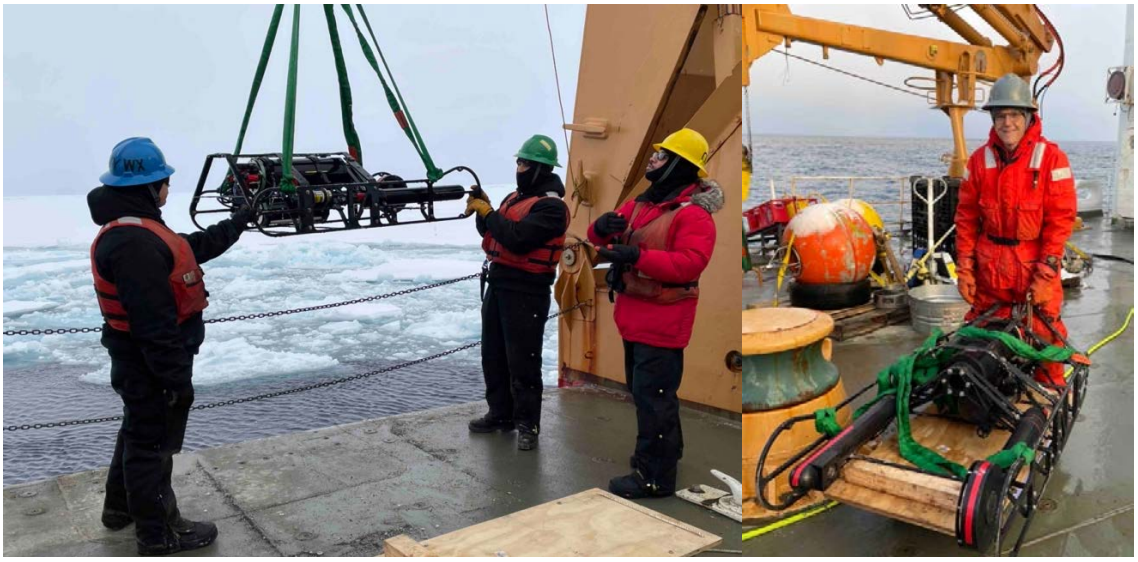


Figure 19. (Left) DAVPR being deployed by the USCG deck crew. (Right) John Wigglesworth wheels the DAVPR out to the fantail for deployment.

The DAVPR is equipped with a data cartridge to which the data from each cast is transferred after the instrument is shut down. Both data cartridges took on water during the cruise and failed. After that, data were downloaded from the internal hard drive of the instrument using an Ethernet connection (many thanks to Max Holmes for his assistance in setting this up). The CTD on the DAVPR was sensitive to the cold; for some casts during the coldest portion of the trip, the conductivity data were bad until about 50-100 m depth and for one cast even the pressure data were not good. The situation improved once the aft staging area was kept warm.

In-focus images from each tow were extracted using the Autodeck software provided by the manufacturer (SeaScan Inc.). The number of images varied by geographic region.

Plankton/particle concentrations were very low over the deep basins so few images were obtained (80-200 at most locations). Concentrations were greater over the Chukchi Slope and Shelf and several thousand images were collected at those locations.

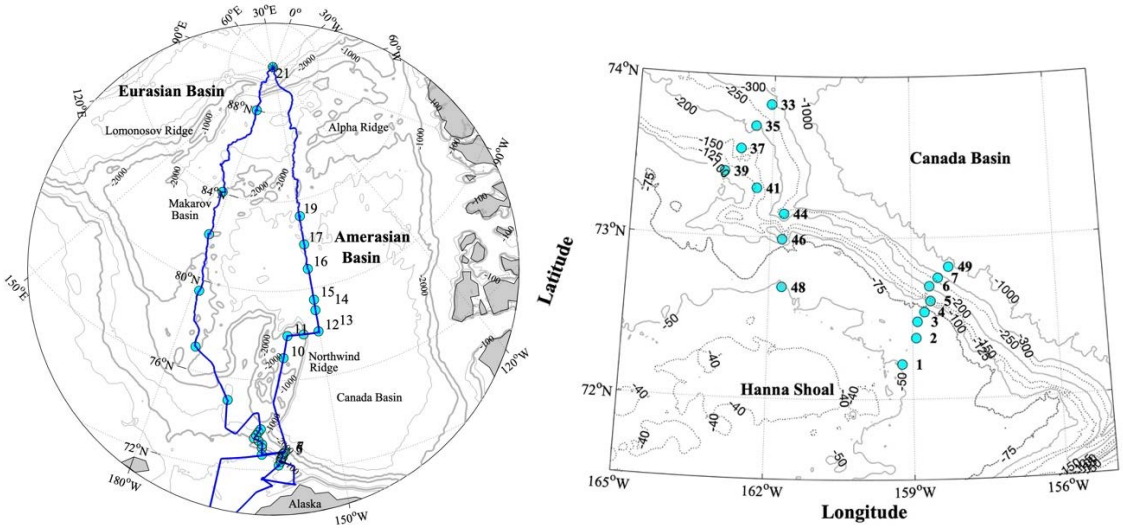


Figure 20. (Left). Locations and station numbers of VPR casts along the entire cruise track except for the southern Chukchi Sea . (Right). Locations and station numbers of VPR casts on Hanna Shoal, along the Chukchi shelf-slope, and during the high-spatial resolution survey along the outflow from Herald alley and across Hanna Canyon.

Zooplankton

Bob Campbell (rgcampbell@uri.edu) and Celia Gelfman (cgelfman@uri.edu) - University of Rhode Island, Graduate School of Oceanography
Carin Ashjian (cashjian@whoi.edu), John Wigglesworth (jcwiggs11@gmail.com) - Woods Hole Oceanographic Institution

Zooplankton were collected using vertical tows with three types of nets: A paired Bongo net system equipped with 53 and 150 µm mesh nets, General Oceanics one-way flow meters, and a Star-Oddi time depth recorder; a 1-m2 ring net equipped with 200 µm mesh net, and a 0.25 m2 Hydrobios Midi Multinet equipped with 150 µm mesh nets (Fig. 21). Bongo tows were conducted at all long stations. Multinet tows were conducted at locations with bottom depths deeper than 100 m except for during the high-spatial resolution survey when Multinet tows were conducted only at the three deepest locations. The ring net was used only once to collect animals for experimental use and morphometric and carbon content measurements at the first station (Station 0 at the CEO); all subsequent tows were conducted with the other nets. During the first portion of the cruise, Bongo tows and the Ring net tow were done using the 9/16" wire rope and the Multinet was conducted from the 0.322 conducting cable, all from the stern. After the 9/16" winch was "retired", Bongo tows also were conducted from the 0.322" wire. Zooplankton were collected at 28 stations (27 Bongo Tows, 1 Ring Net Tow, 16 Multinet tows).

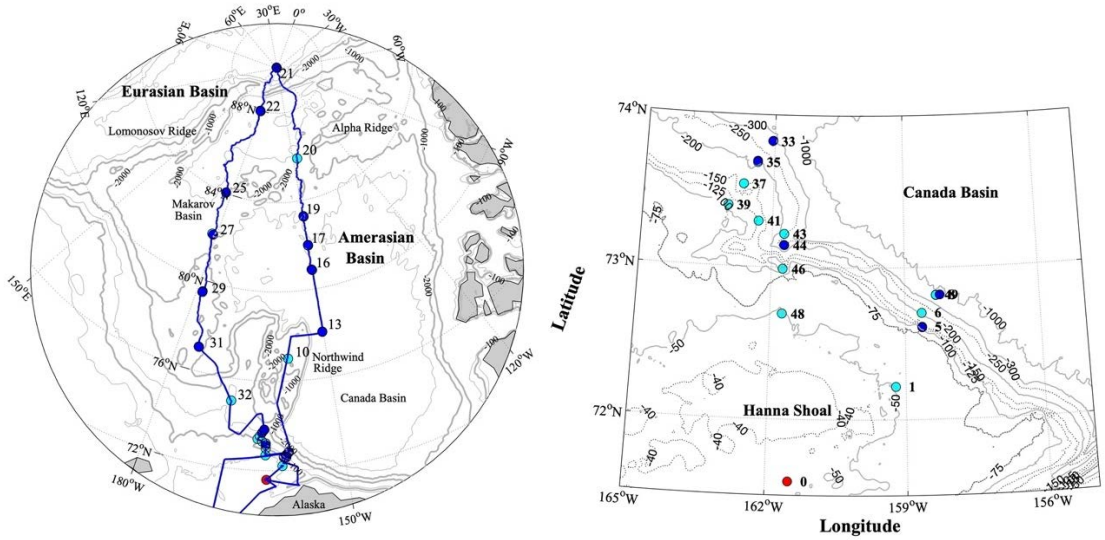


Figure 21. (Left). Locations of net tows along the entire cruise track except for the southern Chukchi Sea . (Right). Locations of net tows on Hanna Shoal, along the Chukchi shelf-slope, and during the high-spatial resolution survey along the outflow from Herald alley and across Hanna Canyon. Red symbol=Ring net; cyan symbol=Bongo tow; dark blue symbol=both Bongo and Multinet tows.

The very cold temperatures presented difficulties in washing the nets and in keeping samples unfrozen. It was necessary to keep the seawater hose drained and inside the house when not in use to prevent it from freezing. The science seawater had quite low pressure so washing the nets was accomplished by first emptying buckets of ambient seawater on the nets while the net was suspended and then finishing the rinse using the hose. The cod ends had to be removed rapidly to keep the sample from freezing. Another problem was that the seawater on the net would freeze in the air and drop down into the cod end, filling it with ice fragments.

Zooplankton for respiration experiments, carbon and nitrogen content, stable isotope content, and morphometric measurements were sorted from the samples prior to preserving the samples in 5% formalin for later enumeration.

Morphometrics, elemental composition, stable isotopes, and population genetics

Prior to preservation, the net samples were quickly transferred to 2 or 4 L jars containing seawater collected with Niskin bottles from below the freshwater layer with a target salinity of 32 to 33 ppt and transferred to an environmental room kept at -1.5 C. Here the animals were sorted from dishpans or under a dissecting microscope for further analyses or respiration experiments (Table 5). All the animals that were removed from the net samples were identified to species/life stage, noted, and tracked so that the samples will remain quantitative.

Individual zooplankton were identified to species and life stage under the dissecting scope, their photographs taken at an appropriate magnification, and then placed into tin boats where they were dried at 60°C for 24 hrs. prior to being stored in desiccators until they can be analyzed for carbon (C) and nitrogen (N) content via an elemental CN analyzer at URI or for N and C stable isotope composition at the University of Maryland. Morphometric measurements

will be made on the images at URI with image analysis software. Over 4300 samples were collected for these analyses (Table 6).

In addition, zooplankton primarily *Calanus glacialis, C. hyperboreus* and *Metridia longa* were sorted individually from the collections into scintillation vials containing 95% ETOH for population genetic analysis (Table 7). More that 2100 individuals were collected for analysis.

Respiration Rates

Respiration rates of dominant species and stages were determined in the dark, in filtered seawater (32 – 33 ppt), in 60 ml or 300 ml BOD bottles using an Optode oxygen sensing system (Table 8). Experiments were conducted at 15 stations with 14 different species/life stages. At several locations respiration rates were conducted on *Calanus hyperboreus* females collected from several different depths. These rates will allow for the estimation of basal metabolic rates that will be used to determine the energy requirements for surface and deep, dwelling overwintering animals.

General Observations.

Most mesozooplankton samples appeared to be dominated in terms of biomass by Calanoid copepods and in particular by *Calanus* spp. *Calanus glacialis* dominated the biomass in the shelf/slope region and also in surface waters (0-200 m) in the CAO basins. Stage C5 was more abundant in shallow water, while females had much higher abundance in deeper water. *C. hyperboreus* were more important in basin waters and mostly in subsurface layers (>200 m). Females was generally the dominant stage in terms of biomass. However, stages C2 to C5 were generally present as well. *Metridia longa* C5 and adult females were also very abundant in the basin surface water. Smaller copepod species were dominant in terms of abundance throughout the survey region. *Pseudocalanus* were very noticeable at the southern stations. *Oithona* prominent at the northern most stations, were also present at most locations. Once the samples have been enumerated a much more detailed picture will emerge

We also observed a large phytoplankton bloom at the end of the survey that occurred between Sts. 31 and 48 that was dominated by large diatoms including *Chaetoceros* spp. and pennate diatoms, with their relative proportions varying between stations. *Coscinodiscus* spp. were also present in the bloom, but at lower abundances. The zooplankton that were collected in the surface waters had full guts, evidence that they were feeding on the bloom.

Table 5. Summary of samples collected and respiration experiments conducted during the cruise.

Station	CN / Stable Isotopes	Genetics	Respiration
0	x	x	x
1	x	x	
5	x	x	
6	x	x	x
8	x	x	
10	x	x	
11	x		x
13	x	x	x

16	x	x	x
17	x	x	x
19	x	x	x
20	x	x	x
21	x	x	x
22	x	x	x
25	x	x	x
27	x	x	
29	x	x	x
31	x	x	
32	x	x	x
33	x	x	
37	x	x	
39		x	
41	x	x	
43	x	x	
44	x	x	
46	x		
48	x	x	x
49	x	x	
50	x	x	x
Sum	28	27	15

Table 6. Total samples taken for morphometric analysis and elemental CN or CN stable isotopes.

Species	***Calanus glacialis***						***Calanus hyperboreus***						
Stage	F	M	C5	C4	C3	Total	F	M	C5	C4	C3	C2	Total
Station													
0	7	3	81	62		153							
1	1	1	51	30		83			11	1			12
5	4		51	59		114	10		3	4	6		23
6	7		28	34	1	70	23	1	4	16	1		45
8	5		33			38	15		12	32	1		60
10	25		30			55	29		25	36	6		96
11							18		17				35
13	39					39	47		30				77
16	27		34	15		76	87		31	14	15		147

17	32		32			64	41		17		29	8	95
19	31		31			62	48		40				88
20	35		36			71	36		19				55
21	39					39	112		24				136
22	29		34			63	66		16	10	20		112
25	45	3	30			61	57		8				65
27	47	1	36	5		89	13	42	27	2	10		94
29	39	1	16	15		65	49		43	28	34		154
31	33	1	30			63	62	1	57				120
32	11		29	31		71	6						6
33			17			17	15						15
37			14	15		29							
41			17	17		34	4						4
43							15						15
44			15			15	15						15
46			15			15	6		4				10
49			36			36	20		15				20
48			16			16							
50		30	30			60							
Totals	456	40	742	283	1	1498	794	44	403	143	122	8	1499

Species	***Metridia longa***				**Other copepod**	**Chaetognath**	**Ostracod**	**Krill**	**Amphipod**	**All Zoop**
Stage	F	M	C5	Total	Total	Total	Total	Total	Total	Total
Station										
0					10					163
1					60					155
5					8	9				154
6	4	3	34	41	4					160
8	1		48	49	17					164
10	47			47	1					199
11										35
13	28			28	34			1	6	185
16	5			5	32					260
17					28		9			196
19	39			39		7	12			208
20	29			29	71	8	19		1	254
21	40		30	70	45		46		3	339

22	31			31	53	3	28	1		291
25	40			40	5				1	172
27	33	1	14	48	31			1		263
29	30			30	51	15	22		2	339
31	31			31	2				2	218
32	19		29	48		22			2	149
33										32
37										29
41										38
43					5					20
44										30
46										25
49	30			30	17					103
48					5			26		47
50								21		81
Totals	407	4	155	566	479	64	136	50	17	4309

Table 7. Samples collected at each station for population genetic analysis.

Station	*Calanus glacialis*	*Calanus hyperboreus*	*Metridia longa*	Other Copepods	Other Zooplankton	Aliquot from whole
0	57					
1	60					
5	46					
6	32					
8	31	26				
10		44				
13	32	25	26			
16	10	57	52	2		
17	33	23	37	1		
19	26	32	33	7		
20	59					
21	39	41	33	3		
22	43		35	30		
25	62	31				
27	58	28	34			
29	36	34	31			
31	31	41	30			
32	69	1	33	4		

33	36	40	39	3		
37	60	11	25		1	Yes
39	1					Yes
41	124	9			5	
43		21		1	2	Yes
44	23	39	9	12	2	
48	30			4		
49	44	23	35	4	8	
50	46		1	5	1	
Total	1088	526	453	76	19	

Table 8. Summary of respiration experiments including zooplankton taxa and life stage and the total number of experiments conducted for each taxa.

Zooplankton Taxa	Life Stage	Exps.
Copepoda		
Calanus glacialis	C4	1
	C5	6
	C6F	7
	C6M	1
Calanus hyperboreus	C5	3
	C6F	23
Metridia longa	C5	2
	C6F	2
Paraeuchaeta spp.	C5	2
	C6F	4
Neocalanus cristatus	C5	1
Euphausiacea		
Thysanoessa spp.	Juvenile	5
Chaetognatha		4
Ostracoda		1
Total		62

Benthic Studies

Jackie Grebmeier (jgrebmei@umces.edu), Lee Cooper (cooper@umces.edu), Christina Goethel (cgoethel@umces.edu), Brian Marx (bmarx@umces.edu) - University of Maryland Center for Environmental Science, Solomons, MD
Jona Silberberg (jonasilberberg@gmail.com), Christian-Albrecht-University, Kiel, Germany

with additional sampling assistance by Michael Tepper-Rasmussen, MARSSAM, University of Oregon (tepper.rasmussen@gmail.com; multi-corer technician) and Clare Gaffey (Clark University (cgaffey@clarku.edu)

Overview

Station sampling for the US Synoptic Arctic Survey (SAS) was the primary cruise objective for our component where we occupied stations for water column and sediment measurements, including at the Chukchi Environmental Observatory (CEO). **Table 9** lists the basic station information that we collected samples at. Our team collected vertical profiles of seawater for determinations of chlorophyll biomass, nutrients, oxygen-18/oxygen-16 ratios, and dissolved organic carbon (DOC) for water mass characteristics, bottom water for subset of sediment incubation experiments, and subsamples for phytoplankton taxonomy. Benthic sampling included macro-, meio-, and micro-faunal collections, surface sediments for key parameters (total organic carbon and nitrogen, grain size, sediment chlorophyll, and bacterial content), sediment oxygen uptake rate experiments, and individual bivalve respiration rate measurements.

Table 9. Station information for collections made during the HLY2202 cruise. Key: CEO=Chukchi Environmental Observatory, EHS=East Hanna Shoal (from 2002 Shelf-Basin Interactions cruise), HV=Hanna Valley, and CBL=Chesapeake Biological Laboratory (internal station name). Stations not listed were data from CTD sensors only, XBT, of XCTDs.

Station Number	Station Name	Date Occupied (local)	Latitude (°N)	Longitude (°W, °E if noted)	Bottom depth (m)
000	CEO	9/9/22	71 35.45	161 31.72	46
001	EHS1	9/10/22	72 12.902	159 13.266	50
005	EHS4	9/12/22	72 36.542	158 38.023	116
006	EHS5	9/13/22	72 42.325	158 37.123	204
008	EHS6	9/13/22	72 49.223	158 18.104	395
010	CBL1	9/15/22	76 59.905	157 59.544	1020
011	CBL2	9/16/22	78 00.683	156 59.833	1544
012	CBL3	9/16/22	77 59.874	153 29.888	1731
013	CBL4	9/17/22	78 00.217	149 59.936	3826
014	CBL5	9/18/22	78 59.701	150 0.33	3828
016	CBL6	9/19/22	80 50.269	149 59.009	3793
017	CBL7	9/21/22	81 57.096	149 52.800	3257
018	CBL8	9/22/22	82 43.37	149 58.985	2724
019	CBL9	9/23/22	83 18.694	149 48.475	3017
020	CBL10	9/26/22	85 53.945	147 34.970	2624
021	CBL11-NP	9/30/22	89 59.306	0-180 E/W	4101
022	CBL12	10/4/22	87 57.19	179 17.91E	3941

023	CBL13	10/5/22	87 04.628	179 26.73	3940
024	CBL14	10/7/22	85 07.08	170 56.231E	3081
025	CBL15	10/8/22	84 0.828	177 49.308E	2432
026	CBL16	10/9/22	83 09.811	177 04.814E	1758
027	CBL17	10/10/22	82 02.383	178 59.38E	2284
028	CBL18	10/11/22	80 48.52	179 48.21	1686
029	CBL19	10/12/22	79 38.013	178 36.201	1426
030	CBL20	10/13/22	78 29.595	178 36.93	1404
031	CBL21	10/14/22	77 04.43	175 49.49	1740
032	CBL22	10/15/22	75 0.380	167 57.912	167
033	HC1	10/17/22	73 49.347	162 04.478	290
035	HC3	10/17/22	73 41.321	162 22.958	225
037	HC5	10/18/22	73 37.299	162 33.146	174
039	HC7	10/18/22	73 23.94	163 02.07	105
041	HC9	10/18/22	73 18.377	162 19.527	126
044	HC12	10/19/22	73 08.502	161 43.638	272
046	HC14	10/19/22	72 59.089	161 43.944	112
048	HC16	10/19/22	72 41.432	161 43.755	49
049	EHS6	10/20/22	72 49.268	158 18.403	395
050	DBO3.8	10/22/22	67 40.264	168 55.732	49

Preliminary results indicated very low chlorophyll water column and sediment biomass in the deep Arctic basin, with highest values on the shelf and slope. Macrofaunal population and sediment respiration rates were highest on the Chukchi shelf, declining to extremely low levels in the high Arctic, consistent with lower water column chlorophyll biomass in both the water column and surface sediments under more persistent ice cover. However, significant chlorophyll biomass was present on the shelf and slope as late as mid-October. Benthic images showed marine snow on the outer shelf and slope, with little detritus in the deep Arctic Basin.

Below is a listing of the samples collected during the cruise as part of our water column and benthic component.

A. Water column sampling (lead Lee Cooper)

Water samples were collected during the SAS cruise for chlorophyll a, stable oxygen isotopes, dissolved organic carbon (DOC), phytoplankton populations, and inorganic macronutrients, specifically nitrate + nitrite, silica, phosphate and ammonia **(Table 10).** Generally, samples were collected at all stations where water collections were made using the rosette bottle system. 12 depths were collected for stable oxygen isotopes, dissolved organic carbon and inorganic macronutrients, and six depths (75, 50, 40, 30, 20, 10m) were typically collected for chlorophyll and phytoplankton collections (mixed from all six depths). In some cases where a chlorophyll maximum was identified or depths were less than 75m, different numbers of samples were collected. Chlorophyll samples were analyzed shipboard using a Turner Designs Trilogy fluorometer in the Welschmeyer non-acidification mode and data are available, but calibration checks at the end of the cruise versus the beginning of the cruise with known standards indicated that some adjustments will be necessary and thus the data will be released in the near future, including following comparison with data from Clare Gaffney of Clark University, who is returning to her home laboratory with separate frozen filters to be

measured using the more traditional acidification method for fluorometric determination of chlorophyll a.

All other samples were returned frozen (nutrients and DOC) or shelf stable (stable isotopes and phytoplankton samples preserved with Lugol's solution and added formalin) to the Chesapeake Biological Laboratory for analysis over the coming months. **Table 2** includes a record of all water column samples collected at each station.

Table 10. Water column collections during the HLY2202 SAS cruise. Key: CEO=Chukchi Ecosystem Observatory, EHS=East Hanna Shoal, HV=Hanna Valley. CBL=Chesapeake Biological Laboratory internal station name. X=collection.

Station Number	Station number/name	Chlorophyll and Phytoplankton	Stable Oxygen Isotopes	Dissolved Organic Carbon	Nutrients
000	CEO	X	X	X	X
001	EHS1	X	X	X	X
003	EHS3	X	X	X	X
005	EHS4	X	X	X	X
006	EHS5	X	X	X	X
008	EHS6	X	X	X	X
010	CBL1	X	X	x	X
011	CBL2	X	X	X	X
012	CBL3	X	X	X	X
013	CBL4	X	X	X	X
014	CBL5	X	X	X	X
016	CBL6	X	X	X	X
017	CBL7	X	X	X	X
018	CBL8	X	X	X	X
019	CBL9	X	X	X	X
020	CBL10	X	X	X	X
021-NP	CBL11	X	X	X	X
022	CBL12	X	X	X	X
023	CBL13	X	X	X	X
024	CBL14	X	X	X	X
025	CBL15	X	X	X	X
026	CBL16	X	X	X	X
027	CBL17	X	X	X	X
028	CBL18	X	X	X	X
029	CBL19	X	X	X	X
030	CBL20	X	X	X	X
031	CBL21	X	X	X	X
032	CBL22	X	X	X	X
033	HC1	X	X	X	X
035	HC3	X	X	X	X
037	HC5	X	X	X	X
039	HC7	X	X	X	X
041	HC9	X	X	X	X
044	HC12	X	X	X	X
046	HC14	X	X	X	X

048	HC16	X	X	X	X
049	EHS6	X	X	X	X
050	DBO3.8	X	X	X	X

B. Benthic macrofaunal and sediment sampling (lead Jackie Grebmeier)

A 0.1 m^2 weighted van Veen grab was used for collecting seafloor macrofauna (population studies) and sediments at stations 200m and shallower, along with subsampling for multiple sediment parameters (sediment chlorophyll a, organic carbon and nitrogen content, grain size, bacteria (see Goethel, section D) and meiofauna (Silberberg-section E). At stations deeper than 200m depth, all sediment samples were collected from an 8-tube Multi-Core 800 for sediment macrofaunal, meiofaunal, and bacterial population studies, along with other sediment parameters listed previously. Initially all grabs and coring devices were deployed from the stern 9/16th wire, but later in the cruise a winch malfunction required us to use the 0.680" or 0.322" wires for deployment. See **Table 11** for a summary of benthic sediment collections.

Table 11. Sediment collections during the HLY2202 cruise. Key: CEO=Chukchi Environmental Observatory, EHS=East Hanna Shoal, HV=Hanna Valley, NP=North Pole, CBL=Chesapeake Biological Laboratory (internal). Note sediments parameters collected from van Veen grab collections to 200m, then all parameters collected >200 m from Multi-corer (MC). Key: a=One sectioned MC for analysis. A benthic camera was deployed on most coring devices (=no camera due to low battery level).*

Station Number	Station Name	Sediment Chlorophyll	Sediment TOC/N, grain size, bacterial content	Van Veen grabs for fauna (4)	Van Veen grab for sediments (1)	Haps corer, HC or Multi-corer, MC, with camera (# SCOC cores); *=no camera
000	CEO	X	X	X	X	HC (10)
001	EHS1	X	X	X	X	HC (2)
005	EHS4	X	X	X	X	HC (2)
006	EHS5	X	X	X	X	HC (3)
008	EHS6	X	X	-	-	HC (1)
010	CBL1	X	X	-	-	MC (4)
013	CBL4	X	X	-	-	MC (4)
016	CBL6	X	X	-	-	MC (4)
018	CBL8	X	X	-	-	MC (4)
021-NP[a]	CBL11	X	X	-	-	MC (4)
022	CBL12	X	X	-	-	MC (4)
025	CBL15	X	X	-	-	MC (4)
027	CBL17	X	X	-	-	MC (4)
029	CBL19	X	X	-	-	MC (4)
031	CBL21	X	X	-	-	MC (4)
032	CBL22	X	X	X	X	MC (4)
033	HC1	X	X	-	-	MC (4)
035	HC3	X	X	-	-	MC (2) + 2 cores for replicates
037	HC5	X	X	X	X	-

039	HC7	X	X	X	X	MC (2) + 2 cores for replicates
041	HC9	X	X	X	X	MC (2) + 2 cores for replicates
044	HC12	X	X	-	-	MC (4)
046	HC14	X	X	X	X	MC (2) + 2 cores for replicates
048	HC16	X	X	X	X	MC* (2) + 2 cores for replicates
049	EHS6	X	X	-	-	MC (2) + 2 cores for replicates
050	DBO3.8	X	X	X	X	-
Total number		**26 stns**	**26 stns**	**11 stns x 4 grabs/stn =44 grabs**	**11 stns x 1 grab/stn=11 grabs**	**24 stns: 25 HCores and 72 MCores; also an additional 3-4 MCores collected for sediment parameters**

1. Macrofaunal populations

Four sediment grabs were collected at stations at depths to ~200m for post cruise analyses for macrofaunal composition, abundance, and biomass. Sediments were sieved through one mm metal screens with running seawater and animals preserved in 10% buffered seawater formalin for post-cruise analyses at CBL. A 5th grab was collected for sediment parameters.
At stations beyond the ~200m depth all faunal samples were collected from the multi-corer, with 4 cores sieved through 180-micron screens after completion of the sediment respiration experiments for post-cruise identification. The smaller screen size was necessary to capture the small size fraction and limited number of organisms in the deep basin sediments. All macro- and meio-faunal collected by the UMCES team will be sorted and identified at CBL.

2. Sediment samples

Sediments were collected via the 0.1 m2 Van Veen grab at stations <200 m for the following surface sediment parameters: chlorophyll a, grain size, total organic carbon and nitrogen, C13/N15 stable isotope content, and bacteria. For stations >200m sediment parameters were collected from replicate cores obtained from the Multi-corer (MC) for the same sediment parameters listed above, bacteria (Goethel, section D3), and the separate meiobenthic project by Jona Silberberg (section E).

C. Sediment Oxygen Consumption-SAS (Lead Jackie Grebmeier)

Sediment cores were collected at 24 stations during the cruise (**Table 11**; also see Goethel section D.1) for sediment community oxygen consumption rates (SCOC) using either multi-HAPS corer (HC; surface area 133 cm^2) or a Multi-core 800 (MC; surface area 70.85 cm^2). The number of cores collected for SCOC ranged from 2-4 for experimental studies maintained at either 4°C and/or -1°C in climate control rooms on the ship. Cores were subsequently sieved and preserved for post-cruise determination of macro – or meio-faunal population composition, abundance and biomass as outlined previously. Note that MC collections >200m were sieved through 180-micron screens due to the low population levels. Additional MC samples were

collected for standard sediment parameters (Grebmeier, section B1), bacteria (Goethel, section D.3) and a meiobenthos study (Silberberg, section E).

D. Sediment Oxygen Consumption and Individual Animal Experiment (lead Christina Goethel)

D1. Sediment community oxygen consumption (SCOC)

Ten sediment cores were collected at the Chukchi Ecosystem Observatory (CEO) mooring (station 000) using a 0.133 m^2 multi-HAPS corer to examine the effects of warm temperatures and food additions. Five cores were held in a climate control chamber set to 4°C and five cores were held in climate control chamber set to -1°C. In eight of the cores, bottom water was removed and replaced with bottom water collected from the CTD. The final two (one in each room) were kept with the original bottom water. Within each set of five, two cores had 5 mL of a phytoplankton solution added as an addition of food, and other three had no further addition. This solution was created onboard and was measured for chlorophyll-a (27.06 mg m^{-3}) to determine a concentration. Oxygen concentrations (µmol O_2) were measured using a Presens meter at the start, 6-hour mark, 12-hour mark, and the final mark around 18-20 hours. At the beginning and end of the experiments nutrient samples were taken and frozen for later analyses. Cores were then sieved through a 1-mm screen and organisms preserved in 10% buffered seawater formalin for later identification.

D2. **Bivalve respiration**

Individual dominant bivalves (*Macoma calcarea*, *Nuculana pernula*, and *Ennucula tenuis*) were collected from the 5th van Veen grab at the CEO station. Six bivalves (mixed species) were held in the warmer climate control room and 6 were held in the colder climate control room. An additional four of each species were held in the warmer cold room for a set of resiliency experiments. A set of three individual bivalves were held in 100 mL airtight jars in each of the four treatments (warm unfed, warm fed, cold unfed, and cold fed) and oxygen concentrations were measured using a FireSting oxygen meter. Measurements were taken every minute for a 48-hour period. After the 48 hours, individuals were measured to the nearest tenth of a cm and frozen for post-cruise evaluation. Volumes of water from each jar were measured at the end of the experiment.

A set of four individuals of each species were also used for a resiliency study. The same four individuals were acclimated for at least 48 hours to each of the treatments throughout the cruise and oxygen concentrations were measured using the FireSting oxygen probes. The goal here was to see a single individual's ability to adapt to changing conditions, rather than a species.

D3. Microbial Samples

Approximately 5 mL of sediment was collected from the top of grabs or cores for microbial composition at every station where van Veen grabs or coring activities took place (**see Table 11**) for a total of 49 samples. At station 021 (North Pole) samples were taken down core at intervals of every two centimeters. These samples were kept in the climate control room at 4°C and will be shipped to the University of Akureyri, Iceland for the community composition analyses.

E. Meiobenthos Project (lead Jona Silberberg), Christian-Albrecht-University, Kiel, Germany

The overall aim of the meiobenthos project is to investigate the spatial variability in meiobenthic communities in the Chukchi Sea and Central Arctic Ocean. Sampling was conducted from Multi-HAPS and Multi-corer cores using cut-off syringes (with diameters of 1.2 cm and 2 cm) to take down-core samples of 5 cm depth (**Table 12**). 8 parameters were sampled per station: meiofauna and bacteria as well as select environmental parameters that may impact the distribution of organisms. Sampling included 3 replicates of each parameter per station, except for bacteria for which only one sample was available to be taken and will be compared with the Goethel collections (Section D).

Sampling from the 1.2 cm diameter syringes included:
- chlorophyll a and phaeopigments
- proteins
- C-org
- bacteria

Sampling from the 2 cm syringes included:
- meiofauna
- sediment grain size
- phospholipids
- sediment porosity.

The 5 cm down-core samples for meiofauna and bacteria analysis were separated into 1 cm layers (i.e., 0-1 cm layer, 1-2 cm layer, 2-3 cm layer, etc.) and fixed in a buffered seawater formalin solution (4%). The environmental parameter samples were flash-frozen at -80°C and subsequently stored at -20°C for lab analysis. It was not possible to sample 3 replicates at every station, due to sample availability - the number of replicates and the environmental parameters collected at each station are indicated in the table below.

Table 12: Parameters and number of replicates sampled at each station.

Station	Meio-fauna	Bacteria	Chl + Phaeopig.	Proteins	C-org	Grain size	Phospho-lipids	Sediment porosity
000 (CEO)	3	1	3	3	3	3	3	3
001 (EHS1)	2	1	2	2	2	2	2	2
005 (EHS4)	2	1	2	2	2	2	2	2
006 (EHS5)	2	1	2	2	2	2	2	2
008	2	1	2	2	2	2	2	2
010	2	1	2	2	2	2	2	2
013	2	1	2	2	2	2	2	2
016	3	1	3	2	3	2	3	2
018	3	1	3	2	2	2	3	2
021	2	1	2	2	2	2	2	2
022	3	1	3	2	3	2	3	2

025	2	1	2	2	2	2	2	2
027	3	1	3	2	3	2	3	2
029	2	1	2	2	2	2	2	2
031	3	1	3	3	3	2	3	2
032	3	1	3	2	2	2	3	2
033	2	1	2	2	2	2	2	2
035	3	1	3	3	3	3	3	3
037	2	1	3	2	2	3	3	2
039	3	1	3	2	1	3	2	1
041	3	1	3	3	3	3	3	3
044	3	1	3	3	2	3	3	2
046	3	1	3	3	3	3	3	3
048	3	1	3	3	3	3	3	3
049	2	1	2	2	2	2	2	2

Acknowledgments

We thank Captain Boda and the crew of the USCGC Healy for ship and deck operations and assistance with sampling during the cruise. Financial support was provided for ship days and research through the US National Science Foundation, with specific funding to PIs Cooper and Grebmeier (OPP-2053101) and PI Grebmeier (OPP-2237847). Additional personnel and science support was provided through Christian-Albrecht-University, Kiel, Germany, Clark University, MA, and MARSAM, OR.

Dissolved Oxygen, Oxygen/Argon, Oxygen/Nitrogen, and O2 Isotope Sampling

Laurie Juranek (laurie.juranek@oregonstate.edu), Maria Cristina Alvarez Rodriguez (alvarmar@oregonstate.edu), and Genevieve Coblentz-Strong (coblentg@oregonstate.edu) - Oregon State University

Dissolved oxygen sampling on HLY2202 included a number of different data types and sampling approaches. We collected (1) surface seawater O_2/Ar and O_2 /N_2 gas ratio data from Healy's science seawater system; (2) bottle samples for dissolved O_2 /Ar and dissolved O_2 isotopes (^{16}O, ^{17}O, ^{18}O) from the surface underway and CTD stations (to be analyzed later at OSU); and (3) discrete sampling of dissolved O_2 from both CTD casts and the surface seawater system, analyzed onboard by Winkler titration.

O_2/Ar and O_2 /N_2 surface underway data collection from science seawater system:

Observations of dissolved oxygen relative to other inert or semi-inert gases in surface waters are used to constrain net biological oxygen production. Net O_2 production gives the balance between community-level photosynthesis and respiration in the surface mixed layer, also known as net community production (NCP). On HLY2202 we tracked NCP by measuring the ratios of the dissolved gas pairs O_2/N_2 and O_2/Ar. An equilibrated inlet mass spectrometer was used to continuously monitor the ratio of O_2/Ar in the surface underway. We also monitored the O_2/N_2 in surface seawater using a Pro-Oceanus total dissolved gas pressure (TDGP) and a Seabird Dissolved O_2 (SBE43) sensor mounted on Healy's Port Science sensor wall. Both systems collected data for nearly the entire cruise, with brief interruptions for maintenance and stops

related to freezing of overboarding drains. Preliminary data for the cruise track are shown in Figs. 22-24.

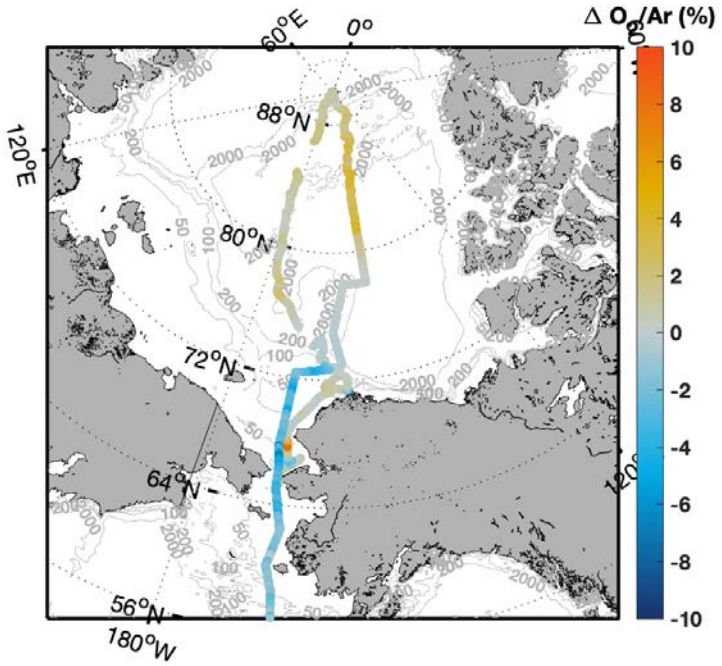


Figure 22. Preliminary O_2/Ar saturation (%) along HLY2202 cruisetrack. Warm colors indicate where the net metabolism is autotrophic (photosynthesis>respiration); cold colors indicate where the balance is heterotrophic (respiration>photosynthesis). Note that ice-cover allows for build-up of photosynthetic O_2, and mixing of subsurface water to the surface (e.g. during stratification breakdown) will advect a net heterotrophic signal to the surface. NCP rates (in mmol m^{-2} d^{-1}) will be calculated by interpreting these data in the context of a simple mixed layer mass balance.

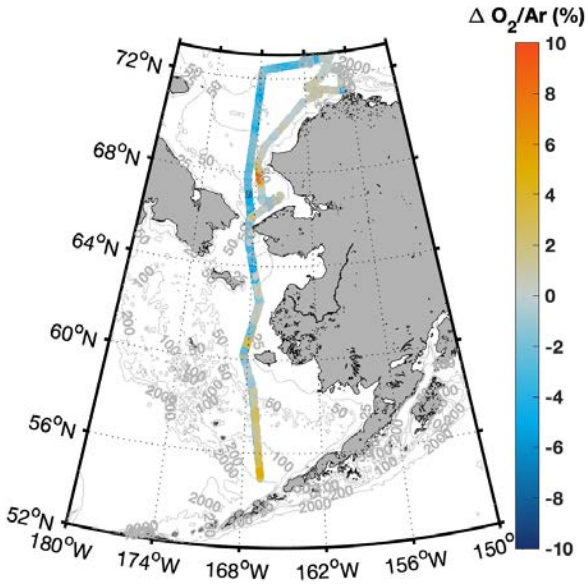


Figure 23. Close up of O_2/Ar saturation in the Bering and Chukchi

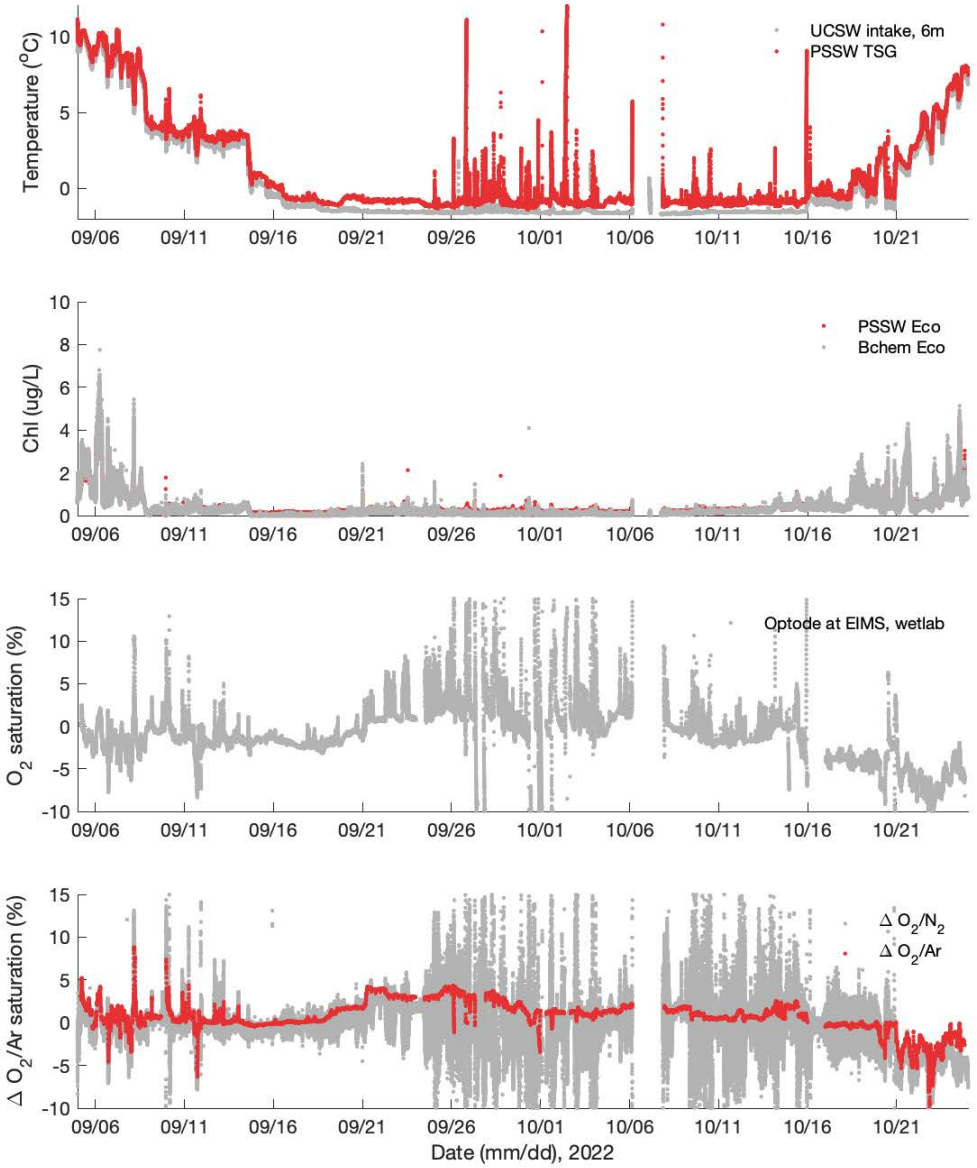


Figure 24. Time-series of select underway data during HLY2202. High noise in gas data was encountered while transiting in the pack ice.

Discrete sampling for O_2 /Ar and O_2 isotopes

We also collected bottle samples for analysis of O_2/Ar from the surface underway roughly once a day, with some duplicate samples. In addition to providing a calibration of EIMS O_2 /Ar data, collected samples will also be used to determine the dissolved O_2 triple isotope composition, a tracer of gross primary production. Profiles of O2/Ar and O2 isotope samples were collected at select CTD stations (4-6 depths per cast, sampling focused in the upper 300 m).

The gas ratio and O_2 isotope samples will be analyzed in a shore-based stable isotope facility at Oregon State University.

Dissolved oxygen analysis via Winkler titration

We collected bottle samples for analysis of dissolved O_2 concentration via Winkler titrations from 37 CTD stations (Table 14). Duplicate samples were drawn from each Niskin bottle; prior to sampling we conducted a leak check on each bottle and recorded any issues encountered. Draw temps were recorded for each bottle prior to collecting the duplicate samples. Winkler titrations were automated with an amperometric endpoint detection (titrator by Langdon Enterprises). Average standard deviation of duplicates was 0.39 µmol kg^{-1} (n=443).

Table 14. Locations of bottle O_2 sampling during HLY2202

Stations Sampled	Cast	# of Depths	Total Samples	Underway	
0	0	5	12	Yes	
1	1	5	12	Yes	
3	3	4	10	Yes	
5	5	8	16	No	
6	6	10	22	Yes	
8	8	6	12	No	
27	11	16	34	Yes	
11	13	2	6	Yes	
12	14	3	6	No	
13	15	18	37	No	
15	17	2	4	No	
16	18	20	40	No	
17	19	21	44	Yes	
18	20	2	4	No	
19	21	19	38	No	
20	22	16	32	No	
21	23	23	46	No	
22	24	20	42	Yes	
23	25	8	16	No	
24	26	14	28	No	
25	27	19	40	Yes	
26	28	15	32	Yes	
27	29	19	40	Yes	
28	30	15	32	Yes	
29	31	17	36	Yes	
30	32	15	32	Yes	
31	33	19	40	Yes	
32	34	10	22	Yes	
33	36	12	24	No	
35	38	10	20	No	
39	42	8	16	No	
41	44	9	18	No	
44	47	12	24	No	
46	49	8	18	Yes	
48	51	4	8	No	
49	52	12	26	Yes	
50	53	4	12	Yes	
37			**901**		**Total**

We compared the Winkler O_2 values to CTD O_2 sensor data reported for each Niskin. Following SeaBird recommendations, we determined a Soc gain factor to apply to CTD O_2 data as follows:

Corrected [O_2]=Soc*SBE-43[O_2]; where Soc is determined from the mean ratio of Winkler [O_2]/SBE-43 [O_2].

In these comparisons, a depth dependent-trend in the Soc factor was evident, which indicates that the default value for hysteresis correction likely requires refinement. Ideally, the Soc factor should be a constant throughout the water column. After reprocessing the data with a range of hysteresis correction factors given by the manufacturer in SeaBird Application Note 64-3 we were able to reduce, but not completely eliminate this trend. At present, a hysteresis correction factor of H1= -0.07 gives the best results (Figure 25), but we will continue to explore the hysteresis correction in consultation with SeaBird over the coming months.

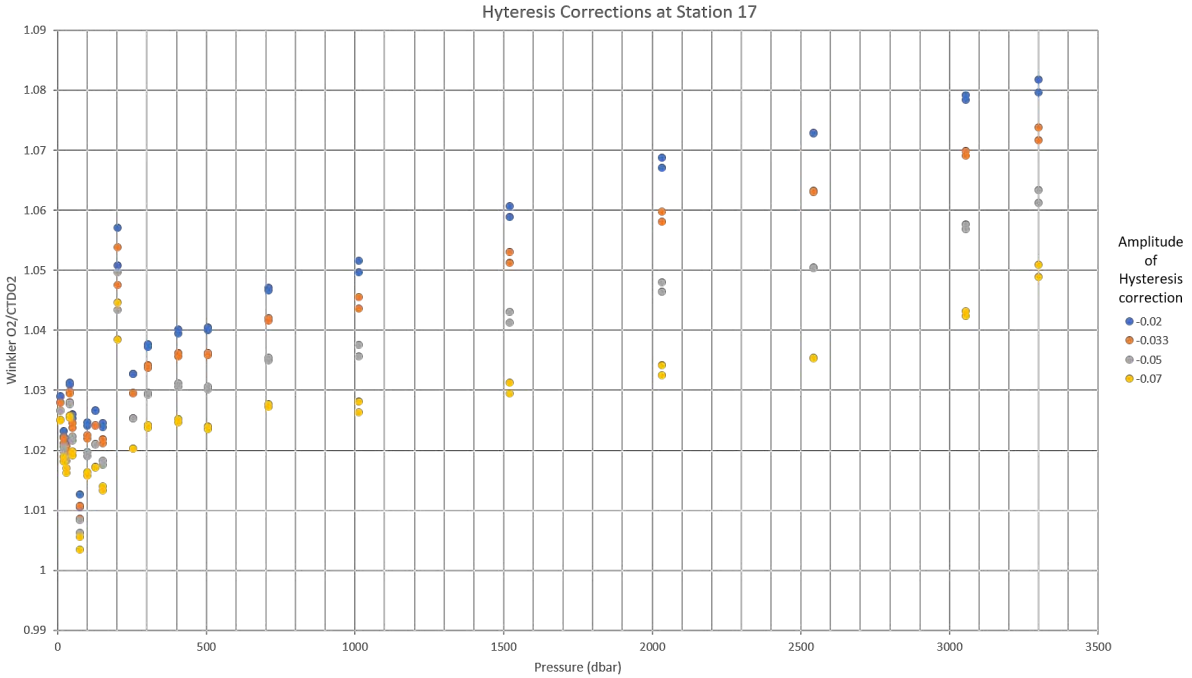


Figure 25. Example of the effect of varying the H1 Hysteresis factor in the SeaBird Dissolved Oxygen processing for the CTD cast at Station 17. The depth-dependent trend in the Soc factor indicates a potential issue with hysteresis. The given default range for H1 in the SeaBird manual is -0.02 to -0.05, but this range was insufficient to remove the depth trend. We computed average gain factors using a H1=-0.07, but will continue to evaluate ways to remove hysteresis effects post-cruise.

Our preliminary estimate for Soc for the CTD in use through Station 10 is 1.016.
Our preliminary estimate for Soc for the CTD in use for Stations 11-50 is 1.024.

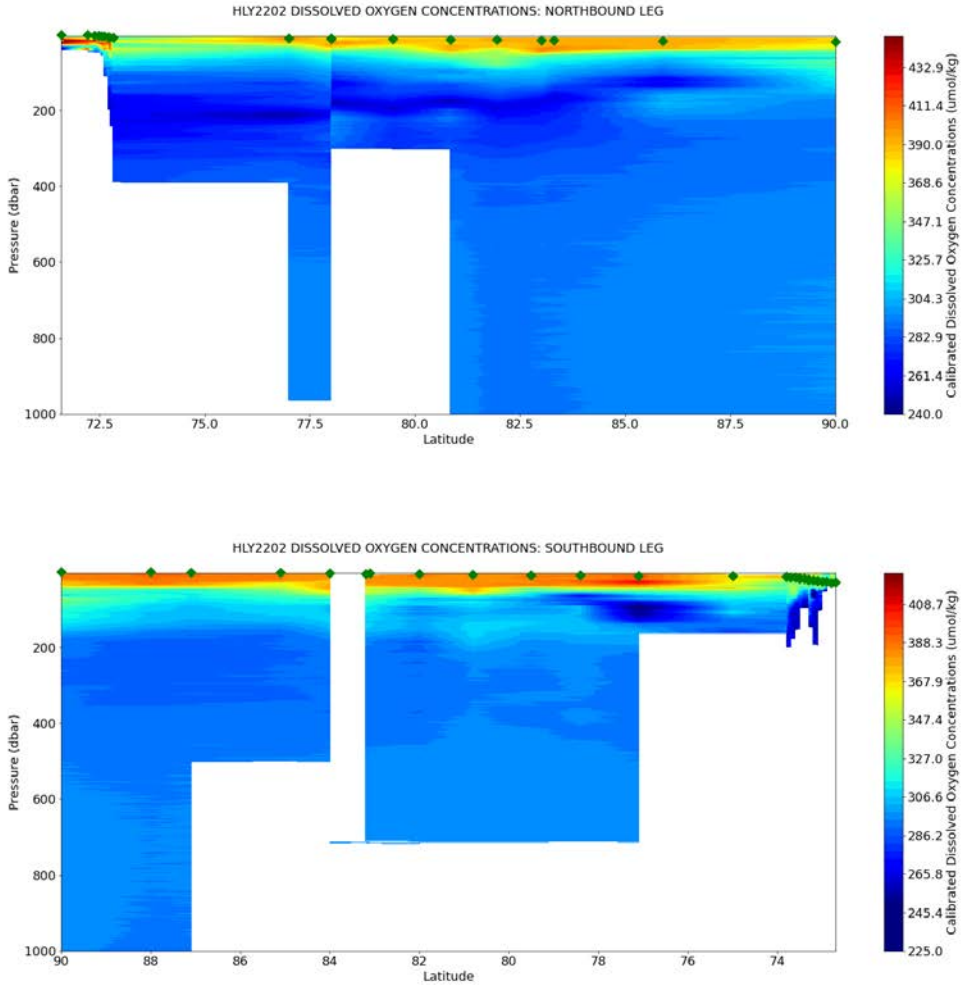


Figure 26. Preliminary sections of corrected CTD O2 concentrations for the HLY2202 cruise.

Data Access and Reporting

All dissolved gas data (O_2 /N_2, O_2 /Ar, [O_2], [N_2], [Ar], and $\delta^{17}O$ and $\delta^{18}O$) will be submitted with corresponding position, time and associated metadata to the Arctic data center upon final quality control after shore-based analysis is complete (estimated submission March 2023).

Particulate Carbon Dynamics Via Large Volume Pumps

Marcia Campbell (mcampbell6@umass.edu) - University of Massachusetts and Jessica Drysdale (jdrysdale@whoi.edu) - Woods Hole Oceanographic Institution, On-board team
Cynthia Pilskaln (cpilskaln@umass.edu) - University of Massachusetts, PI

Overview

At 16 long stations, upright McLane large volume pumps (LVP) were deployed with a two-layer baffled filter system to collect water column particles. These were deployed at depths of 500 m (deepest), 225 m, 125 m and 75 m off the stern of the Healy using the ship wires and

winches. Each pump contained two, 142 mm-diameter filters in sequence where a 51 μm screen collects particles greater than 51 μm, followed by a 1 μm GFF glass filter to collect smaller particles. These filters were then removed from the pump system upon recovery, where the 51 μm filter was cut in half and rinsed onto two smaller 47 mm GFF filters. The two smaller and one large GFFs were then frozen for storage and transport back to the University of Massachusetts Dartmouth where they will be analyzed for particulate organic carbon (POC), particulate organic nitrogen (PON), stable isotopes of particulate carbon and nitrogen ((δ^{13}POC, δ^{15}PON) and particulate inorganic carbon (PIC). This data will be used for the student Marcia Campbell's Master's thesis.

Reasoning

Particulate carbon concentrations and isotopic ratios indicate how much carbon is in the water column as well as its origins and fates. Ranges in stable carbon isotopes will reveal whether the POC is marine-derived or terrestrially sourced. Stable nitrogen isotopes and carbon-nitrogen elemental ratios will point to the extent of organic matter degradation and recycling. Particulate inorganic carbon concentrations will inform on the strength of ocean acidification. This data will provide insight into the efficacy of the biological pump and carbon uptake capacity of the area. The Arctic region has already been identified as a key global carbon sink and with global climate change, the ability of the Arctic waters to absorb or release carbon will have significant impacts on the global carbon budget.

Healy Specific Methods

Storage

For the transit time at the start the cruise, the pumps were stored inside the Wet Lab where our group was assigned lab space. We were able to secure the pumps to the lab floor using the bolt holes with an aluminum bar brought for such purpose. This provided a warm, dry and clean space for installing/uninstalling batteries and checking plumbing.

During active science time on the cruise the pumps were stored in the CTD bay up against the aft side of the room near the gas tanks. Due to a lack of bolt holes in the space, they were secured to the wall with ratchet straps in rough seas. This space was warm (more so than the aft staging bay) and a good storage location. Batteries were brought into the lab for changing on the central table. As pumps often occurred following the CTD deployment, it was sometimes very busy in the room and a slight challenge to get out the garage door. It was also imperative that the door remain closed except when actively moving the CTD or pumps to prevent freezing.

Deployment

Pumps were generally deployed during the daylight from the stern. Initially we used the ship 9/16" wire with ½" clamp inserts for the pumps. Due to winch and wire issues (not involving pumps) we then switched to using the .322 conducting wire with 5/16" clamp inserts. Luckily, we had brought both clamp inserts. It is suggested on future cruises that users bring clamps for both the 9/16" and .322 wires and possibly also larger ones for use with the .680 wire.

Following the deployment recommendations from GEOTRACES in 2015, a plank platform was secured to the deck with large deck bolts and used to get a hard square edge rather than working on a rounded edge of the fantail. This was made with a ½" piece of plywood (4' x 8') with 2 x 2x4 pieces of wood forming the lip. The plywood was removed after each

deployment so that nets and other equipment did not get caught on it. It was stored in the aft outdoor staging area without problem.

For deployment, pumps were generally programed with a countdown timer changed depending on the evolution preceding pumps. This generally worked in terms of timing, however for shorter deployment during decent weather some were programmed on deck. Pumps were brought out individually using the hand truck. The Coast Guard (CG) Deck crew secured a bottom weight to the wire, lowered it to below water level and brought the wire in to attach pumps. The CG was extremely helpful in moving and attaching the pumps, willing to help with any issues and listened to any instruction needed. They were cheery and great to work with. It is recommended to go over the protocol prior to deploying so that everyone is on the same page and knows the protocol saving any confusion.

Recovery

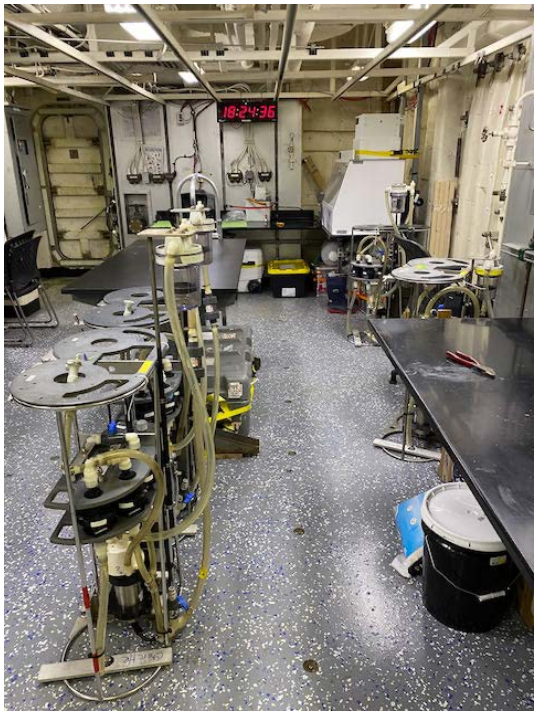
Following between 90 minutes to 4 hours of active pumping, pumps were recovered. This generally went very smoothly with help from the CG deck crew and winch operators. The pumps were raised to deck level, the top clamp removed and then the pump was lifted off the base and carried to the flat dolly. A technician or CG crew then removed the lower clamp. Initially pumps were then wheeled near the aft storage area and water was sucked off the filter heads with an aspirator pump, but as temperatures dropped, the hose lines froze and so pumps were wheeled back to their warm home in the CTD bay immediately upon recovery. CG crew was very helpful escorting the pump back to the CTD bay and lifting them off the dolly. One recovery in open water during high winds required the use of tag lines to hold the wire against the platform.

Lab Processing

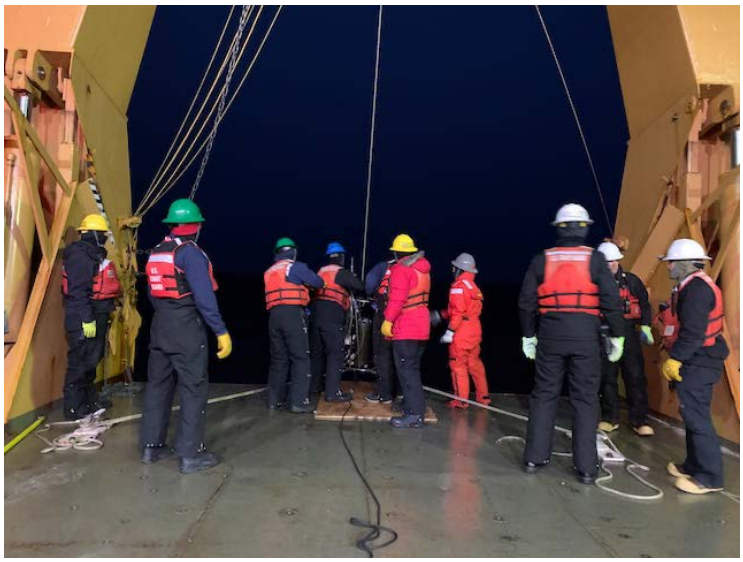
Pump filter heads were aspirated (i.e., water was removed) in the CTD bay where it was warm. Filter heads were then removed and brought to the wet lab where we had a laminar flow hood set up for processing. The wet lab space was perfect for our two-person team use and for fitting the flow hood. The central shared table space was ideal for changing the pump batteries and worked well sharing with the oxygen and methane teams.

Notes, Suggestions, Issues

- USCG deck crew were always extremely helpful. A pre-deployment and/or recovery brief with each new team or shift ensured everyone knew what the plan was and how to treat the pump. This is especially important for crew changes mid-deployment or recovery.
- On one deployment in the thick ice, we noticed one filter (75 m) had distinct black particles that appeared to be the anti-skid material used on the deck. Upon request this material was no longer used on the aft deck and deck snow/dirt was not swept over the side during and prior to pump deployment. We did not encounter this issue in subsequent deployments.
- Due to the proximity to the edge of the deck that is required for deployment and recovery of the pumps, in future it would be advised to have chest harnesses with clip-in on the back available for the two main operators during inclement weather. These could easily be fastened to the available cleats, as described for this work in 2015 aboard the Healy.



(above) Wet lab set up for transit, pumps secured to floor
(top right) Lab bench set up with laminar flow hood (and Marcia)
(bottom right) Pump recovery off platform in ice



(right) Securing bottom clamp to the wire
(above) Recovering the pump with tag lines used to keep the wire close to the edge of the fantail

Inorganic Carbon System Measurements

Rebecca Garley (rebecca.garley@bios.edu), Matt Enright (matt.enright@bios.edu), Claire Medley (claire.medley@bios.edu) - Bermuda Institute of Ocean Sciences, on-board
Nick Bates (nick.bates@bios.edu) - Bermuda Institute of Ocean Sciences, PI

Objectives

Our purpose on this cruise was to collect high quality dissolved inorganic carbon (DIC) and total alkalinity (TA) measurements from both the CTD rosette and the ships underway system, in conjunction with underway surface seawater measurements of TA, pH and pCO2, to study the current status of the Arctic Ocean dissolved inorganic carbon system.

Aiming to try to determine the current status of the Arctic regions inorganic carbon reservoir and to investigate impacts of the increasing atmospheric carbon dioxide (CO_2) levels. Oceans absorb much of the increasing CO_2, with colder waters having a higher capacity to hold gases. Due to the Arctic Oceans cold water temperatures, the carbonate system is sensitive to even small perturbations. Much of the ice-covered Arctic waters are undersaturated with CO_2 relative to the atmosphere and so a potential CO_2 sink, expected to absorb increased quantities of CO_2 as sea ice recedes, exposing larger areas of the undersaturated surface waters. As ocean CO_2 levels increase, the carbon chemistry of the water is altered, including decreasing pH, termed ocean acidification. The ocean can act as a buffer but only effectively on much longer timescales than the changes are currently occurring. Ocean acidification is likely to have detrimental effects on numerous calcifying organisms. To study this, we are collecting discrete samples for DIC and TA from each depth on CTD rosette casts and from the surface sea water system.

We sampled the transect to/from 90ºN, plus sampling of the previously sampled lines along Hanna Canyon and East Hanna Shoal. Our data from this cruise will be comparable to past cruises; the 1994 Arctic Ocean Section and data from the Chukchi will be comparable with data from the SBI project 2002 and 2004.

Inputting the DIC and TA data into CO2SYS (Lewis and Wallace, 1998) to compute other carbonate parameters (e.g. pH, pCO2, calcium carbonate mineral saturation states) to further understand the carbonate system of these waters.

Methods and Samples

Discrete samples for DIC and TA were drawn from the niskin into 250ml glass bottles according to standard JGOFS methods. Sample bottles were rinsed out 3 times, bottom filled using silicone tubing and allowed to overflow at least 1 times the bottle volume, ensuring no bubbles are in the sample. The sample is sealed with a small (0.2%) headspace, to allow for water expansion, using a screw cap and PTFE taped threads.

Water samples were collected from all depths the CTD-rosette sampled. Two samples were collected from each Niskin bottle. The samples were collected and stored in a dark container for no longer than 12 hours (to minimize any biological activity altering the sample) and analyzed on board, DIC first, followed by TA. Three replicates from each cast were poisoned with 100µl mercuric chloride for analysis back at the BIOS lab in Bermuda. In addition to sampling from the rosette, samples were also collected and analyzed on board from the underway system approximately every 10 nautical miles between stations.

Samples were run on the VINDTA 3S (Versatile Instrument for the Determination of Titration Alkalinity) and the AIRICA (Automated Infra-Red Inorganic Carbon Analyzer) (www.marianda.de). TA is measured on the VINDTA 3S by titration with a strong acid (HCl). The titration curve shows 2 inflection points, characterising the protonation of carbonate and bicarbonate respectively, where consumption of acid at the second point is equal to the titration alkalinity. DIC is measured on the AIRICA by the extraction of total dissolved inorganic carbon content from the sample by phosphoric acid addition. The liberated CO_2 flows with a nitrogen carrier gas into a Li-Cor non-dispersive IR gas analyser where the CO_2 levels are measured.

For both instruments, within bottle replicates were run consecutively on start up to check the precision, continuing once the instrument precision was ±2µmol kg^{-1} or better. These were followed by Certified Reference Materials (CRMs) produced by the Marine Physical Laboratory at UCSD, which were run every ~12 samples on the VINDTA and every ~6 samples on the AIRICA, to determine the accuracy of the measurements and to correct for any discrepancies. The TA system CRM values did not vary more than 2µmol within each batch of HCl acid. The AIRICA is more susceptible to drift and can be affected by the lab temperature which is why CRMs were run more frequently on the AIRICA. The values for DIC and TA were used to calculate other parameters of the carbonate system using CO2sys (Lewis and Wallace, 1998). Parameters calculated are pH, *f*CO2, *p*CO2, [HCO3-], [CO32-], [CO2], alkalinity from borate; hydroxide ion; phosphate and silicate, Revelle Factor, plus the saturation states of calcite and aragonite.

Table 15. Summary of sample collection and analysis.

Sample collected	# of stations	# of samples	analysis
CTD DIC/TA	39	527/412 replicates	Analysed on board
CTD DIC/TA	39	115 replicates	Analysis at BIOS
Underway DIC/TA cruise	233	233	Analysed on board

Underway measurements were collected with a frequency of every 15 minutes for TA, pH and pCO_2 from the ships surface seawater system. TA and pH were measured from a filtered flow using CONTROS HydroFia (www.4h-jena.de). TA is calculated from pH using HCl and an indicator dye and VIS absorption spectrometry. pH is determined using m-Cresol purple indicator and VIS absorption spectrometry. pCO2 and secondary underway pH measurements were collected using the SAMI-pCO2 and SAMI-pH (www.sunburstsensors.com). SAMI-pCO2 and pH are measured using colourimetric reagent methods.

Initial findings

Below are initial data plots from the bottle samples collected and analysed on board during the cruise. There was a break in the sampling from the surface seawater system on part of the southern leg from the pole due to the outflow freezing. Further QC and processing of the bottle data will be carried out including processing of the underway data files.

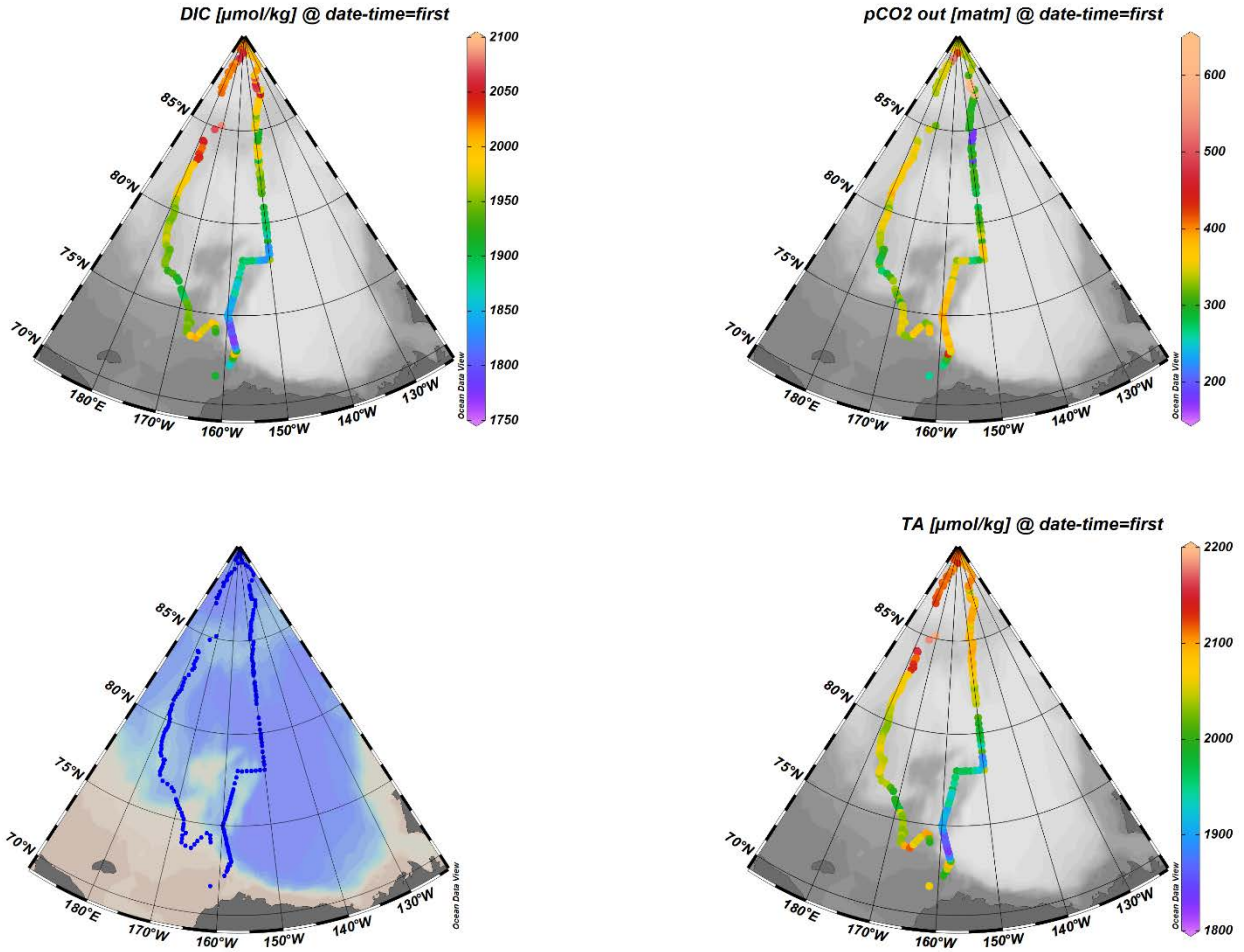


Figure 27. Bottle data collected from the surface seawater system. Showing top left DIC, top right pCO2, bottom right TA and bottom left the map view. A break in data on the return leg from the pole due to freezing of the seawater system outflow.

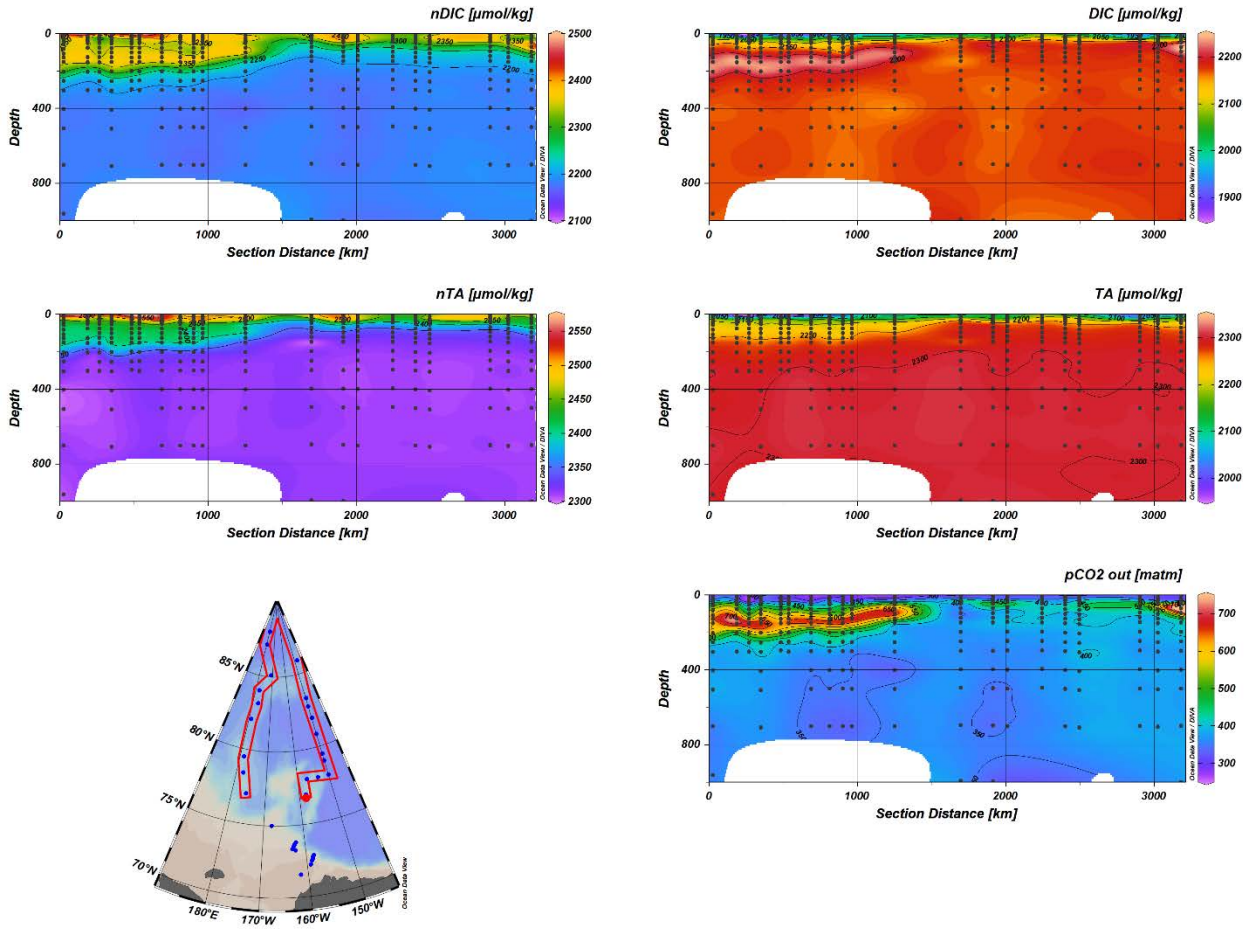


Figure 28. 1000m depth profiles of the north and south transect. Showing top left nDIC (salinity normalized DIC) and top right DIC. Middle left nTA (salinity normalized TA) and middle right TA. Bottom right pCO2 and bottom left the map view.

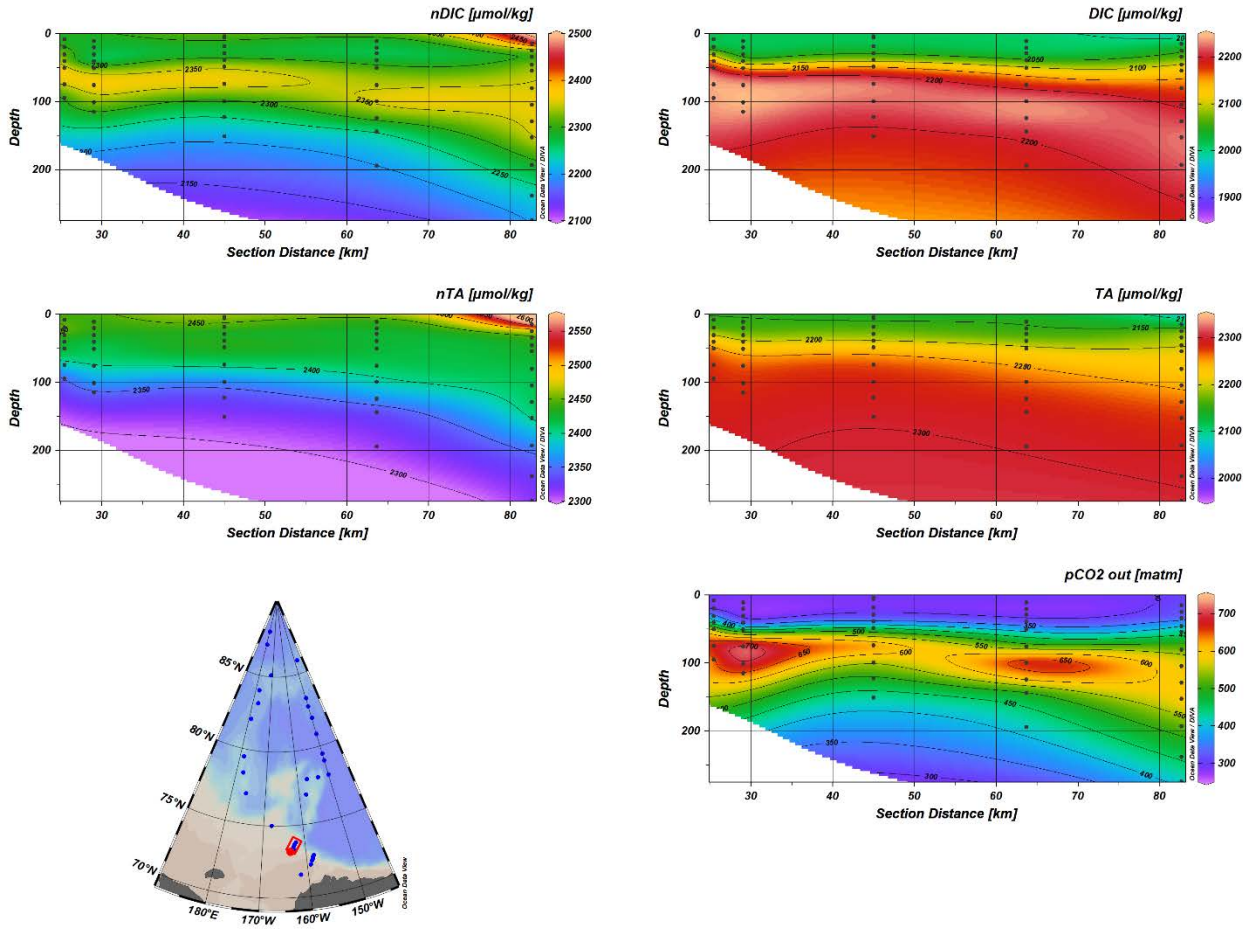


Figure 29. Full depth profiles of Hanna Canyon. Showing top left nDIC (salinity normalized DIC) and top right DIC. Middle left nTA (salinity normalized TA) and middle right TA. Bottom right pCO2 and bottom left the map view.

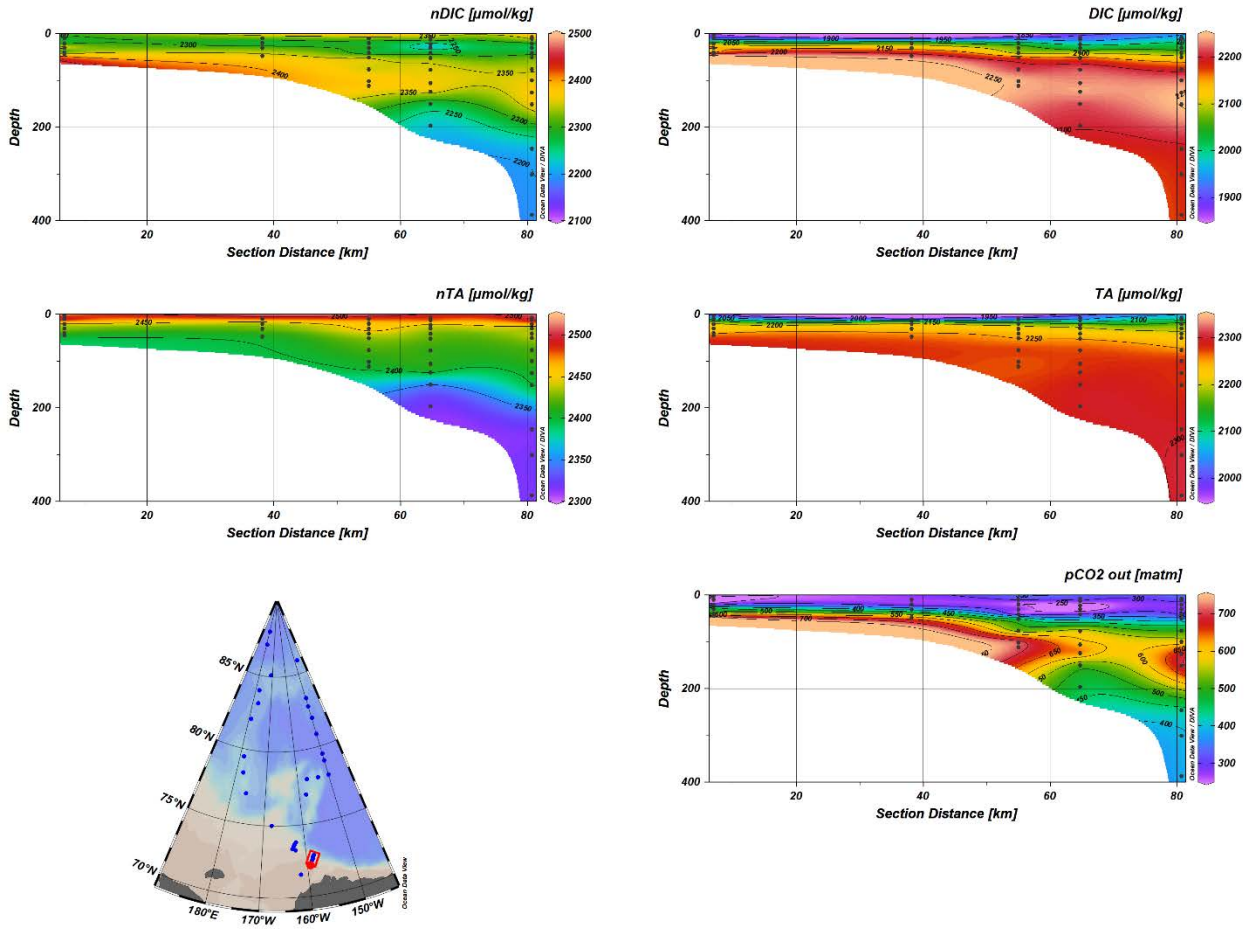


Figure 30. Full depth profiles of Hanna Shoal. Showing top left nDIC (salinity normalized DIC) and top right DIC. Middle left nTA (salinity normalized TA) and middle right TA. Bottom right pCO2 and bottom left the map view.

Methane Measurements

Cedric Magen (cmagen@umd.edu) - University of Maryland

Introduction

While methane (CH_4) is about 200 times less abundant in the atmosphere than carbon dioxide (CO_2), it is 80 times more powerful at trapping heat in a 20-year period, making it the 2nd most important greenhouse gas behind CO_2 and anthropogenic activities are largely responsible for the accelerated increase of CH_4 in the atmosphere over the past decade. Natural reservoirs of methane contribute about 40% of the global methane emissions to the atmosphere, and the ongoing global warming may have created source instability. These natural reservoirs of trapped CH_4 could in the near future add considerably to atmospheric methane, and they need to be understood in order to comprehend the whole global methane cycle and what to expect with ongoing global warming.

Natural CH_4 in the Arctic comes from two sources: CH_4 hydrates and microbial decomposition of previously frozen permafrost. Gas hydrates are the largest reservoir of methane stored within an ice lattice that forms under high pressures and cold temperatures. Because of the cold temperatures in the Arctic, hydrates there form much closer to the air surface compared to the deep ocean reservoirs and are likely undergoing dissociation on shelves bordering the Arctic Ocean due not only to recent warming but Holocene warming in general. The microbial decomposition of previously frozen permafrost can lead to the generation of methane. The Arctic permafrost contains about 60% of the world soil carbon, stored frozen as organic carbon. In a warming Arctic, the decomposition of this carbon pool is accelerating, releasing greenhouse gases to the atmosphere, which could over time generate enough CO_2 and CH_4, depending on environmental conditions (e.g., presence of oxygen), to further contribute to global warming.

The ongoing changes to submarine permafrost and CH_4 hydrate stability could enhance CH_4 fluxes into the deep waters of the Arctic Ocean through physical mixing. Release of ancient methane to shallow waters of the Beaufort Sea have also been observed. The timing of the response to warming of these sub-seafloor reservoirs is poorly known, and will likely vary, but it can be expected that dissociating hydrates will release large quantities of methane faster than thawing permafrost. This timing needs to be better understood for future modelling efforts, hence further observations are needed. While many Arctic shelves have been surveyed for CH_4, the central Arctic Ocean has to our knowledge, only been investigated for methane 28 years ago. The gap in time between now and then warrants conducting a more extensive methane inventory of the deep Arctic basin to evaluate if the CH_4 cycle has changed. In this study, we investigated the distribution of methane on a shelf-slope-deep basin transect to evaluate if methane released in shelf/slope waters is transported to deeper Arctic Basins. We also investigate the origins of this methane using stable isotopes to better understand methane dynamics in this relatively unexplored environment.

Results

We measured methane concentrations and $^{13}C/^{12}C$ ratios in methane in air at the bow of the ship while underway using a cavity ring down spectrometer (CRDS, Picarro G2201-i). In addition, methane and its ^{13}C isotopic composition was measured on water column samples by collecting ~5L of seawater at different depths from the CTD rosette. ~1L of the water was equilibrated with headspace gas (UZ Air – Airgas) and analyzed onboard using the same Picarro analyzer used for underway measurements. The results were calibrated against commercially available standards for CH_4 and $\delta^{13}C\text{-}CH_4$, previously diluted to concentrations matching what is observed in air. The remaining 4L of water were equilibrated separately with headspace UZ Air, and the resulting headspace was placed in capped serum vials for later analysis of $\delta^{13}C\text{-}CH_4$ and $\delta^{2}H\text{-}CH_4$ values in the lab at the University of Maryland. The rationale behind this measurement is that taken alone, the $\delta^{13}C$ signature can change with the oxidation history of methane in the water column, rendering the isotopic signal difficult to interpret. $\delta^{2}H$ values of CH_4 are another key element to characterize methane sources.

A total of 39 stations were samples for methane analyses. The depths sampled were almost systematically 10, 20, 30, 40, 50, 75, 150, 300 m, and bottom depth. However, these depths could vary slightly to accommodate for observed artefacts in the water column (e.g. Chloro-a maximum, sudden change in water density, etc.). On the transect north from the Alaska Shelf to the North Pole, methane concentrations were higher in a subsurface layer spanning from 30 to 50

m. This layer coincided with Pacific Cold Water distribution. Remaining data will be processed upon return to land.

Optics, chlorophyll pigments, and atmospheric aerosols

Clare Gaffey (cgaffey@clarku.edu) - Clark University (on board)
Karen Frey (kfrey@clarku.edu) - Clark University and Alexander Smirnov, PIs

Objectives

Objectives include the characterization of light transmittance through the upper ocean water column to investigate vertical heat distribution (and potential contributions back to sea ice melt), and available light for primary productivity. Chlorophyll-*a* and pheophytin were collected to find a baseline of productivity at high latitudes into the fall. Atmospheric aerosols were collected opportunistically to add to the public NASA AERONET database.

Observations

Optics were collected at stations when sufficient light was available using a Biospherical Compact-Optical Profiling System (C-OPS) that was hand-deployed to 50 m depth. Light transmittance (320–780 nm) was measured throughout the water column. Specifically, C-OPS collected both downwelling irradiance and upwelling radiance at 19 channels (320, 340, 380, 395, 412, 443, 465, 490, 510, 532, 555, 560, 625, 665, 670, 683, 710, 780 nm), and photosynthetically active radiation (PAR, 400–700 nm) with cm-scale vertical resolution. Optics were attempted at each station indicated in the table below, though the cast at STN11 had to be aborted due to strong currents.

Water column chlorophyll-*a* and pheophytin were collected using the acidification method. Seawater collected at 10, 20, 30, 40, 50, and 75 m along with chlorophyll maximum depths when available was filtered on Whatman GF/F filters and frozen for transport. Pigment values will be extracted at the Polar Science Research Laboratory at Clark University. Lastly, atmospheric aerosol measurements were taken opportunistically when no clouds were visible near the sun. Six to seven replicate measurements were taken using a handheld Microtops instrument while underway and stationary at one station when clear skies were available (see table below).

Table 16. Activities at each station where sampling for this project was conducted.

Station Name	Optics	Chlorophyll/Pheophytin	Microtops
CEO(STN0)	x	x	
EHS1 (STN1)	x	x	
EHS2 (STN2)	x		
EHS3 (STN3)	x	x	
EHS3.5 (STN4)	x		

EHS4 (STN5)	x	x	
EHS5 (STN 6)		x	
EHS6 (STN8)		x	
STN10	x	x	
STN11	x	x	
STN12	x	x	
STN13	x	x	
STN14	x	x	
STN15	x	x	
STN16	x	x	
STN17	x	x	
STN18	x	x	
STN19	x	x	
STN20	x	x	
STN21	x	x	
STN22	x	x	
STN23	x	x	
STN24		x	
STN25	x	x	
STN26	x	x	
STN27	x	x	
STN28	x	x	x
STN29	x	x	
STN30	x	x	
STN31	x	x	
STN32	x	x	
STN33	x	x	
STN34	x		
STN35		x	
STN36			
STN37		x	
STN38			
STN39	x	x	
STN40	x		
STN41		x	
STN42			
STN43			

STN44		x	
STN45	x		
STN46	x	x	
STN47	x		
STN48		x	
STN49	x	x	
STN50	x	x	

DNA/RNA, Large Volume Particulate Organic Matter (POC, PON, POP, PCOD), and EDA

Adam Fagan (afagan@uci.edu) - University of California Irvine (on-board)
Adam Martiny (amartiny@uci.edu) - University of California Irvine (PI)

DNA/RNA

DNA/RNA samples were collected approximately at 0900, 1500, and 2100 local time from the uncontaminated underway seawater system and pre-filtered (30 µm mesh) (129 stations). Deviations from these times was done to collect the second sample during solar noon while keeping the six-hour separation. In total, 204 samples were collected. For each sample, up to 8L of seawater was collected into a carboy and filtered immediately. Water was filtered through a Sterivex 0.22µm filter using a peristaltic pump at a low speed. Once all water was pumped through the Sterivex cartridge, one end was sealed with Crito-seal putty. For 152 samples, 1620µL of sterile lysis buffer was pipetted into the filter cartridge and the other end was sealed with a luer-lok cap. 52 additional samples were collected but used RNA/DNA Shield buffer (Shield) to allow for a future comparison of results. Along with these Shield collections, one day collected duplicates of RNA/DNA samples with Shield every three hours. This was requested midway through the cruise for a methodological comparison. The filters were placed in a separate Ziplok bag and preserved frozen at -80C until shipment to the Adam Martiny lab at UC Irvine for analysis. Final filtration volume was recorded for all samples. Gloves were worn during all steps.

Prior to the cruise, all silicone tubing and carboys were cleaned in soapy water, 10% HCL, and Milli-Q water. Weekly, the tubing was soaked in a 10% bleach solution over four hours and rinsed with Milli-Q water. Between sample collections, the tubing and sample container were rinsed 3x with Milli-Q water. All carboys were rinsed 3x with sample water just before collection.

Large Volume Particulate Organic Matter

Large volume particulate organic matter (POM) samples were collected for particulate organic carbon (POC), nitrogen (PON), phosphorous (POP) and particulate chemical oxygen demand (PCOD). POM samples were collected approximately at 0900, 1500, 2100 local time from the uncontaminated underway seawater system and pre-filtered (30 µm mesh) (127 stations). Deviations from these times were done to collect the second sample during solar noon while keeping the six-hour separation. In total, 1011 samples were collected from 127 stations. 264 samples over 44 stations were also collected with the uncontaminated seawater system without a pre-filter. These samples were taken in duplicate along with the pre-filtered sample

during the second day sample to determine the influence of a pre-filter. Each sample passed through a GF/F filter (nominal pore size 0.7µm). An aspirator pump was used to pull water through the filters at a vacuum setting of -0.06 to -0.08 MPa. Nine carboys were filled with 1-8L of water (volume biomass-dependent) and designated as follows: 3x POP, 3x POC/PON, 3x PCOD. POP filters were rinsed with 5mL of 0.017M Na2SO4 to remove traces of dissolved organic phosphorous at the end of filtration. PCOD filters were rinsed with 5ml of Milli-Q water to remove excess salt at the end of filtration. Filters were folded and stored frozen at -80°C in pre-combusted foil squares.

All carboys were rinsed 3x with sample water before collection. GF/F filters and foil squares were pre-combusted at 500°C for 4.5 hours. Prior to the cruise, all silicone tubing, filter holders, and carboys were cleaned in soapy water, 10% HCL, and Milli-Q water. All filters will be shipped frozen and analyzed by the Martiny lab at UC Irvine. Gloves were used for all steps mentioned above.

EDA

EDA samples were collected approximately at 2100 local time every other day from the uncontaminated underway seawater system and pre-filtered (30 µm mesh) (22 stations). Each station collected a single sample. 500ml of seawater were passed through a Millipore filter, using an aspirator pump to pull water at a vacuum setting of -0.06 to -0.08 MPa. Sides of the container and filter were rinsed with deionized water to increase the final cell concentration. Filtering down to 1ml and resuspending material, 0.2 µm was pipetted onto a TEM grid to dry. Once dry, the TEM grid is stored in the original holder for future analysis.

Marine Bird Surveys

Marty Reedy (mtreedyjr@gmail.com) - U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska (Onboard observer)
Elizabeth Labunski (Elizabeth_labunski@fws.gov) - U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska (PI)

Background

The U.S. Fish and Wildlife Service (USFWS) conducted marine bird surveys during the 2022 Synoptic Arctic Survey (SAS) cruise aboard the US Coast Guard icebreaker *Healy*. SAS is an international initiative to generate a comprehensive dataset that allow for a complete characterization of Arctic hydrography and circulation, carbon uptake and ocean acidification, tracer distribution and pollution, and organismal and ecosystem functioning and productivity. The marine bird and mammal survey component of SAS was funded through the Bureau of Energy Management (BOEM), Project AK-17-03, Marine Distribution and Abundance in Offshore Waters (M17PG00039). Marine bird surveys were conducted between 4 September - 24 October 2022, in the Bering, Chukchi, and Beaufort seas as well as observations en route to and from the geographic North Pole. Survey data will be archived with BOEM and in the North Pacific Pelagic Seabird Database (http://alaska.usgs.gov/science/biology/nppsd). This cruise report contains preliminary data and summaries collected during marine bird surveys. Please contact the authors of the final report (above) before citing summary data or statements from the cruise reports.

Methods

Marine birds and mammals were surveyed from the port side of the bridge using standard USFWS protocols. Because we used seabird survey protocols, our observations cannot be used to calculate densities of marine mammals. Observations were conducted during daylight hours while the vessel was underway. The observer searched an area within a 300-m, 90° arc from the bow to the beam, using hand-held 10x binoculars when necessary for identification. All birds and mammals were recorded using modified strip transect methodology, with four distance bins from the center line: 0-50 m, 51-100 m, 101- 200 m, 201-300 m. Rare birds, large flocks, and mammals beyond 300 m or on the port side ('off transect') were also recorded but will not be included in density calculations. We recorded the species, number of animals, and behavior (on water, in air, foraging). Birds on the water or actively foraging were counted continuously, whereas flying birds were recorded during quick 'Scans' of the transect window. Scan intervals were based on ship speed, ranging during this cruise from 49 sec to 97 sec, with the median at 65 sec. Geometric and laser hand-held rangefinders were used to determine the distance bin or to calibrate the observer as needed. Observations were directly entered into a GPS-interfaced laptop computer using the DLOG3 program (Ford Ecological Consultants, Inc., Portland, OR). Location data were also automatically written to the program in 20-second intervals, which allowed us to track survey effort and simultaneously record weather conditions, Beaufort Sea State, glare, and ice coverage. Other environmental variables recorded at the beginning of each transect included wind speed and direction, cloud cover, sea surface temperature, and air temperature.

Significant ice coverage was encountered during the cruise in the northern portion of the study area. When heavy ice coverage was present, the ship would follow open leads in the icepack to expedite transit time. We recorded the predominate ice conditions while the vessel was underway by using NOAA's Observers Guide to Sea Ice: https://response.restoration.noaa.gov/sites/default/files/Sea_Ice_Guide.pdf. The observer recorded the predominate ice type and ice concentration present near the vessel while underway (Fig 1).

Preliminary Results

We surveyed approximately 3640 km (150 transects) during 50 days at-sea. We recorded a total of 3672 birds on transect and 384 off transect birds representing 38 species.
Total hours surveyed: 267
Average transect length: 22.6 km

Marine birds

This report documents on transect bird observations unless noted otherwise. *S*hearwaters (*Ardenna spp*.) were the most abundant taxa observed during the survey with 2486 individuals. Shearwaters in this survey included unidentified shearwaters, which consisted of Sooty Shearwaters (*A. grissa*), as well as Short-tailed Shearwaters (*A. tenuirostris*). Typically, the majority of these transequatorial migrants at this time of year have migrated out of Alaska or are migrating south to their breeding grounds in Tasmania and Western Australia. Shearwaters were 68% of total birds encountered throughout the cruise (Table 17, Fig. 32). Northern Fulmars (*Fulmaris glacialis),* with 258 individuals, were 7% of all individuals sighted and the second most common bird species observed (Table 17,

Fig. 33). A single Fulmar was seen north of 75°N and was one of two on transect species observed in that region.

Observations of the Alcidae family included 376 individuals which together comprised 10% of the total birds observed. Ancient Murrelets (*Synthliboramphus antiquus*) were the most common Alcid species with 76 individuals consisting of 2.1% of total birds seen or 20% of all Alcids recorded during the survey (Table 17, Fig. 33). The majority of the Ancient Murrelets were recorded near Nunivak Island in the southern Bering Sea. Black Guillemots (*Cepphus grylle*) were observed only in the Chukchi Sea with 20 birds or 12% of all Alcids observed in that region (Table 17, Fig 33). The Black Guillemots were observed exclusively in the southwestern area of the Borderlands region. Parakeet Auklets (*Aethia psittacula*), Least Auklets (*A. pusilla*), and Crested Auklets (*A. cristatella*) sightings consisted of 135 animals or 3.7% of all birds seen (Table 17, Fig. 34. The majority of the *Aethia spp.* observations were made in the Bering Strait region northward towards Pt. Hope. Crested Auklets were recorded primarily in the Bering Strait. There were three records of Least Auklets in the southern Borderland region, and Parakeet Auklets aggregated just northwest of Nunivak Island as well as the Bering Strait. Observations of 11 Horned Puffins (*Fratercula corniculata*) and 61 Tufted Puffins (*F. cirrhata*) were recorded (Table 17, Fig. 34) in the study area. The majority of the Tufted Puffins were observed north of Dutch Harbor and just south of the Bering Strait, whereas the less numerous Horned Puffin were observed sporadically from the southern Bering Sea, through the southern Chukchi Sea, and offshore of Wainwright, AK. Common Murres (*Uria aalge*) and Thick-billed Murres (*U. lomvia*) were 1.3% of all observed birds (Table 17, Fig 35). While Common Murres were rarely seen during this survey in the more southern areas of the Bering Sea, they were present in, and north of, the Bering Strait as well as off Pt. Lay in the Chukchi Sea. Thick-billed Murres were more frequently observed in the southern and northern Bering with one record north of Pt. Hope. A single Dovekie (*Alle alle*) was recorded between Wainwright and Pt. Lay.

Eight species of gulls (Laridae family) totaling 264 individuals were recorded on transect and comprised 7.1% of the total observations (Table 17). There were 210 Black-legged Kittiwakes (*Rissa tridactyla*) on transect which comprised 5.7% of all birds - the third most numerous species observed aside from shearwaters and fulmars (Table 17, Fig. 35). Black-legged Kittiwakes were also observed on two occasions in the Arctic Ocean region in the northern Borderlands – only two of four total birds seen in that region. Black-legged Kittiwakes were also the most northern of all birds recorded on transect during the entire survey. Their distribution was otherwise fairly consistent throughout the survey from Dutch Harbor to Utqiaġvik, along with larger congregations west of Nunivak Island and south of the Bering Strait. A single Red-legged Kittiwake (*R. brevirostris*) was recorded approximately 65 nm northwest of Unimak Pass (Table 1). Ross's Gulls (*Rhodostethia rosea*), Glaucous Gulls (*L. hyperboreus*), Glaucous-winged Gulls (*L. glaucescens*), Sabine's Gulls (*Xema sabini*), and Herring Gulls (*Larus argentatus*), were seen in relatively smaller numbers than kittiwakes (Table 1). Glaucous Gulls observations comprised of 23 animals or 0.63% of the total birds recorded. Other Larid observations ranged between five and eight individuals. Ross's Gulls, normally seen only in North America during their winter distribution to the ice pack edge, were recorded five times for a total of eight individual birds (Table 1, Fig 9). A single Arctic Tern (*Sterna paradisaea*) was noted approximately 81 nm southwest of Nunivak Island (Table 17).

Several species of ducks and geese of the Anatidae family were recorded on transect. Long-tailed Ducks (*Clangula hyemalis*) were the most commonly observed sea duck species and the fifth most common marine bird seen with 82 individuals recorded on transect. Most of the Long-tailed Ducks were observed in large migrating flocks north of Nunivak Island and comprised 2.4% of all birds seen. Other Anatidae observations included one unidentified eider (*Somateria* or *Polysticta sp*.) and five unidentified ducks (Anatidae family) (Table 17).

We observed a total of 113 cormorants (Urile family) during the survey. Observations included one Red-faced Cormorant (*Urile urile*) and 112 migrating Pelagic Cormorants (*U. pelagicus*). Most of these birds were observed as individuals, although there were three flocks of 14, 30, and 42 birds respectively. All observations were of flying (SCAN) birds in the northern Bering Sea. Both species of cormorant comprised 3% of the total birds observed (Table 17).

Marine mammals

We include marine mammal observations as part of our survey on the 2022 SAS cruise. The mammal data presented in Table 2 was collected using USFWS seabird survey protocols and thus cannot be used to calculate densities. A formal marine mammal watch was conducted by Sue Moore from the University of Washington and the numbers presented here reflects a collaboration between these two efforts. Sightings were shared and numbers were reconciled daily as well as post-cruise. We recorded 390 mammal individuals representing 13 species on and off transect (Table 2). The species most frequently encountered were 170 Humpback Whales (*Megaptera novaeangliae*), 60 Gray Whales (*Eschrichtius robustus*), and 43 Walrus (*Odobenus rosmarus*). These three species represent 70% of all marine mammals observed during the survey (Table 2). Humpback Whales were more commonly seen north of Dutch Harbor and west of Kotzebue Sound in the Chukchi Sea. Gray Whales were predominately recorded west of Kotzebue as well as Barrow Canyon south of Utqiaġvik, AK. In high latitude areas north of 75°N, we also recorded on and off transect two unidentified pinnipeds, one Bearded Seal, one Polar Bear, one Harbor Porpoise, and five Ringed Seals Table 18, Figs. 36 and 37). The Ringed Seals were the only animal with a broad distribution throughout this region.

Other observations of interest

There were two sightings of Short-tailed Albatross (*Phoebastria albatrus*), one while leaving Dutch Harbor and another upon our return in the southern Bering Sea. This species is listed as endangered and will be reported to the USFWS Ecological Services in Anchorage, AK.

There were two sightings of deceased birds. One was a Larid, most likely a Black-legged Kittiwake, found floating on the water in the Chukchi Sea approximately 90 nm west of Kotzebue. The other, an unidentified marine bird, was seen on the water about 38 nm west of Port Clarence in the northern Bering Sea.

A Sharp-tailed Sandpiper *(Calidris acuminate)* landed on the ship during Coast Guard operations in Kotzebue Sound on 7 Sept 2022 and was later found deceased aboard the ship a few days later. Due to an abundance of caution concerning Highly Pathogenic Avian Influenza (HPAI), the bird was not brought back to Anchorage for necropsy and the remains were committed to the depths of the sea. There was a separate encounter with an unidentified passerine that briefly visited the ship 26 nm west of Nunivak Island.

Anecdotally, on 18 Sept 2022, there was a report from the Healy's Chief Bos'n of a Snowy Owl *(Bubo scandiacus)* that had approached the ship during the previous night while the ship was on station (77.9° N, -157° W) within the Borderlands region. Several other people also confirmed the sighting but the observer was unable to document this report. A search of the flying bridge and aloft conn provided no evidence of a predatory bird having taken residence on board the Healy. It had been hoped that he would have used the ship as a hunting platform (as opposed to the ice). Apparently, that was not the case as there were no further sightings of this animal. The location of the sighting was 390 nm north of Utqiaġvik, AK.

A Northern Fulmar was the furthest northern bird observation during this survey and was observed off transect while the ship was heading northbound to the pole at 78.6°N, -150°W on 18 September 2022. No birds were seen until 24 September 2022 during the ship's southern transit. This first bird observation southbound was a Black Guillemot on 24 September 2022 at 78.4°N, -177.8°E. Incidentally, this was also the same location (on station) where the second Polar Bear was seen.

Other on and off transect marine birds seen north of 75°N were a second Northern Fulmar, two Short-tailed Shearwaters, seven Black-legged Kittiwakes, one Black Guillemot, two unidentified gulls, and one unidentified bird. There was also a piece of plastic trash reported by the bridge at 82.6°N, -150.0°W - the most northern sighting of anything that wasn't ice or water.

Figure 31. Winter plumage Black Guillemot on 24 September 2022 at 78.4°N, -177.8° W.

Table 17. Seabirds (on transect) counts and percentages, by region and all combined, 4 Sept-24 Oct 2022 during the fall SAS cruise.

Scientific Name	English Name	S Bering Sea	Per Cent Total	N Bering Sea	Per Cent Total	Chukchi Sea	Per Cent Total	Arctic Ocean	Per Cent Total	All Regions	Per Cent Total
Aves (Class)	Unidentified Bird	2	0.11	1	0.27	2	0.14			5	0.14
Anatinae (Subfamily)	Unidentified Duck			5	1.37					5	0.14
Clangula hyemalis	Long-tailed Duck					82	5.84			82	2.23
Somateria or Polysticta sp.	Unidentified Eider			1	0.27					1	<0.1
Gavia sp.	Unidentified Loon			2	0.55	3	0.21			5	0.14
Gavia pacifica	Pacific Loon					4	0.28			4	0.11
Gavia immer	Common Loon					2	0.14			2	<0.1
Phoebastria immutabilis	Laysan Albatross	6	0.32							6	0.16
Phoebastria nigripes	Black-footed Albatross	2	0.11							2	<0.1
Phoebastria albatrus	Short-tailed Albatross	2	0.11							2	<0.1
Fulmarus glacialis	Northern Fulmar	201	10.59	25	6.85	31	2.21	1	25	258	7.03
Ardenna sp.	Unidentified Shearwater	1282	67.54							1282	34.91
Ardenna tenuirostris	Short-tailed Shearwater	148	7.80	57	15.62	998	71.03	1	25	1204	32.79
Oceanodroma furcata	Fork-tailed Storm-petrel	37	1.95	1	0.27					38	1.03
Urile urile	Red-faced Cormorant	1	<.01							1	<0.1
Urile pelagicus	Pelagic Cormorant	2	0.11	109	29.86	1	<0.1			112	3.05
Arenaria interpres	Ruddy Turnstone			1	0.27					1	<0.1
Phalaropus sp.	Unidentified Phalarope	11	0.58	4	1.10	1	<0.1			16	0.44
Stercorarius sp.	Unidentified Jaeger					1	<0.1			1	<0.1
Stercorarius pomarinus	Pomarine Jaeger			3	0.82					3	<0.1
Stercorarius parasiticus	Parasitic Jaeger	1	<.01	1	0.27					2	<0.1
Laridae sp.	Unidentified Gull	3	0.16			1	<0.1			4	0.11
Rissa tridactyla	Black-legged Kittiwake	29	1.53	93	25.48	86	6.12	2	50	210	5.72
Rissa brevirostris	Red-Legged Kittiwake	1	<.01							1	<0.1
Xema sabini	Sabine's Gull	1	<.01			4	0.28			5	0.14
Rhodostethia rosea	Ross's Gull					8	0.57			8	0.22
Larus argentatus	Herring Gull	2	0.11	1	0.27	1	<0.1			4	0.11
Larus glaucescens	Glaucous-winged Gull	7	0.37			1	<0.1			8	0.22
Larus hyperboreus	Glaucous Gull	5	0.26	4	1.10	14	1.00			23	0.63
Sterna paradisaea	Arctic Tern	1	<.01							1	<0.1
Alcidae (Family)	Unidentified Alcid	5	0.26	5	1.37	7	0.50			17	0.46
Alle alle	Dovekie					1	<0.1			1	<0.1
Uria sp.	Unidentified Murre	3	0.16			4	0.28			7	0.19
Uria aalge	Common Murre	5	0.26	4	1.10	18	1.28			27	0.74
Uria lomvia	Thick-billed Murre	5	0.26	4	1.10	11	0.78			20	0.54
Cepphus grylle	Black Guillemot					20	1.42			20	0.54
Synthliboramphus antiquus	Ancient Murrelet	71	3.74	5	1.37					76	2.07
Aethia or Ptychoramphus sp.	Unidentified Auklet	3	0.16	6	1.64	11	0.78			20	0.54
Aethia psittacula	Parakeet Auklet	3	0.16	14	3.84	31	2.21			48	1.31
Aethia pusilla	Least Auklet	8	0.42			34	2.42			42	1.14
Aethia cristatella	Crested Auklet	1	<.01	1	0.27	23	1.64			25	0.68
Fratercula spp.	Unidentified Puffin					1	<0.1			1	<0.1
Fratercula corniculata	Horned Puffin	2	0.11	6	1.64	3	0.21			11	0.30
Fratercula cirrhata	Tufted Puffin	48	2.53	12	3.29	1	<0.1			61	1.66
	Total	**1898**	**100%**	**365**	**100%**	**1405**	**100%**	**4**	**100%**	**3672**	**100%**
	KM surveyed	**493 km**		**510 km**		**1527 km**		**1277 km**		**3807 km**	

Table 18. Marine mammals (on and off transect) recorded 4 Sept-24 Oct 2022 during the fall SAS cruise.

Scientific Name	English Name	Total On Tran	Per Cent Total	Total Off Tran	Per Cent Total	Total On/Off Tran	Per Cent Total
Ursus maritimus	Polar Bear			2	0.59	2	0.51
Unidentified Phocidae (Family)	Unidentified pinniped	6	11.32	4	1.18	10	2.56
Callorhinus ursinus	Northern Fur Seal	5	9.43	3	0.89	8	2.05
Odobenus rosmarus	Walrus	19	35.85	24	7.10	43	11.00
Erignathus barbatus	Bearded Seal			2	0.59	2	0.51
Phoca largha	Spotted Seal	3	5.66	13	3.85	16	4.09
Pusa hispida	Ringed Seal	3	5.66	5	1.48	8	2.05
Cetacea (Order)	Unidentified Whale	1	1.89	22	6.51	23	5.88
Balaena mysticetus	Bowhead Whale	8	15.09	13	3.85	21	5.37
Eschrichtius robustus	Gray Whale	1	1.89	59	17.46	60	15.35
Balaenoptera acutorostrata	Minke Whale			1	0.30	1	0.26
Balaenoptera physalus	Fin Whale			22	6.51	22	5.63
Megaptera novaeangliae	Humpback Whale	7	13.21	163	48.22	170	43.48
Orcinus orca	Killer Whale			2	0.59	2	0.51
Phocoena phocoena	Harbor Porpoise			3	0.89	3	0.77
	Total	**53**	**100%**	**338**	**100%**	**391**	**100%**

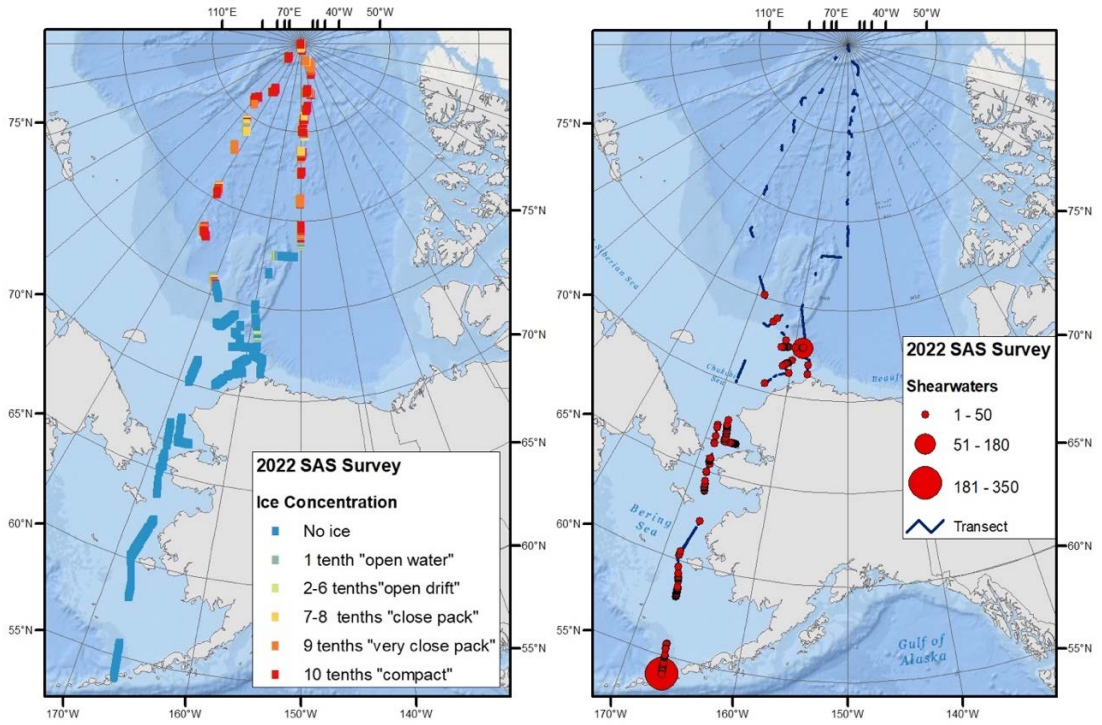


Figure 32. (Left) Sea ice concentration SAS2022. (Right) Shearwaters on transect distribution SAS2022.

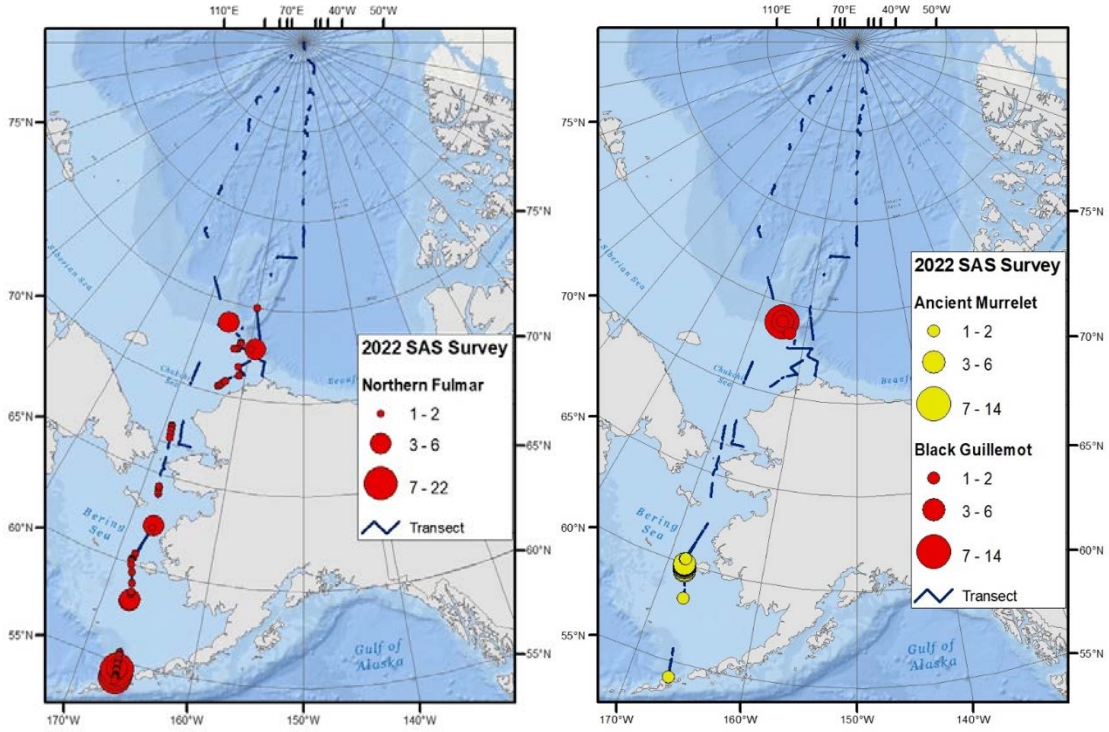


Figure 33. (Left) Northern Fulmar and (Right) Black Guillemot and Ancient Murrelet on transect distribution SAS2022.

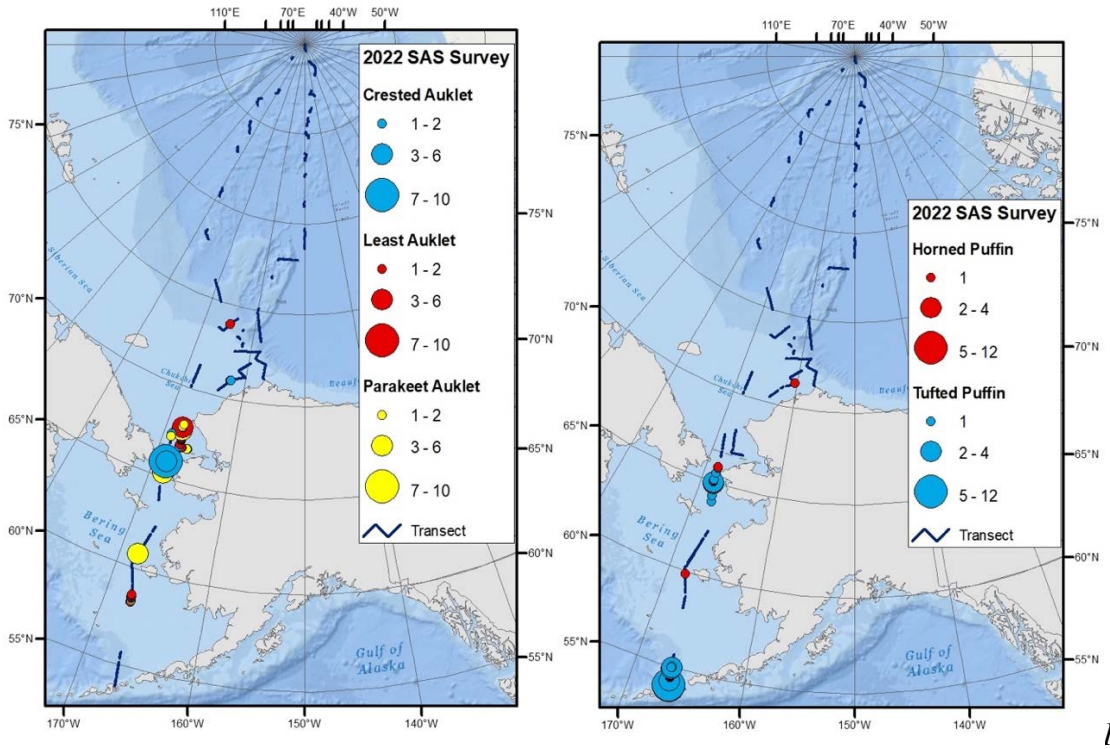


Fig. Figure 34. (Left) Aethia spp. and (Right) Fratercula spp. on transect distribution SAS2022.

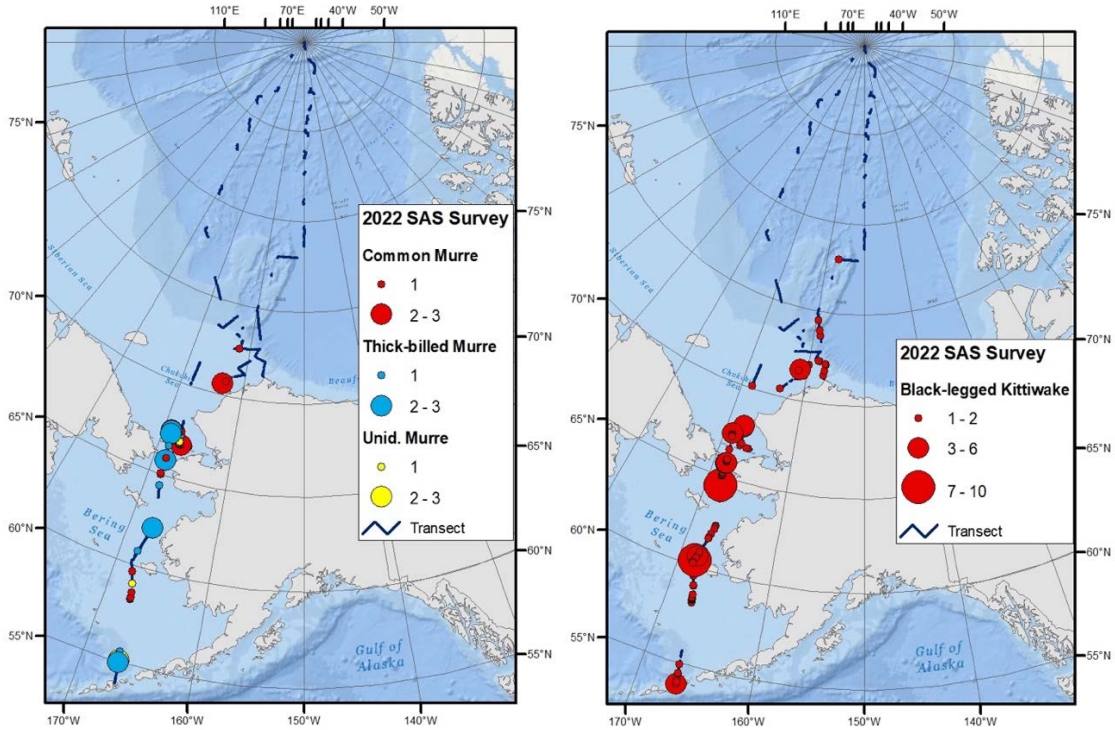


Figure 35. (Left) Uria spp. and (Right) Black-legged Kittiwake on transect distribution SAS2022.

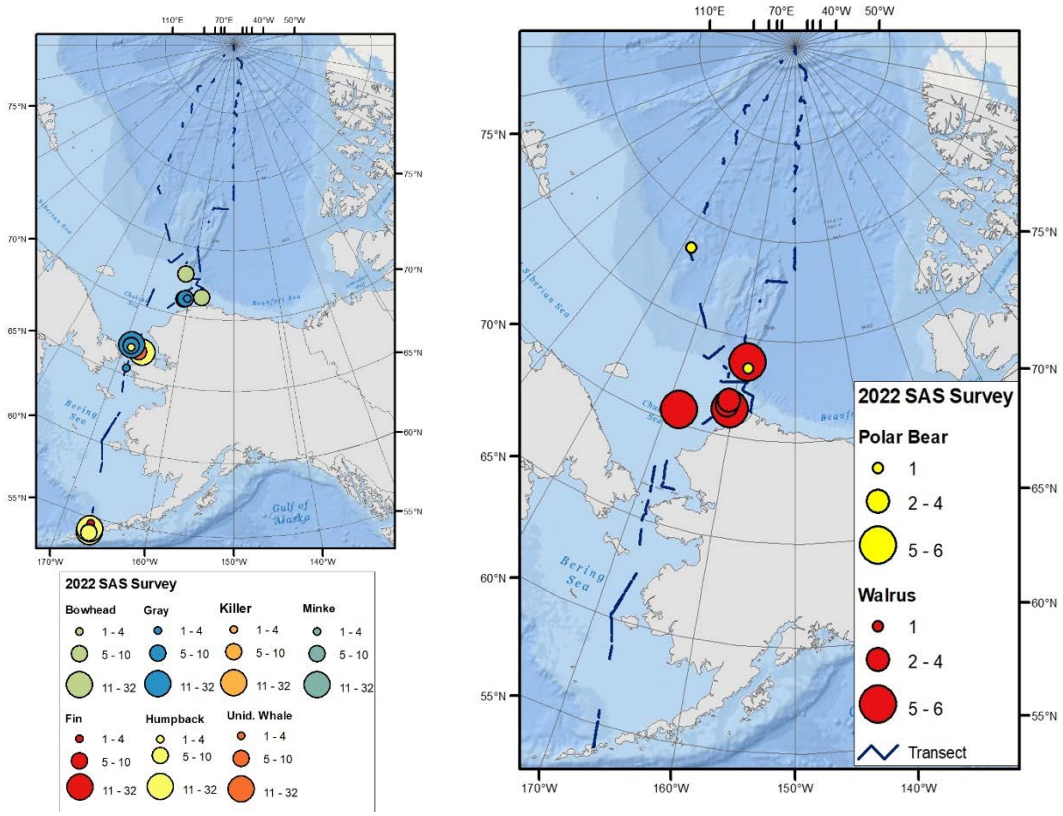


Figure 36. (Left) Cetaceans on and off transect and (Right) Polar Bear and Walrus on and off transect distribution SAS2002.

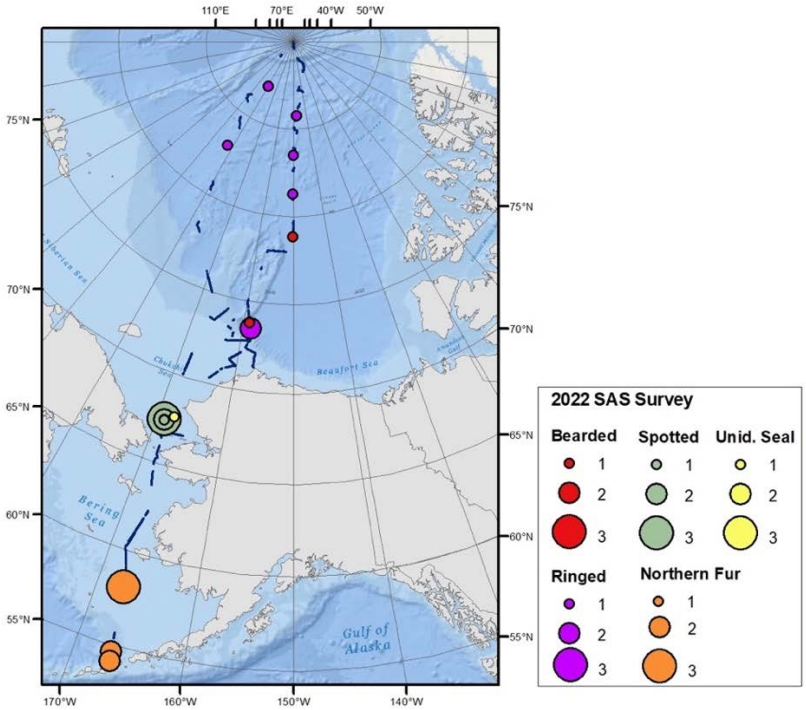


Figure 37. Pinniped on and off transect distribution SAS2022.

Marine Mammal Watch

Sue E. Moore (moore4@uw.edu) - University of Washington

A watch for marine mammals was conducted from the bridge of the USCGC HEALY (height = 18.3m) during the Synoptic Arctic Survey (SAS) cruise from Dutch Harbor to the North Pole and return. Watches were conducted during daylight hours when the ship was underway, augmented by periodic scans around the ship when on station. The lone marine mammal watch stander was aided in spotting mammals by a seabird observer and the ship's crew. The purpose of the watch is to detect marine mammals and identify sightings to species at temporal and spatial scales coincident with the oceanographic sampling. The overarching goal is to improve integration of upper-trophic species' distribution and behaviors with measures of biophysical variability in the Pacific Arctic marine ecosystem.

A total of 220 hours of watch effort was completed between 4 September and 24 October. Marine mammal sightings were tallied as the total number of sightings/total number of animals seen, by species (Table 19). From the perspective of the marine mammal watch, the SAS cruise consisted of four periods that roughly correspond to bathymetric zones, including: (1) a transit from Dutch Harbor across the relatively shallow Bering and Chukchi shelves to the Chukchi slope (CS), (2) transits to and from the North Pole, sampling in the deep Canada and Makarov basins, (3) sampling near a long-term mooring site on the Chukchi Plateau, followed by a 16-station high-resolution slope-shelf grid focused on Hanna Canyon, then returning to a single-station on the CS slope, and (4) a southbound transit through Chukchi-Bering shelf waters back to Dutch Harbor. A brief summary of marine mammal sightings, total numbers and behaviors observed are provided below for these four periods of the SAS cruise.

4-13 September: Dutch Harbor to the Chukchi Slope

A total of 45 hours of watch effort was conducted during this period. Humpback and fin whales were seen in the southern Bering Sea, as the ship departed from Dutch Harbor (4 Sep), and in the southern Chukchi Sea, as the ship departed Kotzebue Sound (7 Sep). In the Bering Sea, 104 humpbacks fed in groups of 5-10 whales extending along the ship's track for roughly 30km (17nm). Rafts of 1000s of short tailed shearwaters were seen among the feeding humpback whales, a spectacle that is common in the waters north of Unalaska Island. After a break of about 20km (12nm), 9 fin whales, including 1 possible calf, were seen along roughly 18km (10nm) of the ship's track; these whales were swimming on a SSE course and did not appear to be feeding. Only one gray whale was seen in the northern Bering Sea (6 Sep), presumably because the ship's track was very close to shore in the fresh and warm Alaska Coastal Current (ACC) where gray whales are seldom seen.

In the southern Chukchi Sea, one minke whale was seen in the vicinity of the stationary ship during a helicopter training exercise (similar to a sighting under similar circumstances in 2017, HLY 1702). Clusters of feeding humpback and fin whales were seen as the ship departed Kotzebue Sound, with groups of 2-4 fin whales (total = 13 whales) interspersed with groups of 7-12 humpbacks (total = 48 whales). This 2-species feeding aggregation extended from roughly 66° 51'N x 165° 50'W to 66° 48'N x 167°

10’W, which coincided with a shoal (<20m depth) along the north coast of Seward Peninsula. Of note, 15 whales seen beyond that track were too far away to be identified to species, as the ship turned north towards Point Lay.

In the northeast Chukchi Sea, 26 gray whales and 25 walruses were seen offshore Point Franklin (8 Sep), as the ship turned towards the Chukchi Environmental Observatory (CEO). The gray whales were aggregated and appeared to be feeding in clusters of 3-5 whales, while the walruses were swimming, several with calves alongside or riding on an adult female. Two adult walruses were also seen swimming near the first CS station (EHS 1; 10 Sep). On 11 September, the ship stopped at Utqiaġvik to pick up personnel and equipment, with 14 bowhead whales seen in the Barrow Canyon area as the ship departed. The whales were seen in the vicinity of tracks from 3 (of 6) tagged bowheads and near where bowheads are often seen feeding, usually on copepods. Patchy fog prevented a thorough search during the ship’s outbound track, such that the number seen was probably only a fraction of whales in the area.

14 Sep-14 Oct: Chukchi Slope to/from the North Pole

A total of 130 hours of watch effort was conducted during this period. On 14 September, a few walruses (n=11) and ringed seals (n=3) were seen as the ship passed through a patch of 10-30% sea ice cover. A single bearded seal and one polar bear were also sighted in this localized ice zone (*ca.* 73º 30’N to 73º 50’N); all species were hauled out on the ice. Open water, prevailed as the ship steamed north over the next four days, with 30-80% ice cover finally encountered from *ca*. 78º 40’N to 79º 30’N on 18 September, with one bearded seal resting on the ice. Polar bear tracks were noted on four days (18-20 & 28 Sep) and 4 ringed seals were seen between 21 Sep and 9 Oct, usually in open-water pools near the ship while on station. One polar bear was seen on 13 October, as it approached and passed in front of the ship at STN 30. The bear appeared to be a curious young female, in good body condition; she lingered near the ship for roughly an hour attracted by the smell of food. The dearth of marine mammal sightings over this month-long period was likely due to the low-productivity noted in the deep-basin habitats being sampled.

15-21 October: Chukchi Plateau, Hanna Canyon Grid, Chukchi Slope & Transit South

A total of 30 hours of watch effort was conducted during this period. On 15 October, the ship transited to a sampling station (STN 32) at the Arctic Ice Mooring (AIM) mooring site on the Chukchi Plateau. The AIM mooring has included a passive acoustic recorder since 2008, with calls from bowhead and beluga whales, and bearded and ribbon seals detected there in summer and autumn. Unfortunately, no marine mammals were seen during the transit to, nor while on station at the AIM site. On 16 October, the ship undertook a dog-leg search transit across the Chukchi slope on the way to the Hanna Canyon (HC) high-resolution sampling grid, and ultimately back to complete sampling station EHS 6 on the Chukchi slope. On 19 October, seven bowhead whales were seen milling &/or feeding on the Hanna Shoal slope (110m depth) as the ship approached STN46/HC14. A very large bowhead was among a group of 5 whales, with a pair of whales seen roughly 1km north of the group. On 21 October, the ship sailed a SW course to *ca.* 168º15’W longitude, then turned south and adopted a transit course roughly

parallel to the IDL. Strong winds and high sea states delayed watch effort until mid-afternoon when 5 walruses (3 adult females, 2 w/ calves) were seen swimming in rolling waves. Of note, the ship was passing (far) offshore the large shoreside walrus haul-out that is now common in summer and autumn near the village of Point Lay, Alaska.

22-24 October: Transit South – DBO Station 3.8- Transit South – Dutch Harbor

A total of 15 hours of watch effort was conducted during this period. The ship continued its southbound transit on 22 October, with calm winds and low sea states. A loose aggregation of spotted seals (n=16, + 5 unidentified seals) were seen between 67º30'N and 67º25' N latitude along ~168º 52'W longitude. Roughly 30km (17 nm) further south, 46 whales were noted (in 65 minutes) between 67º08'N and 66º58'N along ~168º44W longitude. The initial sighting was of blows from 9 unidentified whales seen at the horizon (~18 km/10 nm away); 5 whales in that group had tall-columnar blows like those of fin whales, while the blows of the other 4 whales were smaller and 'puffier', like those of humpback or gray whales. The whale assemblage within ~9km (5nm) of the ship was comprised mostly of gray whales (n=33) that appeared to be feeding in groups of 3-5 whales, accompanied by a few humpback whales (n=4) that were seen near three of the gray whale groups. Forecasts of extreme storms headed for the Bering Sea forced an abrupt transition in the ship's operation to rapid transit to Dutch Harbor to ensure safe arrival, with marine mammal watches conducted when weather allowed. No marine mammals were seen on 23 October. On 24 October, 14 humpback whales and 5 fur seals were seen as the ship approached Dutch Harbor. Three whales were too distant to be positively identified (but were likely humpbacks); one unidentified pinniped was seen, likely a fur seal. The ship safely arrived Dutch Harbor at 1730.

Table 19. Marine Mammal Watch Summary
Hours of watch effort (EFT) and number of sightings/number of animals, by species.
Species Codes: HW=humpback whale, FW=fin whale, GW=gray whale, MW=minke whale, BH= bowhead whale, KW=killer whale, HP=harbor porpoise, WS=walrus, BS=bearded seal, RS=ringed seal, PB=polar bear; in Comments, FS= fur seal, SP=spotted seal CT=unidentified cetacean, PN=unidentified pinniped

DATE	EFT	HW	FW	GW	MW	BH	KW	HP	WS	BS	RS	PB	Comments
9/4	3	8/104	3/9				1/2	1/2					Depart Dutch
9/5	9												FS=3
9/6	7			1/1				1/1					ACC track
9/7	5	6/48	4/13		1/1								CT=15, PN=1
9/8	8			5/26					4/25				NE Chukchi
9/9	0												**CEO day-no watch**
9/10	3.5								1/2				Station EHS 1
9/11	7.5					2/14							To/from UTQ
9/12	1												EHS 2, 3 & 4
9/13	1												EHS 5&6 **CTD lost**
Sub total	**45**	**14/152**	**7/22**	**6/27**	**1/1**	**2/14**	**1/2**	**2/3**	**5/27**				**Dutch-CS slope**
9/14	9								1/11	1/1	2/3	1/1	Heading North
9/15	1												SAS #27 all day
9/16	10												PN=2 – likely RS
9/17	0												SAS #36 all day
9/18	10									1/1		*	PB tracks*
9/19	0											*	STN 16; **PB tracks**

9/20	6											*	PB tracks*
9/21	0										1/1		STN 17 all day
9/22	4												SRN 18 2/3 day
9/23	0										1/1		STN 19 all day
9/24	11												Transit thru ice
9/25	10												Transit thru ice
9/26	8										1/1		RS; Trnst **& STN 20**
9/27	5												Transit bck-ram
9/28	8											*	Transit PB tracks
9/29	9												Transit-OW river
9/30	5												**North Pole STN 21**
10/1	0												STN 21 all day
10/2	4												**Ice Liberty**-depart
10/3	2												Transit South
10/4	0												STN 22 all day
10/5	4												STN 23-short
10/6	6												Transit South
10/7	3												**STN 24 CTD T-south**
10/8	0												STN 25 all day
10/9	3										1/1		STN 26-short RS
10/10	0												STN 27 all day
10/11	6												**STN 28-short T-south**
10/12	0												STN 29 all day
10/13	6											1/1	STN 30-short PB
10/14	0												STN 31 all day
Sub total	**130**								**1/11**	**2/2**	**6/7**	**2/2**	**To/from N Pole**
10/15	7												**Transit to AIM site**
10/16	7												Slope search
10/17	1												STN 33 & 34
10/18	2												STN/HC stations
10/19	3					1/7							STN/HC BH!
10/20	6												**STN49/EHS6; PN=1**
10/21	4								1/5				**WS; W Pt. Lay haulout**
Sub total	**30**					**1/7**			**1/5**				**Transit South**
10/22	7	2/4		4/33									**DBO STN 3.8 SP=16;CT=9;PN=5**
10/23	3												**Fast transit south; gale-force winds**
10/24	5	2/14											**CT=1/3, FS=2/5 PN=1/1**
Sub total	**15**	**4/18**		**4/33**									
GRAND TOTAL	**220**	**18/170**	**7/22**	**10/60**	**1/1**	**3/21**	**1/2**	**2/3**	**7/43**	**2/2**	**6/7**	**2/2**	**SAS TOTALS**

Science and Landscape Photography

Leonard Sussman (lsuss410@pipeline.com)

As the science party photographer on the *Healy* North Pole Cruise, Leonard Sussman photographed the Arctic landscape (icescapes) and science activities during the cruise. He shot approximately 4500 images, including work in the science lab, instrument deployments and retrieval, and the work of the crew and scientists during instrument deployments.

Sussman provided access to a selection of his work to the science party and the Healy crew. His work from the cruise will be available for use by the USCG, the NSF, and

other science-related government, educational and non-profit organizations for non-profit usage.

During the cruise, Sussman has been posting frequently to a blog on his website titled: On the USCG *Healy* to the North Pole (http://www.Leonardsussman.com/new-blog-1). The website accumulated over 4700 page views during the cruise. While by far the largest number of visits have been from the United States, there have been visits from Canada, Chile, Argentina, multiple countries in Europe, Russia, Australia, New Zealand, and many other countries.

Sussman is also planning to exhibit his work from cruise in galleries and other venues.

Education and Outreach (Float Your Boat)

John Wigglesworth (jcwiggs11@gmail.com) - Woods Hole Oceanographic Institution

At the center of the overarching questions and scientific structure that hopes to describe the current state of the Arctic Ocean is education and outreach. The present state of the Arctic ecosystem is important to the understand especially in the changing climate of our planet. SAS 2022 carried out two significant educational endeavors designed to give students and the public an awareness and appreciation of the Arctic Ocean System. First, Healy deployed over 250 boats that were decorated by students as part of the secondary school Float Your Boat (FYB) Program. FYB (www.floatboat.org) is a project of the International Arctic Buoy Program with the U.S. Coast Guard and other institutions. Student Groups from around the country individualized small wooden boats that were patterned to spell "90°N" on the North Pole Ice Flow. A GPS Ice Ball tracker was launched with them. Students are able to track their boat and learn about ice flow movement as it moves with Arctic Winds and Ocean Currents. When the boats enter open water, they may be found on a distant coast somewhere. In addition to FYB, two schools engaged in regular discussions and updates with the Outreach Education Coordinator on board. The Ipswich High School (MA) AP Environmental Science Class and Winterberry Middle School (AK) 8th Grade General Science Class got daily updates on observations about living, working, studying, and doing science on Healy. Most of the email exchange was driven by student questions that were developed during school. The question ranged from topics such as "Have you seen a Polar Bear?" "How do you make water?" "How big are the engines?", "What is the food like?" and "How Thick is the Ice?"

Thanks to the Healy Crew and Science Team for all their efforts on behalf of educational outreach to and for the public.

Ship-based Science Technical Support in the Arctic (STARC) Weekly Reports

Max Hughes (mrhughes@ucsd.edu), Brendon Mendenhall (bcmendohall@ucsd.edu), Mason Schettig (mschettig@ucsd.edu) – Scripps Institution of Oceanography, University of California San Diego

Emily Shimada (Emily.Shimada@oregonstate.edu) - Oregon State University

See Appendix B for Weekly System Status Reports

Date: September 4 – 11, 2022

Cruise Summary: After several days mobilizing in port, moving science equipment out of the science hold and setting up all the labs, Healy departed Dutch Harbor on Sunday September 4 for flight OPS and a Helo personnel transfer. Additional GE staff were delayed on transit, so the ship headed to the first science station (Station 0) to recover and deploy moorings, a CTD, optics, ring nets, Van Veen sediment grabs, and the HAPS Corer. Weather delays allowed time for another science station (1) prior to personnel pickup. Now the crew complement is complete, and Healy is on site Station (2).

Comments on STARC systems: The new CDOM ECO fluorometer was installed on the rosette, underway systems performing well, after a week underway there was no noticeable biofouling. A spike in SSW pressure resulted in flow rates near 6 L/m, twice our typical flow, which pushed the ECO Triplets out of their housings. This was caused by Engineering increasing the SSW pump speed for increased uncontaminated science seawater flow on deck, however our and the science party's underway systems should have been taken offline beforehand. Engineering has now established that all requests for water pump adjustments will be routed through STARC to prevent further such incidents.

Date: September 12– 18, 2022

Cruise Summary:

It's been a busy week for ship crew and scientist alike.

A fire alarm resulted from smoke produced by the trawl winch brake assembly overheating – which was very dirty and gummy inside, possibly too tight, has since been resolved but required winch override to recover HAPS corer.

Main Lab flooded due to a clogged drain and higher volumes of water being accumulated in STBD Staging from CTD sampling. No longer an issue.

A request for increased science seawater pressure on deck (without informing STARC) resulted in pressure spiking on the flow through system, ECO Triplets were blown out of their housing, other science party flow through equipment was also impacted alarming the PIs. ECC has now established only STARC can request changes to the distilled water or science seawater pump configurations.

Deck handling kinked the starboard 0.322 when it caught on U-bolt while taking up tension – required retermination by STARC.

While on station the ship lost control of heading due to 20+ knot winds, ended up in the trough, drifting over the CTD wire. During an attempt to recover control the .322 wire was severed when it contacted the starboard prop. A total loss of the rosette, CTD and sensors plus 800 meters of wire. Healy transited to calmer seas so the spare rosette could be raised from the hold through the starboard deck hatch. STARC scrambled to reterminate the .322 and put together a completely new CTD package and 24-place rosette with our spares. We queried other oceanographic institutions with icebreaking vessels to explore a potential ship – ship transfer, as the SAS mission had just begun, and we had already used up a large percentage of our spare sensors. Solutions are still being explored.

Date: September 19–25, 2022

Cruise Summary:

Healy has made steady progress towards the North Pole, once past the Marginal Ice Zone the pack ice became an ever-increasing factor. When wind speeds are low it has not been difficult to hold station, however as wind speeds increase the ship tends to drift and ice floes become a hazard. Several stations have been skipped due to such environmental factors and Healy's reduced speed.

During recovery of a deep Multicorer cast, the 9/16th trawl wire wrapped poorly. After numerous attempts to pay out beyond the bad wraps and spool back on neat, it was determined the problem lies too deep in the drum to address underway, likely caused by spooling issues this past dockside. The contractor assigned the task broke their equipment and kinked the wire in the process, resulting in over a thousand meters of trawl wire being trashed, so we were disappointed but not surprised. STARC has repeatedly advocated for the UNOLS West Coast Winch and Wire Pool to be contracted for spooling and lubrication of Healy's scientific wires. Since the 9/16th is now considered unusable, we tested, sealed, and terminated the .680 wire to use for coring operations. Bongo nets and McLane pumps are now being deployed using the aft .322 wire which had previously been exclusively used for the real time triggering of the Multinet.

Due to the thick ice, pumping sewage while the ship is stationary has recently become an issue. STARC has requested to be consulted prior to any over boarding of waste to assess whether our relative speed warrants securing of the Science Seawater pumps.

Date: September 26 – October 2, 2022

Cruise Summary:

After two days at the North Pole combining science operations, Coast Guard Ceremonies, and Ice Liberty, Healy is on her way South to continue the SAS mission. Thick ice floes required a steady grinding pace toward the pole, environmental conditions did not allow for many stations this past week so on the return transit data gaps will be filled. Shifting winds caused several stations to be cut short as the ice and ship began to drift, endangering scientific equipment. Terminating the .680 with a PMI Grip for coring has been successful, however due to sustained damage to the grip and wire, an alternate termination with a larger diameter thimble and saddle clamps is being explored.

Comments on STARC systems:

SIS is not able to display multibeam data in Geographical view past 86°N, as well as the Date Line, requiring a projection shift. Mapping in thick ice is problematic, data are being collected but shall require significant processing. The 3.5 kHz single beam has difficulty tracking bottom in ice as well though we do well when on station.

We have had to secure uncontaminated science seawater several times over the past week for various issues including frozen overboard piping runs, sewage pumping, and reduction in pressure from ice and organic matter clogging the supply.

The starboard Metek ultrasonic anemometer iced up for a few hours but was defrosted by switching the heater "ON" at all times rather than switched automatically like the other Meteks. Will investigate in port.

Date: October 3-9, 2022

Cruise Summary:

The past week has been a steady grind South through the Pack ice as Healy finds leads sheared open by the Southerly winds to the East and Northerly winds to the West. We occupied Long Stations at 88°N and 84°N, however variable conditions contributed to the 86°N station being skipped. XBTs and XCTDs are being used to collect data at 20 nautical mile intervals when CTDs are not feasible.

Comments on STARC systems:

On several occasions, extremely cold temperatures froze the overboard discharge for science sea water and sinks, requiring those systems to be secured for extended periods as Damage Control teams addressed similar issues across the ship. The CTD also experienced freezing during a recovery so a test cast was performed to verify the sensors were undamaged. The primary pump remained frozen until a cast depth of 200 meters then kicked on once the conductivity sensor reached the minimum salinity threshold; data look fine to the scientists. A warm blanket and warm saline solutions are being used on deployments and recoveries to protect the sensors during winch tensioning.

The new .680 saddle clamp termination has performed well and allows for more flexibility than the PMI grip. Multicorer casts have gone well with the OIS Pinger being used to track the approach to the bottom.

Date: October 10-16, 2022

Cruise Summary:

After a month in the pack ice, Healy exited the Marginal Ice Zone on October 15th and entered open water. Wind speeds are moderate, swell height and direction are once again variables to consider for starboard and aft deployments. Ambient temperatures have risen to 25°F, allowing pipes to flow and underway data to be collected more consistently. The sonars are functioning well without sheets of ice under the keel. Deck force has split into watches to support our high-frequency sampling line at Hanna Canyon, which requires 24-hour operations.

Date: October 17-24, 2022

Cruise Summary:

Healy has successfully completed the 2022 SAS Mission.

After a few days of and intensive 24-hour operations to sample a high resolution line, Healy transited South to the final station DB03. Incoming low-pressure systems in the Bering Sea and Gulf of Alaska prompted the Chief Scientist and Healy Command to reassess plans for opportunistic science on route to port; rather than face 50 knot winds

and 30-foot seas, Healy pulled into Dutch Harbor a few days early. Along the way XBTs were deployed every degree of latitude with a final XCTD in Barrow Canyon offshore Unalaska.

Overall, the 50-day leg of science to the North Pole and back was a resounding success, with numerous challenges overcome, and a vast amount of data collected from one of the most remote locations in the world. Out of all the US research vessels, only Healy can reach such high latitudes and conduct world class research along the way.

Operations Summary: 51 science stations (short and long)
CTD casts: 51
Optic casts: 37
Ring Net: 2
Bongo Net: 31
Multinet: 16
HAPS Corer: 18
Van Veen grabs: 53
Multicorer 800: 20
Video Plankton Recorder: 34
XCTDs: 24
XBTs: 121
Moorings recovered: 3
Moorings deployed: 3
McLane Pumps: 15

U.S. Coast Guard C5I Polar IT

Sarah Kaye (lead), Brian Nuttall (brian.nuttall@polarscience.net) - USCG

USCG C5I provided IT support including satellite communications, email, file transfer, file share, and ad hoc services to the science party on HLY2202. New team member Brian Nuttall also trained up in order to be an independent, solo technician on future cruises.

As this cruise went all the way to 90°N, we spent significant time outside of our regular VSAT satellite Internet service. We left VSAT service at 80°N 150°W on the northbound leg on Sept 19 and regained it at 80°N 179°W on Oct 12.

While we were out of VSAT range we used our fallback system, Iridium Certus service via a Thales VesseLink terminal. This was the first sustained time of use for this system in production using the second-generation Iridium satellites. Overall, the system performed quite well. We had some learning experiences with technical details that have been logged to assist with Iridium usage on future trips. While the system has a data cap (10GB/month, with no rollover), we were able to support email, weather imagery file transfer, and limited Internet browsing. It was convenient that our time out of VSAT range was distributed evenly between September and October, so we were able to use the data allocation for both months. In addition, the NIC Ice Analyst brought his own Certus system so ice imagery transfer did not come out of our data allocation. Either factor may not be true on future trips, so data controls may be different under different circumstances.

We also provided routine user account, web site, printing, data distribution, and user support. Onboard requests were handled as resources were available.
There was an extended email outage for 31 hours starting on Friday Oct 7. This was due to the service provider for our shore node located at USCG Base Seattle experiencing a fiber bundle break. Our chain of command is researching options for a fallback service provider. Otherwise, services were consistent and satisfactory.

Appendix A. Personnel

PERSONNEL. ON BOARD

CAPT	Boda, Kenneth
CDR	Armstrong, Patrick
OPERATIONS	
LCDR	Greendyk, Jamie
LTJG	Grimes, Megan
ENS	Doherty, Robert
LT	Ames, Lydia
ENS	Siler, Emi
ENS	Dunkle, Ryan
ENS	Miagany, Zane
ENS	Monaco, Luke
ELECTRONICS	
ETCS	McArdle, James
ET1	Bice, Scott
ET2	Diko, Brandon
ET2	Baggs, Keaton
ET3	Myrick, Corey
COMMUNICATIONS	
OSC	Mallory, Matthew
IT1	Anderson, Brandon
IT1	Breuer, Samuel
MARINE SCIENCE	
MSTCS	Fritchey, Matthew
MST1	Gribbon, Michael
MST2	Austin, Makenzi
MEDICAL	
LT	Thompson, John
HS1	Mesenscott, Roy
SUPPORT	
F&S3	Meister, Elizabeth
GALLEY	
CSCS	Hoover, David
CS1	Alexander, Benjamin
CS2	Collins, Regan
CS2	Sinning, Gregory
CS3	Evans, Christopher
CS3	Munselle, Eric
CS3	Nitz, Joel
SUPPLY	
SKC	Nelson, Kevin
SK1	Soler, Jose
SK1	Barton, Mayra
SK1	DeLaRosa, Luis
SK2	Eldridge, Andrew

ADMIN	
YNC	Bowen, Mandy

DECK	
BOSN	Seevers, Christopher
BMC	Whitehead, Justin
BM1	Olsen, Gwendolyn
BMC	Heyob, Eric
DECK E-5 & BELOW	
BM2	Martini, Michael
BM2	Lyons, Derek
BM2	Edge, Patrick
BM2	Gotudo, Vincent
BM3	Cloney, Eden
BM3	Wilson, Blake
BM3	Glosek, Zachary
SN	Reasner, Braydon
SA	Halbert, Anthony
SN	Lewis, Emily
SN	Molenkamp, Nicholas
SN	Nelson, Marquise
SN	Tomasello, David
SN	Swanson, Gaven
ENGINEERING	
LCDR	Brockus, Aaron
LT	Kotchman, Tyler
ENG4	McSweeney, Sean
ENS	Tarbrake, Grace
ENS	Taylor, Ryan
ENS	Kirvelevicius, Rasa
DAMAGE CONTROL	
DCC	Weintraub, Steven
DC1	Rightweiser, Scott
DC2	Asher, Erin
DC3	Gittleson, Caleb
EM	
EM1	Twohy, Samantha
EM1	Walvatne, Michael
EM2	Adams, Peter
EM3	Anderson, Caman
EM2	Jones, Kalil
MAIN PROPULSION	
MKC	Arriola, Peter
MK1	Neermann, Christopher
MK1	Thompson, Katie
MK2	Kyler, Kyle
MK3	Grossman, Alexander
FN	Cascaden, Tony
FN	Kehoe, Nathan
AUXILIARY	
MKCS	Collins, Jennifer
MK1	Underwood, Michael
MK1	Mason, Betty
MK2	Hanlon, Brian
MK3	Dyer, Nicholas
MK3	Bynum, Donovan
FN	D'Antonio, Nicholas
MK3	Breckner, Jason

SCIENCE PARTY
Ashjian, Carin-Co-Chief Scientist
Grebmeier, Jackie-Co-Chief Scientist
Alvarez-Rodriguez, Maria Cristina
Campbell, Bob
Campbell, Marcia
Coblentz-Strong, Genevieve
Cooper, Lee
Danielson, Seth
Drysdale, Jessica
Enright, Matt
Fagan, Adam
Gaffey, Claire
Garley, Rebecca
Gelfman, Celia
Goethel, Christina
Juranek, Laurie
Magen, Cedric
Margevich, Annika
Marx, Brian
Medley, Claire
Moore, Sue
Reedy, Marty
Sandy, Savannah
Shipton, Peter
Silberg, Jona
Sussman, Leonard
Tepper-Rasmussen, Michael
Wigglesworth, John
C5I POLAR SCIENCE
Nuttall, Brian
Kaye, Sarah
STARC
Mendenhall, Brendon
Shimada, Emily
Schettig, Mason
Hughes, Maxwell

TEMPORARY PERSONNEL	
LCDR	Rudnickas, Donald
ENS	Bates, Curtis
CWO	Latin, Mike
AUX	Schrag, Lyle
AUX	Cordone, Deborah
	Reed, Clive

Appendix B. STARC Weekly Science Systems Status

Week 1: September 4 – 11, 2022

Science Systems

- **Seapath:** Working.
    - **SeaTex MRU 5 (primary MRU)** Working.
- **SeaTex MRU6:** Not installed. Output feed and serial splitter moved to the Seapath 330+'s EM3000 feed.
- **PosMV:** Working.
- **Ceesync 1 PPS:** Working
- **Trimble SPS 356:** Working.
- **Trimble ABX-Two:** Working.
- **MK39 Gyro:** Working.
- **Multibeam EM-122:** Working.
    - **SIS:** Working
        - Run Weekly BIST? Yes, all passed.
    - **TRU/Pre-Amp:** Working
    - **Helmsman:** Used for displaying UHDAS data, per Lt. Ames. Helmsman-2 in use; Helmsman-1 is showing a CPU fan issue, although the fan is spinning.
- **Mosaic:** Tested and found to be working, not in use this mission.
- **Knudsen Echosounder:** Echo-01 is the primary. Working
    - **3.5 kHz:** parts have been received from Knudsen and installed; issue resolved
    - **12 kHz:** Working as above
- **ADCP:** Working.
    - **UHDAS:** Working.
    - **OS 75:** Working.
    - **OS 150:** Working.
- **K-Sync:** Working.
- **Reference Hydrophone:** Working.
- **ArcGIS:** Working to display our trackline, station waypoints, ice imagery and NIC products for situational awareness
        - Ice Imagery Imported – Yes, though Canadian imagery is the exception
        - Remote Display Client – Mediacento with a Dell 3040 Wyse thin client
    - **Qimera:** Not used.
    - **Fledermaus:** Not used.
- **Hypack:** Not in use.
- **OpenCPN:** Had crashed prior to cruise. Completely wiped ctd02 of all traces of config files, downloaded Microsoft C++ runtime package, and reloaded the

software starting at version 4.8. From there, we were able to add back in all charts, layers, GPS and AIS feeds, and upgrade back to version 5.2.4

- **AIS:** Working.
- **GeoMapApp:** Not used though a new version is available – recommend for 2023
- **Meteorological:**
    - **FWD JackStaff Sensors:** Working.
        - **Temperature/Relative Humidity**
            - RH sensor working.
        - **Ultrasonic Wind (METEK uSonic-2 HD) –** Working.
            - S/N: 0114038499
            - Configured to output data.
        - **Main Mast Sensors:**
            - **Ultrasonic Wind (Metek uSonic-2 HD) –** Working.
                - Port S/N 0113038032
                - STBD S/N 0113038052
        - **Bridge Sensors:** Working. Relative humidity has been near or at 100% throughout time in science operations area. Came down to low 80's in the Bering Strait. SAMOS reports NaNs being filled in for many humidity readings- possibly a setting in the MET that fills in NaNs for consecutive 100% readings. Formula used to calculate humidity is not well suited for Arctic conditions.
            - **Relative Humidity/Temp (Vaisala HMP110)** Not installed
                - S/N - N/A
            - **Relative Humidity/Temp (E+E EE08-PFT1V11D6HCO1/T02)**: Working.
                - S/N - 171505000253F0
                - S/N – 17080500052093 – Replaces EE60 listed below. New Cal. File from July 2022 used.
                - Will show a NaN value intermittently
            - **Barometer (RM Young 61302V)**: Working.
                - Pressures appear to change with speed of the vessel even with gill plate…
                - S/N - BPA6176
            - **Temperature (RM Young 41342VC)**
                - S/N - 17609
            - **Temp / Relative Humidity (E+E EE33) –** Not Installed.
                - S/N – N/A
            - **Relative humidity (EE60)**
                - S/N – S86493 – Removed 8/28/2022 and replaced by another EE08. See above.
                - Sensor not showing values in line with other two sensors.
        - **HCO Sensors:** Working
            - **Surface PAR (Biospherical QSR2200):**
                - S/N- 20153
            - **Spectral Pyranometer (Eppley PSP/SPP):**

        - S/N- 35032F3
    - **Infrared Pyranometer (Eppley PIR):**
        - S/N 34463F3
- **Seawater Intake Temperature Sensor:** Working.
    - SBE3+
        - S/N 034063
- **Hull Temp Sensor:** Working now with new thermal paste applied and mounted to the deck instead of external bulkhead. Temperature is tracking with sea water temps.
        - SBE 48 S/N- 0042

- **LCI-90i:** Working
- **Scoreboards**: Tested, working.
- **CTD:** Tested, working
    - **Fish (SBE 9+):**
        - S/N- 0639 installed as primary
    - **Conductivity (SBE 4C):**
        - Primary S/N- 2545
        - Secondary S/N- 2575 (replaced 2619 on 22Aug2022)
    - **Temperature (SBE 3+):**
        - Primary S/N- 2841
        - Secondary S/N- 2824
    - **O2 (SBE 43):**
        - Primary S/N- 0459
        - Secondary S/N- (not installed)
    - **Fluorometer (WetLabs ECO):**
        - S/N- 7624 (replaced 074 on 23Aug2022)
    - **Fluorometer (WetLabs CDOM)**
        - S/N – 7552 (new sensor install for this cruise)
    - **Transmissometer (WetLabs C-STAR):**
        - S/N- CST-390DR
    - **Altimeter (Valeport VA500):**
        - S/N- 60362?
    - **PAR (Biospherical QSP 2300):**
        - S/N- 70112 Put back on rosette 28AUG2022
    - **Carousel (SBE 32):**
        - S/N- 0116?
    - **Pumps (SBE 5T):**
        - S/N- 3114
        - S/N- 3116
    - **Primary Deck Unit (SBE 11):**
        - S/N- 416
    - **Secondary Deck Unit (SBE 11):**
        - S/N- 417
    - **Niskin Bottles:** No leaks found, monofilament lanyards should ould be replaced after this cruise

    - **Sippican MK21 Ethernet DAQ:** Working, DAQ successfully connects to the launcher via j-box above CL rack 6.
    - **Sippican LMC16 DAQ:** Not used.

- **Launcher:** Working.
- **XBT supply:** have not used any as we are on the shelf and the multibeam is performing well
    - **Fast Deep:** 46 manufactured in 2017, 24 manufactured in 2019, 12 manufactured in 2020 located in science stores; 9 manufactured in 2019 located in Main Lab.
    - **T5**: 30 manufactured in 2010, 26 manufactured in 2011 located in science stores.
    - **Deep Blue:** 23 manufactured in 2011 located in science stores
- **Science Sea Water (SSW):** Working and used for both water walls, supply to hoses on the back deck, and various lab sink instruments in Main Lab, Wet Lab, and Bio Lab. Inspected sensors and tubing on both waterwalls on September 11th and found clean with no biofouling concerns.
    - **Surface Temp: (SBE 3S)**
        - S/N - 4063
    - **Port Side:**
        - **Thermosalinograph: (SBE 45)**
            - S/N - 0215
        - **O2: (SBE 43)**
            - S/N - 0458
        - **WetStar Fluorometer**
            - S/N – 1648 installed.
        - **WetLabs C-STAR Transmissometer:**
            - S/N - CST-596PR
        - **Eco- Triplet Fluorometer:**
            - BBFL2 - 6484
        - **Optical Oxygen (SBE63)**
            - S/N - 2885be
        - **Additional Sensors for the Season**
            - Mini-TDGP: Working.
        - **Bio Chem Lab:** Working with BIOS sampler plumbed in.
            - **Thermosalinograph: (SBE 45)**
                - S/N - 0228
            - **O2 (SBE 43):**
                - S/N - 1307
            - **WetStar Fluorometer**
                - S/N – 1642
            - **Eco- Triplet Fluorometer**
                - S/N- 6865
- **Milli-Q:**
    - **Main Lab- IQ7000:** Working.
    - **Wet Lab- IQ7000:** Working.

- **pC02:** Working, replaced Vacuguard filter on September 10th and connected full nitrogen tank.
    - **Voltage Test Points checked?** Yes.
    - **Atmospheric CO2:** Running. There is a second machine up forward brought by UMD scientist so 2 new sniffer housings were mounted to jackstaff in port and two new tubes run to forward machinery space.
- **Gravimeter (BGM-3):** Installed and working,
    - **Voltage Test Points checked?** Yes, weekly last performed on 8/31/2022
    - **Entered in Google Drive?** Yes
- **Gravimeter (AT1M-19):** Not sailing in 2022.
- **AutoSal:** 2 serviced units onboard. Unit 65-715 in the Bio Lab did not have any flushing air coming out of the vent when going through initial startup checks. After inspections, we found one of the pumps was never bolted in and had fallen and disconnected from the air line tubing. It is now working and the second unit is on standby in the Main Lab.
- **Pingers:** New OIS 6000 pinger and additional 9/16 book clamps onboard, located in biolab, now though not tested yet. The obsolete Benthos 2216 pingers are stored in the warehouse and not onboard.

INFRASTRUCTURE

- **Intermapper:** Working.
- **E-LOG:** Using old R2R fitlet from Oceanus and configured to work on healy network. Will be using extensively throughout cruise.
- **Jira / Confluence:** Working and used extensively.
- **Console PC:** Working, with Windows 10 console-01 as the primary, and (older) console-pc as the backup. Displaying POSMV and Intermapper
- **STARC Surface Tablet:** Working and software updated. Stylus battery at 61%.
- **CTD/XBT PC:** Working, OpenCPN reverted to 5.2.4 on ctd-02 so that it can display layers.
- **Multibeam PC:** mb-01 working to run SIS; mb-02 not used.
- **Knudsen PC:** echo-01 is currently the primary. Migration to echo-03 as the primary was not performed because the hydrophone is still connected to echo-01 via a fiber-ethernet converter. Migration would require patching the fiber to the Computer Lab and moving the converter box.
- **K-Sync PC:** Working, with ksync-01 as the primary.
- **PCO2:** Working.
- **Hypack PC:** Not used.
- **ArcGIS VM:** ArcGIS updated with a new license. Ice imagery has been loaded for training purposes with NIC representative. ~~May need to dedicate a graphics card to system to utilize software fully.~~
    - VM Host has been better documented to allow for easier troubleshooting in the future.
    - Graphics upgrade not possible due to limitations of VM Host
- **Future Lab Mac Mini:** Updated to macOS Monterrey and OpenCPN 5.2.4.

- **Bridge Met PC:** PC has failed; currently using a Raspberry Pi with option of displaying webpages of the MET and ADCP data displays.
    - **Helmsman1:** Working, but shows a fan error upon boot.
    - **Helmsman2:** Working, currently displaying ADCP webpage on the bridge monitor.
- **Linux Systems:**
    - **ADCP Computers:** Working.
        - **Currents 36:** Working.
        - **Currents 35:** Working, as the primary.
    - **Met Computers:** Working.
- **Serial Logger:** Working.
- **KVM:** Mediacentos working. Spares stowed. Display04 has been replaced with an RX spare. Will warranty return it if the issue is determined to be the Mediacento unit.
    - Display 04 hasn't had any new problems since last report
- **Displays:**
    - **Computer Lab:** Working.
    - **Aft Con:** Working. Reverted back to original
    - **Main Lab:** Working.
    - **Bridge:** Working.
    - **Aloft Con:** N/A, but possible to add a display when C5I installs a new switch.
    - **BioChem:** Working.
    - **Aft Staging:** New install displaying MET.
- **Web Cams:**
    - **IC Gyro:** Working.
    - **Port SSW:** Working.
    - **BioChem SSW:** Working.
    - **Stbd Staging:** Working.
    - **Science comm board:** Working.
- **Power/UPS:**
    - **Computer Lab (Eaton):** Working.
    - **Aft Con (APC):** Working to power winch network and CTD deck units.
    - **HCO (APC):** Working to power GPS and radiometer systems, switch.
    - **MICA Stores:**
        - **Eaton:** Working, for ADCP deck units, Advantech, and switch.
        - **Acumentrics:** Working:
            - Top Battery Pack
                - Model: ACG2500RiBSPC1
                - S/N: W380997113
            - Bottom Battery Pack
                - Model: ACG2500RiBSPC1
                - S/N: W380997112
            - **IC-Gyro (DRS)** Replaced with Acumentrics – working to power STARC and PSN systems, S/N: W211001711

- **FWD/Jackstaff:** Parallel Acumentrics ACG2500 RUPS installed to power STARC MET, C5I switch, and scientist Picarro equipment in the forward machinery space. Top (not powered on) S/N: W380997111 Bottom (powered on) S/N: W091000106

NETWORK

- **Advantech:**
  - **Computer Lab:** Working.
  - **HCO:** Working.
  - **MET-Bridge:** Working.
  - **MICA (ADCP):** Working.
  - **IC Gyro:** Working.
  - **Jackstaff:** Working.
- **Comtrol:**
  - **Port side SSW:** Working.
  - **BioChem SSW:** Working.

- **Fiber Optic:**
  - **Computer Lab:** Working.
  - **HCO:** Working.
  - **MICA:** Working.
  - **IC Gyro:** Working.
  - **Potable Water:** Working.
  - **FWD:** Working.
- **RocketPorts (Computer Lab):** Working.
- **Perle:** CG systems that provide Gyro feeds working.
- **Time Servers:**
  - **HCO:** Working.
  - **Bridge:** Working.
- **Healy NAS:** Working, for DAS (SnagIt) and Data (collected mission data).
- **PSNHSVRDATA:** Working.
- **VSAT:** Working. C5I has applied a network rule to send all traffic to Atlassian tools via VSAT so that a UCSD VPN is not necessary to access them.
  - Back in range of service. Port antenna needs calibration says C5I
- **Starlink:** Worked when near shore in Seattle, with low latency. Starlink has been flapping inport in Dutch. VSAT as primary as of now.

Week 2 - September 12– 18, 2022

Science Systems

- **Seapath:** Working with intermittent dropouts due to high latitude
  - **SeaTex MRU 5 (primary MRU)** Working.
- **SeaTex MRU6:** Not installed. Output feed and serial splitter moved to the Seapath 330+'s EM3000 feed.

- **PosMV:** Working.
- **Ceesync 1 PPS:** Working
- **Trimble SPS 356:** Working.
- **Trimble ABX-Two:** Working.
- **MK39 Gyro:** Working.
- **Multibeam EM-122:** Working but having a difficult time in the ice, dropping most beams and losing bottom frequently. Not hardware or software related.
    - **SIS:** Working
        - Run Weekly BIST? Yes, most recent failed TX Channel and RX Noise
    - **TRU/Pre-Amp:** Working
    - **Helmsman:** Used for displaying UHDAS data, per Lt. Ames. Helmsman-2 in use; Helmsman-1 is showing a CPU fan issue, although the fan is spinning.
- **Mosaic:** Tested and found to be working, not in use this mission.
- **Knudsen Echosounder:** Echo-01 is the primary. Working
    - **3.5 kHz:** Working as primary
    - **12 kHz:** Working, used for pinger deployments
- **ADCP:** Working.
    - **UHDAS:** Working.
    - **OS 75:** Working.
    - **OS 150:** Working.
- **K-Sync:** Working.
- **Reference Hydrophone:** Working.
- **ArcGIS:** Working to display our trackline, station waypoints, ice imagery and NIC products for situational awareness
        - Ice Imagery Imported – Yes, though Canadian imagery is the exception
        - Remote Display Client – Mediacento with a Dell 3040 Wyse thin client
    - **Qimera:** Not used.
    - **Fledermaus:** Not used.
- **Hypack:** Not in use.
- **OpenCPN:** Had crashed prior to cruise. Completely wiped ctd02 of all traces of config files, downloaded Microsoft C++ runtime package, and reloaded the software starting at version 4.8. From there, we were able to add back in all charts, layers, GPS and AIS feeds, and upgrade back to version 5.2.4 - Working
- **AIS:** Working.
- **GeoMapApp:** Not used though a new version is available – recommend for 2023
- **Meteorological:**
    - **FWD JackStaff Sensors:** Working.
        - **Temperature/Relative Humidity**
            - RH sensor working.
        - **Ultrasonic Wind (METEK uSonic-2 HD) –** Working, heater is phenomenal
            - S/N: 0114038499

    - Configured to output data.
- **Main Mast Sensors:**
    - **Ultrasonic Wind (Metek uSonic-2 HD) –** Working – no icing issues
        - PORT S/N 0113038032 - reconfigured for lower Quality Threshold to account for vibration and turbulence
        - STBD S/N 0113038052 – having issues establishing serial comms however the heater is working well and data are good
- **Bridge Sensors:** Working. Relative humidity has been near or at 100% throughout time in science operations area. Came down to low 80's in the Bering Strait. SAMOS reports NaNs being filled in for many humidity readings- possibly a setting in the MET that fills in NaNs for consecutive 100% readings. Formula used to calculate humidity is not well suited for Arctic conditions – requires another analysis
    - **Relative Humidity/Temp (Vaisala HMP110)** Not installed
        - S/N - N/A
    - **Relative Humidity/Temp (E+E EE08-PFT1V11D6HCO1/T02)**: Working.
        - S/N - 171505000253F0
        - S/N – 17080500052093 – Replaces EE60 listed below. New Cal. File from July 2022 used.
        - Will show a NaN value intermittently
    - **Barometer (RM Young 61302V)**: Working.
        - Pressures appear to change with speed of the vessel even with gill plate…
        - S/N - BPA6176
    - **Temperature (RM Young 41342VC)**
        - S/N - 17609
    - **Temp / Relative Humidity (E+E EE33) –** Not Installed.
        - S/N – N/A
    - **Relative humidity (EE60)**
        - S/N – S86493 – Removed 8/28/2022 and replaced by another EE08. See above.
        - Sensor not showing values in line with other two sensors.
- **HCO Sensors:** Working
    - **Surface PAR (Biospherical QSR2200):**
        - S/N- 20153
    - **Spectral Pyranometer (Eppley PSP/SPP):**
        - S/N- 35032F3
    - **Infrared Pyranometer (Eppley PIR):**
        - S/N 34463F3
- **Seawater Intake Temperature Sensor:** Working.

        - SBE3+
            - S/N 034063
    - **Hull Temp Sensor:** Working -Temperature is tracking with sea water temps.
        - SBE 48 S/N- 0042
- **LCI-90i:** Working though getting bad data readings from the 9/16 trawl winch for payout, speed, and tension including the payout going to zero during casts. Timestamped examples were shared with EMs and Clive to check against their own logs. Recently the payout was reset mid-cast, reasons unknown but suspect sensor issues or EMI from new winch drive VFD
- **Scoreboards**: Working, switched between aft winches regularly between ops
- **CTD:** Tested, working
    - **Fish (SBE 9+):**
        - S/N- 0639 (LOST) to the deep
        - S/N – 638 now installed, as primary, has significant pressure port issues that has been calibrated out by adding a FastCat and programming the observed offset. Suspect a mis-entry by Seabird as the error is almost exactly 10 meters
    - **Conductivity (SBE 4C):**
        - Primary S/N 2568
        - S/N- 2545 (LOST)
        - Secondary 2561
        - S/N- 2575 (LOST)
    - **Temperature (SBE 3+):**
        - Primary S/N 2796
        - S/N- 2841(LOST)
        - Secondary S/N 2855
        - S/N- 2824 (LOST)
    - **O2 (SBE 43):**
        - Primary S/N 0456
        - S/N 0459 (LOST)
        - Secondary S/N- (not installed)
    - **Fluorometer (WetLabs ECO):** Zeroing out around 600 m depth, returns on upcast and is believable – reasons unknown but we have communicated to SeaBird
        - S/N- FTLRTD 074
        - 7624 (LOST)
    - **Fluorometer (WetLabs CDOM)** maxing out to 5VDC around 600 m, data returns on upcast and is believable – reasons unknown but we have communicated to SeaBird
        - S/N – FLCDRTD 2226
        - 7552 (new sensor install for this cruise) (LOST)
    - **Transmissometer (WetLabs C-STAR): NONE**
        - S/N- CST-390DR (LOST)
    - **Altimeter (Valeport VA500):** working with new custom-made cable
        - S/N- 65378

        - S/N- 60362? (LOST)
    - **PAR (Biospherical QSP 2350):**
        - S/N- 70682
        - S/N 70112 (LOST)
    - **Carousel (SBE 32):** working
        - S/N- 0116 end cap o-rings were replaced as last service was 2019, needed a sticky latch replaced
        - S/N – 0348 (LOST)
    - **Pumps (SBE 5T):**
        - Primary S/N - 3115
        - S/N- 3114 (LOST)
        - Secondary S/N - 3112
        - S/N- 3116 (lOST)
    - **Primary Deck Unit (SBE 11):**
        - S/N- 416
    - **Secondary Deck Unit (SBE 11):**
        - S/N- 417
    - **Niskin Bottles:** Some leaks found, monofilament lanyards on lower cap all replaced as they were very tight, most of the spigot o-rings needed to be replaced, a number of the cap o-rings were also replaced
    - **Sippican MK21 Ethernet DAQ:** Working, DAQ successfully connects to the launcher via j-box above CL rack 6.
    - **Sippican LMC16 DAQ:** Not used.

- **Launcher:** Working.
- **XBT supply:** have been used regularly in lieu of science stations as we skip them to make up lost time, will have enough for RTHP transit
    - **Fast Deep:** 53
    - **T5**: 6
    - **Deep Blue:** 10 manufactured in 2011 located in science stores
- **Science Sea Water (SSW):** Working and used for both water walls, supply to hoses on the back deck, and various lab sink instruments in Main Lab, Wet Lab, and Bio Lab. Inspected sensors and tubing on both waterwalls on September 11th and found clean with no biofouling concerns.
    - **Surface Temp: (SBE 3S)**
        - S/N - 4063
    - **Port Side:**
        - **Thermosalinograph: (SBE 45)**
            - S/N - 0215
        - **O2: (SBE 43)**
            - S/N - 0458
        - **WetStar Fluorometer**
            - S/N – 1648 installed.
        - **WetLabs C-STAR Transmissometer:**
            - S/N - CST-596PR
        - **Eco- Triplet Fluorometer:**

        - BBFL2 - 6484
    - **Optical Oxygen (SBE63)**
        - S/N - 2885be
    - **Additional Sensors for the Season**
        - Mini-TDGP: Working.
    - **Bio Chem Lab:** Working with BIOS sampler plumbed in.
        - **Thermosalinograph: (SBE 45)**
            - S/N - 0228
        - **O2 (SBE 43):**
            - S/N - 1307
        - **WetStar Fluorometer**
            - S/N – 1642
        - **Eco- Triplet Fluorometer**
            - S/N- 6865
- **Milli-Q:**
    - **Main Lab- IQ7000:** Working used heavily
    - **Wet Lab- IQ7000:** Working used heavily
- **pC02:** Working, replaced Vacuguard filter on September 10th and connected full nitrogen tank, still need to adjust flow rates too often – requires a NOAA groom
    - **Voltage Test Points checked?** Yes.
    - **Atmospheric CO2:** Running. There is a second machine up forward brought by UMD scientist so 2 new sniffer housings were mounted to jackstaff in port and two new tubes run to forward machinery space.
- **Gravimeter (BGM-3):** Installed and working,
    - **Voltage Test Points checked?** Yes
    - **Entered in Google Drive?** No – out of internet range
- **Gravimeter (AT1M-19):** Not sailing in 2022.
- **AutoSal:** 2 serviced units onboard. Unit 65-715 is working and the second unit is on standby in the Main Lab.

  Science party has successfully run a few batches of samples and data is being manually pushed to healynas.

  The LabVIEW program crashed a few times during initial training and trial run but we rebooted the laptop prior to running samples and that seemed to work. We will likely do this each time a new batch is going to be run.

  We had to replace one stopper and added to the SOP is not to twist the bottle once it is in place.

- **Pingers:** New OIS 6000 pinger and additional 9/16 book clamps onboard, located in biolab, now though not tested yet. The obsolete Benthos 2216 pingers are stored in the warehouse and not onboard. MARSSAM pinger did not perform as expected, perhaps the batteries are low. OUS's other OIS 6000 pinger is deployed on the Multicorer and working well.

INFRASTRUCTURE

- **Intermapper:** Working.
- **E-LOG:** Using old R2R fitlet from Oceanus and configured to work on healy network. Will be using extensively throughout cruise.
- **Jira / Confluence:** Working and used extensively – will not be able to use anymore however due to high latitude
- **Console PC:** Working, with Windows 10 console-01 as the primary, and (older) console-pc as the backup. Displaying POSMV and Intermapper
- **STARC Surface Tablet:** Working and software updated. Stylus battery at 61%.
- **CTD/XBT PC:** Working, OpenCPN reverted to 5.2.4 on ctd-02 so that it can display layers.
- **Multibeam PC:** mb-01 working to run SIS; mb-02 not used.
- **Knudsen PC:** echo-01 is currently the primary. Migration to echo-03 as the primary was not performed because the hydrophone is still connected to echo-01 via a fiber-ethernet converter. Migration would require patching the fiber to the Computer Lab and moving the converter box.
- **K-Sync PC:** Working, with ksync-01 as the primary.
- **PCO2:** Working.
- **Hypack PC:** Not used.
- **ArcGIS VM:** ArcGIS updated with a new license. Ice imagery has been loaded for training purposes with NIC representative.
    - VM Host has been better documented to allow for easier troubleshooting in the future.
    - Graphics upgrade not possible due to limitations of VM Host
- **Future Lab Mac Mini:** Updated to macOS Monterrey and OpenCPN 5.2.4.
- **Bridge Met PC:** PC has failed; currently using a Raspberry Pi with option of displaying webpages of the MET and ADCP data displays.
    - **Helmsman1:** Working, but shows a fan error upon boot.
    - **Helmsman2:** Working, currently displaying ADCP webpage on the bridge monitor.
- **Linux Systems:**
    - **ADCP Computers:** Working.
        - **Currents 36:** Working.
        - **Currents 35:** Working, as the primary.
    - **Met Computers:** Working although a strange data outage on 9/16 may be related to hardware/software glitching out as sometimes MET display freezes
- **Serial Logger:** Working.
- **KVM:** Mediacentos working. Spares stowed. Display04 has been replaced with an RX spare. Will warranty return it if the issue is determined to be the Mediacento unit.
    - Display 04 hasn't had any new problems since last report
    - An additional RX deployed to Aft Staging for benthic scientists to see data from their workbench
- **Displays:**

- **Computer Lab:** Working.
- **Aft Con:** Working. Reverted back to original
- **Main Lab:** Working.
- **Bridge:** Working.
- **Aloft Con:** N/A, but possible to add a display when C5I installs a new switch.
- **BioChem:** Working.
- **Aft Staging:** New install displaying MET.

- **Web Cams:**
  - **IC Gyro:** Working.
  - **Port SSW:** Working.
  - **BioChem SSW:** Working.
  - **Stbd Staging:** Working.
  - **Science comm board:** Working.
- **Power/UPS:**
  - **Computer Lab (Eaton):** Working.
  - **Aft Con (APC):** Working to power winch network and CTD deck units.
  - **HCO (APC):** Working to power GPS and radiometer systems, switch.
  - **MICA Stores:**
    - **Eaton:** Working, for ADCP deck units, Advantech, and switch.
    - **Acumentrics:** Working:
      - Top Battery Pack
        - Model: ACG2500RiBSPC1
        - S/N: W380997113
      - Bottom Battery Pack
        - Model: ACG2500RiBSPC1
        - S/N: W380997112
      - **IC-Gyro (DRS)** Replaced with Acumentrics – working to power STARC and PSN systems, S/N: W211001711
    - **FWD/Jackstaff:** Parallel Acumentrics ACG2500 RUPS installed to power STARC MET, C5I switch, and scientist Picarro equipment in the forward machinery space. Top (not powered on) S/N: W380997111 Bottom (powered on) S/N: W091000106

NETWORK

- **Advantech:**
  - **Computer Lab:** Working.
  - **HCO:** Working.
  - **MET-Bridge:** Working.
  - **MICA (ADCP):** Working.
  - **IC Gyro:** Working.
  - **Jackstaff:** Working.
- **Comtrol:**
  - **Port side SSW:** Working.
  - **BioChem SSW:** Working.

- **Fiber Optic:**
    - **Computer Lab:** Working.
    - **HCO:** Working.
    - **MICA:** Working.
    - **IC Gyro:** Working.
    - **Potable Water:** Working.
    - **FWD:** Working.
- **RocketPorts (Computer Lab):** Working.
- **Perle:** CG systems that provide Gyro feeds working.
- **Time Servers:**
    - **HCO:** Working.
    - **Bridge:** Working.
- **Healy NAS:** Working, for DAS (SnagIt) and Data (collected mission data).
- **PSNHSVRDATA:** Working.
- **VSAT:** Working. C5I has applied a network rule to send all traffic to Atlassian tools via VSAT so that a UCSD VPN is not necessary to access them.
    - Back in range of service. Port antenna needs calibration says C5I
- **Starlink:** Worked when near shore in Seattle, with low latency. Starlink has been flapping inport in Dutch. VSAT as primary as of now.

Week 3 - September 19–25, 2022

Science Systems

- **Seapath:** Working with intermittent dropouts due to high latitude
    - **SeaTex MRU 5 (primary MRU)** Working.
- **SeaTex MRU6:** Not installed. Output feed and serial splitter moved to the Seapath 330+'s EM3000 feed.
- **PosMV:** Working with occasional dropouts
- **Ceesync 1 PPS:** Working
- **Trimble SPS 356:** Working.
- **Trimble ABX-Two:** Working.
- **MK39 Gyro:** Working.
- **Multibeam EM-122:** Working but having a difficult time in the ice, dropping most beams and losing bottom frequently. Not hardware or software related.
    - **SIS:** Working
        - Run Weekly BIST? Yes, most recent failed TX Channel and RX Noise
    - **TRU/Pre-Amp:** Working
    - **Helmsman:** Used for displaying UHDAS data, per Lt. Ames. Helmsman-2 in use; Helmsman-1 is showing a CPU fan issue, although the fan is spinning.
- **Mosaic:** Tested and found to be working, not in use this mission.
- **Knudsen Echosounder:** Echo-01 is the primary. Working
    - **3.5 kHz:** Working as primary though difficult to get good bottom trace in ice.

    - **12 kHz:** Working, used for pinger deployments
- **ADCP:** Working.
    - **UHDAS:** Working.
    - **OS 75:** Working.
    - **OS 150:** Working.
- **K-Sync:** Working.
- **Reference Hydrophone:** Working.
- **ArcGIS:** Working to display our trackline, station waypoints, ice imagery and NIC products for situational awareness
        - Ice Imagery Imported – Yes, though Canadian imagery is the exception
        - Remote Display Client – Mediacento with a Dell 3040 Wyse thin client
    - **Qimera:** Not used.
    - **Fledermaus:** Not used.
- **Hypack:** Not in use.
- **OpenCPN:** Had crashed prior to cruise. Completely wiped ctd02 of all traces of config files, downloaded Microsoft C++ runtime package, and reloaded the software starting at version 4.8. From there, we were able to add back in all charts, layers, GPS and AIS feeds, and upgrade back to version 5.2.4 - Working
- **AIS:** Working.
- **GeoMapApp:** Not used though a new version is available – recommend for 2023
- **Meteorological:**
    - **FWD JackStaff Sensors:** Working.
        - **Temperature/Relative Humidity**
            - RH sensor working.
        - **Ultrasonic Wind (METEK uSonic-2 HD) –** Working, heater is phenomenal
            - S/N: 0114038499
            - Configured to output data.
        - **Main Mast Sensors:**
            - **Ultrasonic Wind (Metek uSonic-2 HD) –** Working – no icing issues
                - PORT S/N 0113038032 - reconfigured for lower Quality Threshold to account for vibration and turbulence
                - STBD S/N 0113038052 – having issues establishing serial comms however the heater is working well and data are good
        - **Bridge Sensors:** Working. Relative humidity has been near or at 100% throughout time in science operations area. Came down to low 80's in the Bering Strait. SAMOS reports NaNs being filled in for many humidity readings- possibly a setting in the MET that fills in NaNs for consecutive 100% readings. Formula used to calculate humidity is not well suited for Arctic conditions – requires another analysis

        - **Relative Humidity/Temp (Vaisala HMP110)** Not installed
            - S/N - N/A
        - **Relative Humidity/Temp (E+E EE08-PFT1V11D6HCO1/T02)**: Working.
            - S/N - 171505000253F0
            - S/N – 17080500052093 – Replaces EE60 listed below. New Cal. File from July 2022 used.
            - Will show a NaN value intermittently
        - **Barometer (RM Young 61302V)**: Working.
            - Pressures appear to change with speed of the vessel even with gill plate…
            - S/N - BPA6176
        - **Temperature (RM Young 41342VC)**
            - S/N - 17609
        - **Temp / Relative Humidity (E+E EE33) –** Not Installed.
            - S/N – N/A
        - **Relative humidity (EE60)**
            - S/N – S86493 – Removed 8/28/2022 and replaced by another EE08. See above.
            - Sensor not showing values in line with other two sensors.
    - **HCO Sensors:** Working
        - **Surface PAR (Biospherical QSR2200):**
            - S/N- 20153
        - **Spectral Pyranometer (Eppley PSP/SPP):**
            - S/N- 35032F3
        - **Infrared Pyranometer (Eppley PIR):**
            - S/N 34463F3
    - **Seawater Intake Temperature Sensor:** Working.
        - SBE3+
            - S/N 034063
    - **Hull Temp Sensor:** Working -Temperature is tracking with sea water temps.
            - SBE 48 S/N- 0042
- **LCI-90i:** Working though getting bad data readings from the 9/16 trawl winch for payout, speed, and tension including the payout going to zero during casts. Timestamped examples were shared with EMs and Clive to check against their own logs. Recently the payout was reset mid-cast, reasons unknown but suspect sensor issues or EMI from new winch drive VFD
- **Scoreboards**: Working, switched between aft winches regularly between ops
- **CTD:** Tested, working and have procedure in place to prevent freezing on deck including dry and warm plumbing prior to cast, insulating blanket, and warm saline solution to pump through when back on deck.
    - **Fish (SBE 9+):**
        - S/N- 0639 (LOST) to the deep

    - S/N – 638 now installed, as primary, has significant pressure port issues that has been calibrated out by adding a FastCat and programming the observed offset. Still has sometimes linear and sometimes exponential differences from wire out during deep casts. Pressure port has mineral oil and do not want to take apart housing as this is our only 9plus onboard now.
- **Conductivity (SBE 4C):**
    - Primary S/N 2568
    - S/N- 2545 (LOST)
    - Secondary 2561
    - S/N- 2575 (LOST)
- **Temperature (SBE 3+):**
    - Primary S/N 2796
    - S/N- 2841(LOST)
    - Secondary S/N 2855
    - S/N- 2824 (LOST)
- **O2 (SBE 43):**
    - Primary S/N 0456
    - S/N 0459 (LOST)
    - Secondary S/N- (not installed)
- **Fluorometer (WetLabs ECO):** Zeroing out around 600 m depth, returns on upcast and is believable – reasons unknown but we have communicated to SeaBird and not had helpful recommendations back yet.
    - S/N- FTLRTD 074
    - 7624 (LOST)
- **Fluorometer (WetLabs CDOM)** maxing out to 5VDC around 600 m, data returns on upcast and is believable – reasons unknown but we have communicated to SeaBird and not had helpful recommendations back yet.
    - S/N – FLCDRTD 2226
    - 7552 (new sensor install for this cruise) (LOST)
- **Transmissometer (WetLabs C-STAR): NONE**
    - S/N- CST-390DR (LOST)
- **Altimeter (Valeport VA500):** working with new custom-made cable
    - S/N- 65378
    - S/N- 60362? (LOST)
- **PAR (Biospherical QSP 2350):**
    - S/N- 70682
    - S/N 70112 (LOST)
- **Carousel (SBE 32):** working
    - S/N- 0116 end cap o-rings were replaced as last service was 2019, needed a sticky latch replaced
    - S/N – 0348 (LOST)
- **Pumps (SBE 5T):**
    - Primary S/N - 3115
    - S/N- 3114 (LOST)
    - Secondary S/N - 3112

        - S/N- 3116 (lOST)
    - **Primary Deck Unit (SBE 11):**
        - S/N- 416
    - **Secondary Deck Unit (SBE 11):**
        - S/N- 417
    - **Niskin Bottles:** Some leaks found, monofilament lanyards on lower cap all replaced as they were very tight, most of the spigot o-rings needed to be replaced, a number of the cap o-rings were also replaced
    - **Sippican MK21 Ethernet DAQ:** Working, DAQ successfully connects to the launcher via j-box above CL rack 6.
    - **Sippican LMC16 DAQ:** Not used.

- **Launcher:** Working.
- **XBT supply:** have been used regularly in lieu of science stations as we skip them to make up lost time, will have enough for RTHP transit
    - **Fast Deep:** 46
    - **T5**: 6
    - **Deep Blue:** 10 manufactured in 2011 located in science stores
- **Science Sea Water (SSW):** Working and used for both water walls, supply to hoses on the back deck, and various lab sink instruments in Main Lab, Wet Lab, and Bio Lab. Inspected sensors and tubing on both waterwalls on September 11th and found clean with no biofouling concerns.
    - **Surface Temp: (SBE 3S)**
        - S/N - 4063
    - **Port Side:**
        - **Thermosalinograph: (SBE 45)**
            - S/N - 0215
        - **O2: (SBE 43)**
            - S/N - 0458
        - **WetStar Fluorometer**
            - S/N – 1648 installed.
        - **WetLabs C-STAR Transmissometer:**
            - S/N - CST-596PR
        - **Eco- Triplet Fluorometer:**
            - BBFL2 - 6484
        - **Optical Oxygen (SBE63)**
            - S/N - 2885be
        - **Additional Sensors for the Season**
            - Mini-TDGP: Working.
        - **Bio Chem Lab:** Working with BIOS sampler plumbed in.
            - **Thermosalinograph: (SBE 45)**
                - S/N - 0228
            - **O2 (SBE 43):**
                - S/N - 1307
            - **WetStar Fluorometer**
                - S/N – 1642

        - **Eco- Triplet Fluorometer**
            - S/N- 6865
- **Milli-Q:**
    - **Main Lab- IQ7000:** Working used heavily
    - **Wet Lab- IQ7000:** Working used heavily
- **pC02:** Working and have had to restart system twice due to taking down SSW. Still need to adjust flow rates too often – requires a NOAA groom
    - **Tank pressures checked and recorded?** Yes.
    - **Atmospheric CO2:** Running. There is a second machine up forward brought by UMD scientist so 2 new sniffer housings were mounted to jackstaff in port and two new tubes run to forward machinery space.
- **Gravimeter (BGM-3):** Installed and working,
    - **Voltage Test Points checked?** Yes
    - **Entered in Google Drive?** No – out of internet range
- **Gravimeter (AT1M-19):** Not sailing in 2022.
- **AutoSal:** 2 serviced units onboard. Unit 65-715 was taken out of service on 9/25 as heater might be faulty. We have put 65-743 into service and are waiting for the bath temp to stabilize.
- **Pingers:** New OIS 6000 pinger and additional 9/16 book clamps onboard, located in biolab, now though not tested yet. The obsolete Benthos 2216 pingers are stored in the warehouse and not onboard. MARSSAM pinger did not perform as expected, perhaps the batteries are low. OUS's other OIS 6000 pinger is deployed on the Multicorer and working well.

INFRASTRUCTURE

- **Intermapper:** Working.
- **E-LOG:** Using old R2R fitlet from Oceanus and configured to work on healy network. Will be using extensively throughout cruise.
- **Jira / Confluence:** Working and used extensively – will not be able to use anymore however due to high latitude
- **Console PC:** Working, with Windows 10 console-01 as the primary, and (older) console-pc as the backup. Displaying POSMV and Intermapper
- **STARC Surface Tablet:** Working and software updated. Stylus battery at 61%.
- **CTD/XBT PC:** Working, OpenCPN reverted to 5.2.4 on ctd-02 so that it can display layers.
- **Multibeam PC:** mb-01 working to run SIS; mb-02 not used.
- **Knudsen PC:** echo-01 is currently the primary. Migration to echo-03 as the primary was not performed because the hydrophone is still connected to echo-01 via a fiber-ethernet converter. Migration would require patching the fiber to the Computer Lab and moving the converter box.
- **K-Sync PC:** Working, with ksync-01 as the primary.
- **PCO2:** Working.
- **Hypack PC:** Not used.
- **ArcGIS VM:** ArcGIS updated with a new license. Ice imagery has been loaded for training purposes with NIC representative.

    - VM Host has been better documented to allow for easier troubleshooting in the future.
    - Graphics upgrade not possible due to limitations of VM Host
- **Future Lab Mac Mini:** Updated to macOS Monterrey and OpenCPN 5.2.4.
- **Bridge Met PC:** PC has failed; currently using a Raspberry Pi with option of displaying webpages of the MET and ADCP data displays.
    - **Helmsman1:** Working, but shows a fan error upon boot.
    - **Helmsman2:** Working, currently displaying ADCP webpage on the bridge monitor.
- **Linux Systems:**
    - **ADCP Computers:** Working.
        - **Currents 36:** Working.
        - **Currents 35:** Working, as the primary.
    - **Met Computers:** Working although a strange data outage on 9/16 may be related to hardware/software glitching out as sometimes MET display freezes
- **Serial Logger:** Working.
- **KVM:** Mediacentos working. Spares stowed. Display04 has been replaced with an RX spare. Will warranty return it if the issue is determined to be the Mediacento unit.
    - Display 04 hasn't had any new problems since last report
    - An additional RX deployed to Aft Staging for benthic scientists to see data from their workbench
- **Displays:**
    - **Computer Lab:** Working.
    - **Aft Con:** Working. Reverted back to original
    - **Main Lab:** Working.
    - **Bridge:** Working.
    - **Aloft Con:** N/A, but possible to add a display when C5I installs a new switch.
    - **BioChem:** Working.
    - **Aft Staging:** New install displaying MET.
- **Web Cams:**
    - **IC Gyro:** Working.
    - **Port SSW:** Working.
    - **BioChem SSW:** Working.
    - **Stbd Staging:** Working.
    - **Science comm board:** Working.
- **Power/UPS:**
    - **Computer Lab (Eaton):** Working.
    - **Aft Con (APC):** Working to power winch network and CTD deck units.
    - **HCO (APC):** Working to power GPS and radiometer systems, switch.
    - **MICA Stores:**
        - **Eaton:** Working, for ADCP deck units, Advantech, and switch.
        - **Acumentrics:** Working:
            - Top Battery Pack

        - Model: ACG2500RiBSPC1
        - S/N: W380997113
    - Bottom Battery Pack
        - Model: ACG2500RiBSPC1
        - S/N: W380997112
    - **IC-Gyro (DRS)** Replaced with Acumentrics – working to power STARC and PSN systems, S/N: W211001711
- **FWD/Jackstaff:** Parallel Acumentrics ACG2500 RUPS installed to power STARC MET, C5I switch, and scientist Picarro equipment in the forward machinery space. Top (not powered on) S/N: W380997111 Bottom (powered on) S/N: W091000106

NETWORK

- **Advantech:**
    - **Computer Lab:** Working.
    - **HCO:** Working.
    - **MET-Bridge:** Working.
    - **MICA (ADCP):** Working.
    - **IC Gyro:** Working.
    - **Jackstaff:** Working.
- **Comtrol:**
    - **Port side SSW:** Working.
    - **BioChem SSW:** Working.

- **Fiber Optic:**
    - **Computer Lab:** Working.
    - **HCO:** Working.
    - **MICA:** Working.
    - **IC Gyro:** Working.
    - **Potable Water:** Working.
    - **FWD:** Working.
- **RocketPorts (Computer Lab):** Working.
- **Perle:** CG systems that provide Gyro feeds working.
- **Time Servers:**
    - **HCO:** Working.
    - **Bridge:** Working.
- **Healy NAS:** Working, for DAS (SnagIt) and Data (collected mission data).
- **PSNHSVRDATA:** Working.
- **VSAT:** Working. C5I has applied a network rule to send all traffic to Atlassian tools via VSAT so that a UCSD VPN is not necessary to access them.
    - Back in range of service. Port antenna needs calibration says C5I
- **Starlink:** Worked when near shore in Seattle, with low latency. Starlink has been flapping inport in Dutch. VSAT as primary as of now.

Week 4 - September 26 – October 2, 2022

Science Systems

- **Seapath:** Working with intermittent dropouts due to high latitude, had serious issues pinpointing location around 90°N and SBAS has been disabled for now as we cross back and forth across the date line.
    - **SeaTex MRU 5 (primary MRU)** Working.
- **SeaTex MRU6:** Not installed. Output feed and serial splitter moved to the Seapath 330+'s EM3000 feed.
- **PosMV:** Working with occasional dropouts, used as primary for the EM122 the past few days as Seapath cut in and out.
- **Ceesync 1 PPS:** Working
- **Trimble SPS 356:** Working.
- **Trimble ABX-Two:** Working.
- **MK39 Gyro:** Dropping out regularly
- **Multibeam EM-122:** Working but having a difficult time in the ice, dropping most beams and losing bottom frequently. Not hardware or software related.
    - **SIS:** Working, having a hard time though
        - Run Weekly BIST? No, most recent failed TX Channel and RX Noise due to ice
    - **TRU/Pre-Amp:** Working
    - **Helmsman:** Used for displaying UHDAS data, per Lt. Ames. Helmsman-2 in use; Helmsman-1 is showing a CPU fan issue, although the fan is spinning.
- **Mosaic:** Tested and found to be working, not in use this mission.
- **Knudsen Echosounder:** Echo-01 is the primary. Working
    - **3.5 kHz:** Working as primary though difficult to get good bottom trace in ice.
    - **12 kHz:** Working, used for pinger deployments
- **ADCP:** Working.
    - **UHDAS:** Working.
    - **OS 75:** Working.
    - **OS 150:** Working.
- **K-Sync:** Working.
- **Reference Hydrophone:** Working.
- **ArcGIS:** Working to display our trackline, station waypoints, ice imagery and NIC products for situational awareness
        - Ice Imagery Imported – Yes, though Canadian imagery is the exception
        - Remote Display Client – Mediacento with a Dell 3040 Wyse thin client
    - **Qimera:** Not used.
    - **Fledermaus:** Not used.
- **Hypack:** Not in use.

- **OpenCPN:** Had crashed prior to cruise. Completely wiped ctd02 of all traces of config files, downloaded Microsoft C++ runtime package, and reloaded the software starting at version 4.8. From there, we were able to add back in all charts, layers, GPS and AIS feeds, and upgrade back to version 5.2.4 – Working though does not display our location above 89 North
- **AIS:** Working.
- **GeoMapApp:** Not used though a new version is available – recommend for 2023
- **Meteorological:**
    - **FWD JackStaff Sensors:** Working.
        - **Temperature/Relative Humidity**
            - RH sensor working.
        - **Ultrasonic Wind (METEK uSonic-2 HD) –** Working, heater is phenomenal
            - S/N: 0114038499
            - Configured to output data.
        - **Main Mast Sensors:**
            - **Ultrasonic Wind (Metek uSonic-2 HD) –** Working – no icing issues
                - PORT S/N 0113038032 - reconfigured for lower Quality Threshold to account for vibration and turbulence
                - STBD S/N 0113038052 – having issues establishing serial comms however the heater is working well and data are good
        - **Bridge Sensors:** Working. Relative humidity has been near or at 100% throughout time in science operations area. Came down to low 80's in the Bering Strait. SAMOS reports NaNs being filled in for many humidity readings- possibly a setting in the MET that fills in NaNs for consecutive 100% readings. Formula used to calculate humidity is not well suited for Arctic conditions – requires another analysis
            - **Relative Humidity/Temp (Vaisala HMP110)** Not installed
                - S/N - N/A
            - **Relative Humidity/Temp (E+E EE08-PFT1V11D6HCO1/T02)**: Working.
                - S/N - 171505000253F0
                - S/N – 17080500052093 – Replaces EE60 listed below. New Cal. File from July 2022 used.
                - Will show a NaN value intermittently
            - **Barometer (RM Young 61302V)**: Working.
                - Pressures appear to change with speed of the vessel even with gill plate…
                - S/N - BPA6176
            - **Temperature (RM Young 41342VC)**
                - S/N - 17609
            - **Temp / Relative Humidity (E+E EE33) –** Not Installed.

        - S/N – N/A
    - **Relative humidity (EE60)**
        - S/N – S86493 – Removed 8/28/2022 and replaced by another EE08. See above.
        - Sensor not showing values in line with other two sensors.
- **HCO Sensors:** Working
    - **Surface PAR (Biospherical QSR2200):**
        - S/N- 20153
    - **Spectral Pyranometer (Eppley PSP/SPP):**
        - S/N- 35032F3
    - **Infrared Pyranometer (Eppley PIR):**
        - S/N 34463F3
- **Seawater Intake Temperature Sensor:** Working.
    - SBE3+
        - S/N 034063
- **Hull Temp Sensor:** Working -Temperature is tracking with sea water temps.
        - SBE 48 S/N- 0042

- **LCI-90i:** Working though still getting erroneous spikes for tension and payout. We still suspect sensor issues or EMI from new winch drive VFD and will be running new shielded cable from sheaves to the winch control boxes in hopes of cutting down the noise.
- **Scoreboards**: Working, switched between aft winches regularly between ops
- **CTD:** Procedure in place to prevent freezing on deck including dry and warm plumbing prior to cast, insulating blanket, and warm saline solution to pump through when back on deck. Still experiencing dropped data during downcasts for both our fluorometers and the offsets for the pressure sensor.
    - **Fish (SBE 9+):**
        - S/N- 0639 (LOST) to the deep
        - S/N – 638 Has significant pressure port issues sometimes linear and sometimes exponential differences from wire out during deep casts. Pressure port has mineral oil and do not want to take apart housing as this is our only 9plus onboard now.
    - **Conductivity (SBE 4C):**
        - Primary S/N 2568
        - S/N- 2545 (LOST)
        - Secondary 2561
        - S/N- 2575 (LOST)
    - **Temperature (SBE 3+):**
        - Primary S/N 2796
        - S/N- 2841(LOST)
        - Secondary S/N 2855
        - S/N- 2824 (LOST)
    - **O2 (SBE 43):**
        - Primary S/N 0456

    - S/N 0459 (LOST)
    - Secondary S/N- (not installed)
- **Fluorometer (WetLabs ECO):** Zeroing out from 600 – 1115 m depth during down casts, returns on upcast and is believable – reasons unknown. Tests fine on deck, has been moved to a different voltage channel, and cable confirmed good. We have communicated to SeaBird and not had helpful recommendations back yet.
    - S/N- FTLRTD 074
    - 7624 (LOST)
- **Fluorometer (WetLabs CDOM)** maxing out to 5VDC between 600 – 1115 m during downcast. Data returns on upcast and is believable – reasons unknown. Tests fine on deck, has been moved to a different voltage channel, and cable confirmed good. We have communicated to SeaBird and not had helpful recommendations back yet.
    - S/N – FLCDRTD 2226
    - 7552 (new sensor install for this cruise) (LOST)
- **Transmissometer (WetLabs C-STAR): NONE**
    - S/N- CST-390DR (LOST)
- **Altimeter (Valeport VA500):** working with new custom-made cable
    - S/N- 65378
    - S/N- 60362? (LOST)
- **PAR (Biospherical QSP 2350):**
    - S/N- 70682
    - S/N 70112 (LOST)
- **Carousel (SBE 32):** working
    - S/N- 0116 end cap o-rings were replaced as last service was 2019, needed a sticky latch replaced
    - S/N – 0348 (LOST)
- **Pumps (SBE 5T):**
    - Primary S/N - 3115
    - S/N- 3114 (LOST)
    - Secondary S/N - 3112
    - S/N- 3116 (lOST)
- **Primary Deck Unit (SBE 11):**
    - S/N- 416
- **Secondary Deck Unit (SBE 11):**
    - S/N- 417
- **Niskin Bottles:** Some leaks found, monofilament lanyards on lower cap all replaced as they were very tight, most of the spigot o-rings needed to be replaced, a number of the cap o-rings were also replaced. Occasional bottom caps not seating properly after firing but never the same bottle twice.
- **Sippican MK21 Ethernet DAQ:** Working, DAQ successfully connects to the launcher via j-box above CL rack 6.
- **Sippican LMC16 DAQ:** Not used.

- **Launcher:** Working.
- **XBT supply:** have been used regularly in lieu of science stations as we skip them to make up lost time, will have enough for RTHP transit
    - **Fast Deep:** 46
    - **T5**: 6
    - **Deep Blue:** 10 manufactured in 2011 located in science stores
- **Science Sea Water (SSW):** Working and used for both water walls, supply to hoses on the back deck, and various lab sink instruments in Main Lab, Wet Lab, and Bio Lab. Inspected sensors and tubing on both waterwalls this past week and ran fresh water through during down period.
    - **Surface Temp: (SBE 3S)**
        - S/N - 4063
    - **Port Side:**
        - **Thermosalinograph: (SBE 45)**
            - S/N - 0215
        - **O2: (SBE 43)**
            - S/N - 0458
        - **WetStar Fluorometer**
            - S/N – 1648 installed.
        - **WetLabs C-STAR Transmissometer:**
            - S/N - CST-596PR
        - **Eco- Triplet Fluorometer:**
            - BBFL2 - 6484
        - **Optical Oxygen (SBE63)**
            - S/N - 2885be
        - **Additional Sensors for the Season**
            - Mini-TDGP: Working.
        - **Bio Chem Lab:** Working with BIOS sampler plumbed in.
            - **Thermosalinograph: (SBE 45)**
                - S/N - 0228
            - **O2 (SBE 43):**
                - S/N - 1307
            - **WetStar Fluorometer**
                - S/N – 1642
            - **Eco- Triplet Fluorometer**
                - S/N- 6865
- **Milli-Q:**
    - **Main Lab- IQ7000:** Working used heavily
    - **Wet Lab- IQ7000:** Working used heavily
- **pC02:** Working and have had to restart system a few times due to taking down SSW. Still need to adjust flow rates too often – requires a NOAA groom
    - **Tank pressures checked and recorded?** Yes.
    - **Atmospheric CO2:** Running. There is a second machine up forward brought by UMD scientist so 2 new sniffer housings were mounted to jackstaff in port and two new tubes run to forward machinery space.
- **Gravimeter (BGM-3):** Installed and working,

    - **Voltage Test Points checked?** Yes
    - **Entered in Google Drive?** No – out of internet range
- **Gravimeter (AT1M-19):** Not sailing in 2022.
- **AutoSal:** 2 serviced units onboard. Unit 65-715 was taken out of service on 9/25 as heater might be faulty. We have put 65-743 into service but the lab is still unstable in terms of ambient temperature and our science party may not run salts and instead take our bottles back to UAF. We shall see
- **Pingers:** New OIS 6000 pinger and additional 9/16 book clamps onboard, located in biolab, now though not tested yet. The obsolete Benthos 2216 pingers are stored in the warehouse and not onboard. MARSSAM pinger did not perform as expected, perhaps the batteries are low. OUS's other OIS 6000 pinger is deployed on the Multicorer and working well.

INFRASTRUCTURE

- **Intermapper:** Working.
- **E-LOG:** Using old R2R fitlet from Oceanus and configured to work on healy network. Will be using extensively throughout cruise.
- **Jira / Confluence:** Working and used extensively – will not be able to use anymore however due to high latitude
- **Console PC:** Working, with Windows 10 console-01 as the primary, and (older) console-pc as the backup. Displaying POSMV and Intermapper
- **STARC Surface Tablet:** Working and software updated. Stylus battery at 61%.
- **CTD/XBT PC:** Working, OpenCPN reverted to 5.2.4 on ctd-02 so that it can display layers.
- **Multibeam PC:** mb-01 working to run SIS; mb-02 not used.
- **Knudsen PC:** echo-01 is currently the primary. Migration to echo-03 as the primary was not performed because the hydrophone is still connected to echo-01 via a fiber-ethernet converter. Migration would require patching the fiber to the Computer Lab and moving the converter box.
- **K-Sync PC:** Working, with ksync-01 as the primary.
- **PCO2:** Working.
- **Hypack PC:** Not used.
- **ArcGIS VM:** ArcGIS updated with a new license. Ice imagery has been loaded for training purposes with NIC representative.
    - VM Host has been better documented to allow for easier troubleshooting in the future.
    - Graphics upgrade not possible due to limitations of VM Host
- **Future Lab Mac Mini:** Updated to macOS Monterrey and OpenCPN 5.2.4.
- **Bridge Met PC:** PC has failed; currently using a Raspberry Pi with option of displaying webpages of the MET and ADCP data displays.
    - **Helmsman1:** Working, but shows a fan error upon boot.
    - **Helmsman2:** Working, currently displaying ADCP webpage on the bridge monitor.
- **Linux Systems:**
    - **ADCP Computers:** Working.

        - **Currents 36:** Working.
        - **Currents 35:** Working, as the primary.
    - **Met Computers:** Working although a strange data outage on 9/16 may be related to hardware/software glitching out as sometimes MET display freezes
- **Serial Logger:** Working.
- **KVM:** Mediacentos working. Spares stowed. Display04 has been replaced with an RX spare. Will warranty return it if the issue is determined to be the Mediacento unit.
    - Display 04 hasn't had any new problems since last report
    - An additional RX deployed to Aft Staging for benthic scientists to see data from their workbench
- **Displays:**
    - **Computer Lab:** Working.
    - **Aft Con:** Working. Reverted back to original
    - **Main Lab:** Working.
    - **Bridge:** Working.
    - **Aloft Con:** N/A, but possible to add a display when C5I installs a new switch.
    - **BioChem:** Working.
    - **Aft Staging:** New install displaying MET.
- **Web Cams:**
    - **IC Gyro:** Working.
    - **Port SSW:** Working.
    - **BioChem SSW:** Working.
    - **Stbd Staging:** Working.
    - **Science comm board:** Working.
- **Power/UPS:**
    - **Computer Lab (Eaton):** Working.
    - **Aft Con (APC):** Working to power winch network and CTD deck units.
    - **HCO (APC):** Working to power GPS and radiometer systems, switch.
    - **MICA Stores:**
        - **Eaton:** Working, for ADCP deck units, Advantech, and switch.
        - **Acumentrics:** Working:
            - Top Battery Pack
                - Model: ACG2500RiBSPC1
                - S/N: W380997113
            - Bottom Battery Pack
                - Model: ACG2500RiBSPC1
                - S/N: W380997112
            - **IC-Gyro (DRS)** Replaced with Acumentrics – working to power STARC and PSN systems, S/N: W211001711
        - **FWD/Jackstaff:** Parallel Acumentrics ACG2500 RUPS installed to power STARC MET, C5I switch, and scientist Picarro equipment in the forward machinery space. Top (not powered on) S/N: W380997111 Bottom (powered on) S/N: W091000106

NETWORK

- **Advantech:**
  - **Computer Lab:** Working.
  - **HCO:** Working.
  - **MET-Bridge:** Working.
  - **MICA (ADCP):** Working.
  - **IC Gyro:** Working.
  - **Jackstaff:** Working.
- **Comtrol:**
  - **Port side SSW:** Working.
  - **BioChem SSW:** Working.

- **Fiber Optic:**
  - **Computer Lab:** Working.
  - **HCO:** Working.
  - **MICA:** Working.
  - **IC Gyro:** Working.
  - **Potable Water:** Working.
  - **FWD:** Working.
- **RocketPorts (Computer Lab):** Working.
- **Perle:** CG systems that provide Gyro feeds working.
- **Time Servers:**
  - **HCO:** Working.
  - **Bridge:** Working.
- **Healy NAS:** Working, for DAS (SnagIt) and Data (collected mission data).
- **PSNHSVRDATA:** Working.
- **VSAT:** Working. C5I has applied a network rule to send all traffic to Atlassian tools via VSAT so that a UCSD VPN is not necessary to access them.
  - Back in range of service. Port antenna needs calibration says C5I
- **Starlink:** Worked when near shore in Seattle, with low latency. Starlink has been flapping inport in Dutch. VSAT as primary as of now.

Week 5 - October 3-9, 2022

Science Systems

- **Seapath:** Working with intermittent dropouts due to high latitude, had serious issues pinpointing location around 90°N and SBAS has been disabled for now as we cross back and forth across the date line.
  - **SeaTex MRU 5 (primary MRU)** Working.
- **SeaTex MRU6:** Not installed. Output feed and serial splitter moved to the Seapath 330+'s EM3000 feed.
- **PosMV:** Working with occasional dropouts, used as primary for the EM122 the past few days as Seapath cut in and out.

- **Ceesync 1 PPS:** Working
- **Trimble SPS 356:** Working.
- **Trimble ABX-Two:** Working.
- **MK39 Gyro:** Dropping out regularly
- **Multibeam EM-122:** Working but having a difficult time in the ice, dropping most beams and losing bottom frequently. Not hardware or software related.
    - **SIS:** Working, having a hard time though
        - Run Weekly BIST? No, most recent failed TX Channel and RX Noise due to ice
    - **TRU/Pre-Amp:** Working
    - **Helmsman:** Used for displaying UHDAS data, per Lt. Ames. Helmsman-2 in use; Helmsman-1 is showing a CPU fan issue, although the fan is spinning.
- **Mosaic:** Tested and found to be working, not in use this mission.
- **Knudsen Echosounder:** Echo-01 is the primary. Working
    - **3.5 kHz:** Working as primary though difficult to get good bottom trace in ice.
    - **12 kHz:** Working, used for pinger deployments
- **ADCP:** Working.
    - **UHDAS:** Working.
    - **OS 75:** Working.
    - **OS 150:** Working.
- **K-Sync:** Working.
- **Reference Hydrophone:** Working.
- **ArcGIS:** Working to display our trackline, station waypoints, ice imagery and NIC products for situational awareness
        - Ice Imagery Imported – Yes, though Canadian imagery is the exception
        - Remote Display Client – Mediacento with a Dell 3040 Wyse thin client
    - **Qimera:** Not used.
    - **Fledermaus:** Not used.
- **Hypack:** Not in use.
- **OpenCPN:** Had crashed prior to cruise. Completely wiped ctd02 of all traces of config files, downloaded Microsoft C++ runtime package, and reloaded the software starting at version 4.8. From there, we were able to add back in all charts, layers, GPS and AIS feeds, and upgrade back to version 5.2.4 – Working though did not display our location above 89 North
- **AIS:** Working.
- **GeoMapApp:** Not used though a new version is available – recommend for 2023
- **Meteorological:**
    - **FWD JackStaff Sensors:** Working.
        - **Temperature/Relative Humidity**
            - RH sensor working.
        - **Ultrasonic Wind (METEK uSonic-2 HD) –** Working, heater is phenomenal

        - S/N: 0114038499
        - Configured to output data.
- **Main Mast Sensors:**
    - **Ultrasonic Wind (Metek uSonic-2 HD) –** Working – no icing issues
        - PORT S/N 0113038032 - reconfigured for lower Quality Threshold to account for vibration and turbulence
        - STBD S/N 0113038052 – having issues establishing serial comms however the heater is working well and data are good
- **Bridge Sensors:** Working. Relative humidity has been near or at 100% throughout time in science operations area. Came down to low 80's in the Bering Strait. SAMOS reports NaNs being filled in for many humidity readings- possibly a setting in the MET that fills in NaNs for consecutive 100% readings. Formula used to calculate humidity is not well suited for Arctic conditions – requires another analysis
    - **Relative Humidity/Temp (Vaisala HMP110)** Not installed
        - S/N - N/A
    - **Relative Humidity/Temp (E+E EE08-PFT1V11D6HCO1/T02)**: Working.
        - S/N - 171505000253F0
        - S/N – 17080500052093 – Replaces EE60 listed below. New Cal. File from July 2022 used.
        - Will show a NaN value intermittently
    - **Barometer (RM Young 61302V)**: Working.
        - Pressures appear to change with speed of the vessel even with gill plate…
        - S/N - BPA6176
    - **Temperature (RM Young 41342VC)**
        - S/N - 17609
    - **Temp / Relative Humidity (E+E EE33) –** Not Installed.
        - S/N – N/A
    - **Relative humidity (EE60)**
        - S/N – S86493 – Removed 8/28/2022 and replaced by another EE08. See above.
        - Sensor not showing values in line with other two sensors.
- **HCO Sensors:** Working
    - **Surface PAR (Biospherical QSR2200):**
        - S/N- 20153
    - **Spectral Pyranometer (Eppley PSP/SPP):**
        - S/N- 35032F3
    - **Infrared Pyranometer (Eppley PIR):**
        - S/N 34463F3

        - **Seawater Intake Temperature Sensor:** Working.
            - SBE3+
                - S/N 034063
        - **Hull Temp Sensor:** Working -Temperature is tracking with sea water temps.
            - SBE 48 S/N- 0042
- **LCI-90i:** Working though still getting erroneous spikes for tension and payout. We still suspect sensor issues or EMI from new winch drive VFD and will be running new shielded cable from sheaves to the winch control boxes in hopes of cutting down the noise. The OC2 sending unit experienced a short and is now displaying a bright blank screen with bad data values being transmitted. Since the Trawl 9/16th is not useable we swapped that sending unit over for the remainder of the cruise. Settings do not mirror OC1, so it took about an hour to dial it in so that the correct tension and payouts were being displayed. This will need to be addressed during Dockside.
- **Scoreboards**: Working, switched between aft winches regularly between ops
- **CTD:** Procedure in place to prevent freezing on deck including dry and warm plumbing prior to cast, insulating blanket, and warm saline solution to pump through when back on deck. Still experiencing dropped data during downcasts for both our fluorometers and the offsets for the pressure sensor.
    - **Fish (SBE 9+):**
        - S/N- 0639 (LOST) to the deep
        - S/N – 638 Has significant pressure port issues sometimes linear and sometimes exponential differences from wire out during deep casts. Pressure port has mineral oil and do not want to take apart housing as this is our only 9plus onboard now.
    - **Conductivity (SBE 4C):**
        - Primary S/N 2568
        - S/N- 2545 (LOST)
        - Secondary 2561
        - S/N- 2575 (LOST)
    - **Temperature (SBE 3+):**
        - Primary S/N 2796
        - S/N- 2841(LOST)
        - Secondary S/N 2855
        - S/N- 2824 (LOST)
    - **O2 (SBE 43):**
        - Primary S/N 0456
        - S/N 0459 (LOST)
        - Secondary S/N- (not installed)
    - **Fluorometer (WetLabs ECO):** Zeroing out from 600 – 1115 m depth during down casts, returns on upcast and is believable – reasons unknown. Tests fine on deck, has been moved to a different voltage channel, and cable confirmed good. We have communicated to SeaBird and not had helpful recommendations back yet.
        - S/N- FTLRTD 074

        - 7624 (LOST)
    - **Fluorometer (WetLabs CDOM)** maxing out to 5VDC between 600 – 1115 m during downcast. Data returns on upcast and is believable – reasons unknown. Tests fine on deck, has been moved to a different voltage channel, and cable confirmed good. We have communicated to SeaBird and not had helpful recommendations back yet.
        - S/N – FLCDRTD 2226
        - 7552 (new sensor install for this cruise) (LOST)
    - **Transmissometer (WetLabs C-STAR): NONE**
        - S/N- CST-390DR (LOST)
    - **Altimeter (Valeport VA500):** working with new custom-made cable
        - S/N- 65378
        - S/N- 60362? (LOST)
    - **PAR (Biospherical QSP 2350):**
        - S/N- 70682
        - S/N 70112 (LOST)
    - **Carousel (SBE 32):** working
        - S/N- 0116 end cap o-rings were replaced as last service was 2019, needed a sticky latch replaced
        - S/N – 0348 (LOST)
    - **Pumps (SBE 5T):**
        - Primary S/N - 3115
        - S/N- 3114 (LOST)
        - Secondary S/N - 3112
        - S/N- 3116 (lOST)
    - **Primary Deck Unit (SBE 11):**
        - S/N- 416
    - **Secondary Deck Unit (SBE 11):**
        - S/N- 417
    - **Niskin Bottles:** Some leaks found, monofilament lanyards on lower cap all replaced as they were very tight, most of the spigot o-rings needed to be replaced, a number of the cap o-rings were also replaced. Occasional bottom caps not seating properly after firing but never the same bottle twice.
    - **Sippican MK21 Ethernet DAQ:** Working, DAQ successfully connects to the launcher via j-box above CL rack 6.
    - **Sippican LMC16 DAQ:** Not used.

- **Launcher:** Working.
- **XBT supply:** have been used regularly in lieu of science stations as we skip them to make up lost time, will have enough for RTHP transit
    - **Fast Deep:** 46
    - **T5**: 6
    - **Deep Blue:** 10 manufactured in 2011 located in science stores
- **Science Sea Water (SSW):** Working and used for both water walls, supply to hoses on the back deck, and various lab sink instruments in Main Lab, Wet Lab,

and Bio Lab. Inspected sensors and tubing on both waterwalls this past week and ran fresh water through during down period.

- **Surface Temp: (SBE 3S)**
  - S/N - 4063
- **Port Side:**
  - **Thermosalinograph: (SBE 45)**
    - S/N - 0215
  - **O2: (SBE 43)**
    - S/N - 0458
  - **WetStar Fluorometer**
    - S/N – 1648 installed.
  - **WetLabs C-STAR Transmissometer:**
    - S/N - CST-596PR
  - **Eco- Triplet Fluorometer:**
    - BBFL2 - 6484
  - **Optical Oxygen (SBE63)**
    - S/N - 2885be
  - **Additional Sensors for the Season**
    - Mini-TDGP: Working.
  - **Bio Chem Lab:** Working with BIOS sampler plumbed in.
    - **Thermosalinograph: (SBE 45)**
      - S/N - 0228
    - **O2 (SBE 43):**
      - S/N - 1307
    - **WetStar Fluorometer**
      - S/N – 1642
    - **Eco- Triplet Fluorometer**
      - S/N- 6865

- **Milli-Q:**
  - **Main Lab- IQ7000:** Working used heavily
  - **Wet Lab- IQ7000:** Working used heavily
- **pC02:** Working and have had to restart system a few times due to taking down SSW. Still need to adjust flow rates too often – requires a NOAA groom
  - **Tank pressures checked and recorded?** Yes.
  - **Atmospheric CO2:** Running. There is a second machine up forward brought by UMD scientist so 2 new sniffer housings were mounted to jackstaff in port and two new tubes run to forward machinery space.
- **Gravimeter (BGM-3):** Installed and working,
  - **Voltage Test Points checked?** Yes
  - **Entered in Google Drive?** No – out of internet range
- **Gravimeter (AT1M-19):** Not sailing in 2022.
- **AutoSal:** 2 serviced units onboard. Unit 65-715 was taken out of service on 9/25 as heater might be faulty. We have put 65-743 into service but the lab is still unstable in terms of ambient temperature and our science party may not run salts and instead take our bottles back to UAF. We shall see

- **Pingers:** New OIS 6000 pinger and additional 9/16 book clamps onboard, located in biolab, now though not tested yet. The obsolete Benthos 2216 pingers are stored in the warehouse and not onboard. MARSSAM pinger did not perform as expected, perhaps the batteries are low. OUS's other OIS 6000 pinger is deployed on the Multicorer and working well.

INFRASTRUCTURE

- **Intermapper:** Working.
- **E-LOG:** Using old R2R fitlet from Oceanus and configured to work on healy network. Is being used extensively throughout cruise.
- **Jira / Confluence:** Working and used extensively – will not be able to use anymore however due to high latitude
- **Console PC:** Working, with Windows 10 console-01 as the primary, and (older) console-pc as the backup. Displaying POSMV and Intermapper
- **STARC Surface Tablet:** Working and software updated. Stylus battery at 61%.
- **CTD/XBT PC:** Working, OpenCPN reverted to 5.2.4 on ctd-02 so that it can display layers.
- **Multibeam PC:** mb-01 working to run SIS; mb-02 not used.
- **Knudsen PC:** echo-01 is currently the primary. Migration to echo-03 as the primary was not performed because the hydrophone is still connected to echo-01 via a fiber-ethernet converter. Migration would require patching the fiber to the Computer Lab and moving the converter box.
- **K-Sync PC:** Working, with ksync-01 as the primary.
- **PCO2:** Working.
- **Hypack PC:** Not used.
- **ArcGIS VM:** ArcGIS updated with a new license. Ice imagery has been loaded for training purposes with NIC representative.
    - VM Host has been better documented to allow for easier troubleshooting in the future.
    - Graphics upgrade not possible due to limitations of VM Host
- **Future Lab Mac Mini:** Updated to macOS Monterrey and OpenCPN 5.2.4.
- **Bridge Met PC:** PC has failed; currently using a Raspberry Pi with option of displaying webpages of the MET and ADCP data displays.
    - **Helmsman1:** Working, but shows a fan error upon boot.
    - **Helmsman2:** Working, currently displaying ADCP webpage on the bridge monitor.
- **Linux Systems:**
    - **ADCP Computers:** Working.
        - **Currents 36:** Working.
        - **Currents 35:** Working, as the primary.
    - **Met Computers:** Working although a strange data outage on 9/16 may be related to hardware/software glitching out as sometimes MET display freezes
- **Serial Logger:** Working.

- **KVM:** Mediacentos working. Spares stowed. Display04 has been replaced with an RX spare. Will warranty return it if the issue is determined to be the Mediacento unit.
    - Display 04 hasn't had any new problems since last report
    - An additional RX deployed to Aft Staging for benthic scientists to see data from their workbench
- **Displays:**
    - **Computer Lab:** Working.
    - **Aft Con:** Working. Reverted back to original
    - **Main Lab:** Working.
    - **Bridge:** Working.
    - **Aloft Con:** N/A, but possible to add a display when C5I installs a new switch.
    - **BioChem:** Working.
    - **Aft Staging:** New install displaying MET.
- **Web Cams:**
    - **IC Gyro:** Working.
    - **Port SSW:** Working.
    - **BioChem SSW:** Working.
    - **Stbd Staging:** Working.
    - **Science comm board:** Working.
- **Power/UPS:**
    - **Computer Lab (Eaton):** Working.
    - **Aft Con (APC):** Working to power winch network and CTD deck units.
    - **HCO (APC):** Working to power GPS and radiometer systems, switch.
    - **MICA Stores:**
        - **Eaton:** Working, for ADCP deck units, Advantech, and switch.
        - **Acumentrics:** Working:
            - Top Battery Pack
                - Model: ACG2500RiBSPC1
                - S/N: W380997113
            - Bottom Battery Pack
                - Model: ACG2500RiBSPC1
                - S/N: W380997112
            - **IC-Gyro (DRS)** Replaced with Acumentrics – working to power STARC and PSN systems, S/N: W211001711
        - **FWD/Jackstaff:** Parallel Acumentrics ACG2500 RUPS installed to power STARC MET, C5I switch, and scientist Picarro equipment in the forward machinery space. Top (not powered on) S/N: W380997111 Bottom (powered on) S/N: W091000106

NETWORK

- **Advantech:**
  - **Computer Lab:** Working.
  - **HCO:** Working.
  - **MET-Bridge:** Working.
  - **MICA (ADCP):** Working.
  - **IC Gyro:** Working.
  - **Jackstaff:** Working.
- **Comtrol:**
  - **Port side SSW:** Working.
  - **BioChem SSW:** Working.

- **Fiber Optic:**
  - **Computer Lab:** Working.
  - **HCO:** Working.
  - **MICA:** Working.
  - **IC Gyro:** Working.
  - **Potable Water:** Working.
  - **FWD:** Working.
- **RocketPorts (Computer Lab):** Working.
- **Perle:** CG systems that provide Gyro feeds working.
- **Time Servers:**
  - **HCO:** Working.
  - **Bridge:** Working.
- **Healy NAS:** Working, for DAS (SnagIt) and Data (collected mission data).
- **PSNHSVRDATA:** Working.
- **VSAT:** Working. C5I has applied a network rule to send all traffic to Atlassian tools via VSAT so that a UCSD VPN is not necessary to access them.
  - Back in range of service. Port antenna needs calibration says C5I
- **Starlink:** Worked when near shore in Seattle, with low latency. Starlink has been flapping inport in Dutch. VSAT as primary as of now.

Week 6 - October 10-16, 2022

Science Systems

- **Seapath:** Working with intermittent dropouts due to high latitude, had serious issues pinpointing location around 90°N and SBAS remains disabled until we come in range of our satellites.
  - **SeaTex MRU 5 (primary MRU)** Working.
- **SeaTex MRU6:** Not installed. Output feed and serial splitter moved to the Seapath 330+'s EM3000 feed.
- **PosMV:** Working with occasional dropouts, used as primary for the EM122 the past few days as Seapath cut in and out.
- **Ceesync 1 PPS:** Working

- **Trimble SPS 356:** Working.
- **Trimble ABX-Two:** Working.
- **MK39 Gyro:** Back to working since returning to lower latitudes
- **Multibeam EM-122:** Working well since leaving the ice
    - **SIS:** Working, once below 86°N the grid engine displayed real-time map data again
        - Run Weekly BIST? Yes, most recent failed TX36 Test and TRU Power Test
    - **TRU/Pre-Amp:** Working
    - **Helmsman:** Used for displaying UHDAS data, per Lt. Ames. Helmsman-2 in use; Helmsman-1 is showing a CPU fan issue, although the fan is spinning.
- **Mosaic:** Tested and found to be working, not in use this mission.
- **Knudsen Echosounder:** Echo-01 is the primary. Working
    - **3.5 kHz:** Working as primary when water depth exceeds 300 meters
    - **12 kHz:** Working when shallower than 300 meters otherwise return display is very noisy. Knudsen Engineering team was made aware of this issue last year and results from our EchoSIM testing in April 022 and past line recordings are with them.
- **ADCP:** Working.
    - **UHDAS:** Working.
    - **OS 75:** Working.
    - **OS 150:** Working.
- **K-Sync:** Working.
- **Reference Hydrophone:** Working.
- **ArcGIS:** Working to display our trackline, station waypoints, ice imagery and NIC products for situational awareness
        - Ice Imagery Imported – Yes, though Canadian imagery is the exception
        - Remote Display Client – Mediacento with a Dell 3040 Wyse thin client
    - **Qimera:** Not used.
    - **Fledermaus:** Not used.
- **Hypack:** Not in use.
- **OpenCPN:** Had crashed prior to cruise. Completely wiped ctd02 of all traces of config files, downloaded Microsoft C++ runtime package, and reloaded the software starting at version 4.8. From there, we were able to add back in all charts, layers, GPS and AIS feeds, and upgrade back to version 5.2.4 – Working though did not display our location above 89 North.
- **AIS:** Working.
- **GeoMapApp:** Not used though a new version is available – recommend for 2023
- **Meteorological:**
    - **FWD JackStaff Sensors:** Working.
        - **Temperature/Relative Humidity**
            - RH sensor working.

- **Ultrasonic Wind (METEK uSonic-2 HD) –** Working, heater is phenomenal
    - S/N: 0114038499
- **Main Mast Sensors:**
    - **Ultrasonic Wind (Metek uSonic-2 HD) –** Working – no icing issues
        - PORT S/N 0113038032 - reconfigured for lower Quality Threshold to account for vibration and turbulence
        - STBD S/N 0113038052 – having issues establishing serial comms however the heater is working well and data are good
- **Bridge Sensors:** Working. Relative humidity has been near or at 100% throughout time in science operations area. Came down to low 80's in the Bering Strait. SAMOS reports NaNs being filled in for many humidity readings- possibly a setting in the MET that fills in NaNs for consecutive 100% readings. Formula used to calculate humidity is not well suited for Arctic conditions – requires another analysis
    - **Relative Humidity/Temp (Vaisala HMP110)** Not installed
        - S/N - N/A
    - **Relative Humidity/Temp (E+E EE08-PFT1V11D6HCO1/T02)**: Working.
        - S/N - 171505000253F0
        - S/N – 17080500052093 – Replaces EE60 listed below. New Cal. File from July 2022 used.
        - Will show a NaN value intermittently
    - **Barometer (RM Young 61302V)**: Working.
        - Pressures appear to change with speed of the vessel even with gill plate…
        - S/N - BPA6176
    - **Temperature (RM Young 41342VC)**
        - S/N - 17609
    - **Temp / Relative Humidity (E+E EE33) –** Not Installed.
        - S/N – N/A
    - **Relative humidity (EE60)**
        - S/N – S86493 – Removed 8/28/2022 and replaced by another EE08. See above.
        - Sensor not showing values in line with other two sensors.
- **HCO Sensors:** Working
    - **Surface PAR (Biospherical QSR2200):**
        - S/N- 20153
    - **Spectral Pyranometer (Eppley PSP/SPP):**
        - S/N- 35032F3
    - **Infrared Pyranometer (Eppley PIR):**

        - S/N 34463F3
    - **Seawater Intake Temperature Sensor:** Working.
        - SBE3+
            - S/N 034063
    - **Hull Temp Sensor:** Working - however sometimes values deviate from the intake temperature sensor which remains consistent. We are investigating possible causes during these time periods.
        - SBE 48 S/N- 0042
- **LCI-90i:** Working though still getting erroneous spikes for tension and payout. We still suspect sensor issues or EMI from new winch drive VFD and will be running new shielded cable from sheaves to the winch control boxes in hopes of cutting down the noise.

  The OC2 local unit in the Winch Room experienced a short and is now displaying a bright blank screen with bad data values being transmitted. Since the Trawl 9/16th is not useable we swapped that unit over for the remainder of the cruise. Settings do not mirror OC1, so it took about an hour to dial it in so that the correct tension and payouts were being displayed as we did not have access to recent configuration files locally at the time. We do now. This will need to be addressed during Dockside.

  We also took time to complete a payout/speed calibration for TC1 winch and found the pulse/meter count to be 8.4 while the setting on the local LCI90i read 8.193 p/m. We updated the value and appear to be getting more accurate wire payout readings based on known bottom depth and depth when Multicorer hits bottom. We have asked to perform these calibrations on the other winches as well. This was brought up during shakedown though there was not time to do so then, but we hope to perform these more regularly before the sailing season begins.

- **Scoreboards**: Working, switched between aft winches regularly between ops
- **CTD:** Procedure in place to prevent freezing on deck including dry and warm plumbing prior to cast, insulating blanket, and warm saline solution to pump through when back on deck. Still experiencing dropped data during downcasts for both our fluorometers and the offsets for the pressure sensor.
    - **Fish (SBE 9+):**
        - S/N- 0639 (LOST) to the deep
        - S/N – 638 Has significant pressure port issues sometimes linear and sometimes exponential differences from wire out during deep casts. Pressure port has mineral oil and do not want to take apart housing as this is our only 9plus onboard now.
    - **Conductivity (SBE 4C):**
        - Primary S/N 2568
        - S/N- 2545 (LOST)
        - Secondary 2561
        - S/N- 2575 (LOST)
    - **Temperature (SBE 3+):**

    - Primary S/N 2796
    - S/N- 2841(LOST)
    - Secondary S/N 2855
    - S/N- 2824 (LOST)
- **O2 (SBE 43):**
    - Primary S/N 0456
    - S/N 0459 (LOST)
    - Secondary S/N- (not installed)
- **Fluorometer (WetLabs ECO):** Zeroing out from 600 – 1115 m depth during down casts, returns on upcast and is believable – reasons unknown. Tests fine on deck, has been moved to a different voltage channel, and cable confirmed good. We have communicated to SeaBird and not had helpful recommendations back yet.
    - S/N- FTLRTD 074
    - 7624 (LOST)
- **Fluorometer (WetLabs CDOM)** maxing out to 5VDC between 600 – 1115 m during downcast. Data returns on upcast and is believable – reasons unknown. Tests fine on deck, has been moved to a different voltage channel, and cable confirmed good. We have communicated to SeaBird and not had helpful recommendations back yet.
    - S/N – FLCDRTD 2226
    - 7552 (new sensor install for this cruise) (LOST)
- **Transmissometer (WetLabs C-STAR): NONE**
    - S/N- CST-390DR (LOST)
- **Altimeter (Valeport VA500):** working with new custom-made cable
    - S/N- 65378
    - S/N- 60362? (LOST)
- **PAR (Biospherical QSP 2350):**
    - S/N- 70682
    - S/N 70112 (LOST)
- **Carousel (SBE 32):** working
    - S/N- 0116 end cap o-rings were replaced as last service was 2019, needed a sticky latch replaced
    - S/N – 0348 (LOST)
- **Pumps (SBE 5T):**
    - Primary S/N - 3115
    - S/N- 3114 (LOST)
    - Secondary S/N - 3112
    - S/N- 3116 (lOST)
- **Primary Deck Unit (SBE 11):**
    - S/N- 416
- **Secondary Deck Unit (SBE 11):**
    - S/N- 417
- **Niskin Bottles:** Some leaks found, monofilament lanyards on lower cap all replaced as they were very tight, most of the spigot o-rings needed to be replaced, a number of the cap o-rings were also replaced. Occasional

bottom caps not seating properly after firing but never the same bottle twice.
    - **Sippican MK21 Ethernet DAQ:** Working, DAQ successfully connects to the launcher via j-box above CL rack 6.
    - **Sippican LMC16 DAQ:** Not used.

- **Launcher:** Working.
- **XBT supply:** have been used regularly in lieu of science stations as we skip them to make up lost time, will have enough for RTHP transit
- **Science Sea Water (SSW):** Working and used for both water walls, supply to hoses on the back deck, and various lab sink instruments in Main Lab, Wet Lab, and Bio Lab. Inspected sensors and tubing on both waterwalls this past week and ran fresh water through during down period.
    - **Surface Temp: (SBE 3S)**
        - S/N - 4063
    - **Port Side:**
        - **Thermosalinograph: (SBE 45)**
            - S/N - 0215
        - **O2: (SBE 43)**
            - S/N - 0458
        - **WetStar Fluorometer**
            - S/N – 1648 installed.
        - **WetLabs C-STAR Transmissometer:**
            - S/N - CST-596PR
        - **Eco- Triplet Fluorometer:**
            - BBFL2 - 6484
        - **Optical Oxygen (SBE63)**
            - S/N - 2885be
        - **Additional Sensors for the Season**
            - Mini-TDGP: Working.
        - **Bio Chem Lab:** Working with BIOS sampler plumbed in.
            - **Thermosalinograph: (SBE 45)**
                - S/N - 0228
            - **O2 (SBE 43):**
                - S/N - 1307
            - **WetStar Fluorometer**
                - S/N – 1642
            - **Eco- Triplet Fluorometer**
                - S/N- 6865
- **Milli-Q:**
    - **Main Lab- IQ7000:** Working used heavily
    - **Wet Lab- IQ7000:** Working used heavily
- **pC02:** Working and have had to restart system a few times due to taking down SSW. Still need to adjust flow rates too often – requires a NOAA groom
    - **Tank pressures checked and recorded?** Yes.

    - **Atmospheric CO2:** Running. There is a second machine up forward brought by UMD scientist so 2 new sniffer housings were mounted to jackstaff in port and two new tubes run to forward machinery space.
- **Gravimeter (BGM-3):** Installed and working,
    - **Voltage Test Points checked?** Yes
    - **Entered in Google Drive?** No – out of internet range
- **Gravimeter (AT1M-19):** Not sailing in 2022.
- **AutoSal:** 2 serviced units onboard. Unit 65-715 was taken out of service on 9/25 as heater might be faulty. We have put 65-743 into service but the lab is still unstable in terms of ambient temperature and our science party may not run salts and instead take our bottles back to UAF.
- **Pingers:** New OIS 6000 pinger and additional 9/16 book clamps onboard, located in biolab, now though not tested yet. The obsolete Benthos 2216 pingers are stored in the warehouse and not onboard. MARSSAM pinger did not perform as expected, perhaps the batteries are low. OUS's other OIS 6000 pinger is deployed on the Multicorer and working well.

INFRASTRUCTURE

- **Intermapper:** Working.
- **E-LOG:** Using old R2R fitlet from Oceanus and configured to work on healy network. Is being used extensively throughout cruise.
- **Jira / Confluence:** Working and used extensively – will not be able to use anymore however due to high latitude
- **Console PC:** Working, with Windows 10 console-01 as the primary, and (older) console-pc as the backup. Displaying POSMV and Intermapper
- **STARC Surface Tablet:** Working and software updated. Stylus battery at 61%.
- **CTD/XBT PC:** Working, OpenCPN reverted to 5.2.4 on ctd-02 so that it can display layers.
- **Multibeam PC:** mb-01 working to run SIS; mb-02 not used.
- **Knudsen PC:** echo-01 is currently the primary. Migration to echo-03 as the primary was not performed because the hydrophone is still connected to echo-01 via a fiber-ethernet converter. Migration would require patching the fiber to the Computer Lab and moving the converter box.
- **K-Sync PC:** Working, with ksync-01 as the primary.
- **PCO2:** Working.
- **Hypack PC:** Not used.
- **ArcGIS VM:** ArcGIS updated with a new license. Ice imagery has been loaded for training purposes with NIC representative.
    - VM Host has been better documented to allow for easier troubleshooting in the future.
    - Graphics upgrade not possible due to limitations of VM Host
- **Future Lab Mac Mini:** Updated to macOS Monterrey and OpenCPN 5.2.4.
- **Bridge Met PC:** PC has failed; currently using a Raspberry Pi with option of displaying webpages of the MET and ADCP data displays.
    - **Helmsman1:** Working, but shows a fan error upon boot.

    - **Helmsman2:** Working, currently displaying ADCP webpage on the bridge monitor.
- **Linux Systems:**
    - **ADCP Computers:** Working.
        - **Currents 36:** Working.
        - **Currents 35:** Working, as the primary.
    - **Met Computers:** Working although a strange data outage on 9/16 may be related to hardware/software glitching out as sometimes MET display freezes
- **Serial Logger:** Working.
- **KVM:** Mediacentos working. Spares stowed. Display04 has been replaced with an RX spare. Will warranty return it if the issue is determined to be the Mediacento unit.
    - Display 04 hasn't had any new problems since last report
    - An additional RX deployed to Aft Staging for benthic scientists to see data from their workbench
- **Displays:**
    - **Computer Lab:** Working.
    - **Aft Con:** Working. Reverted back to original
    - **Main Lab:** Working.
    - **Bridge:** Working.
    - **Aloft Con:** N/A, but possible to add a display when C5I installs a new switch.
    - **BioChem:** Working.
    - **Aft Staging:** New install displaying MET.
- **Web Cams:**
    - **IC Gyro:** Working.
    - **Port SSW:** Working.
    - **BioChem SSW:** Working.
    - **Stbd Staging:** Working.
    - **Science comm board:** Working.
- **Power/UPS:**
    - **Computer Lab (Eaton):** Working.
    - **Aft Con (APC):** Working to power winch network and CTD deck units.
    - **HCO (APC):** Working to power GPS and radiometer systems, switch.
    - **MICA Stores:**
        - **Eaton:** Working, for ADCP deck units, Advantech, and switch.
        - **Acumentrics:** Working:
            - Top Battery Pack
                - Model: ACG2500RiBSPC1
                - S/N: W380997113
            - Bottom Battery Pack
                - Model: ACG2500RiBSPC1
                - S/N: W380997112
            - **IC-Gyro (DRS)** Replaced with Acumentrics – working to power STARC and PSN systems, S/N: W211001711

- **FWD/Jackstaff:** Parallel Acumentrics ACG2500 RUPS installed to power STARC MET, C5I switch, and scientist Picarro equipment in the forward machinery space. Top (not powered on) S/N: W380997111 Bottom (powered on) S/N: W091000106

NETWORK

- **Advantech:**
  - **Computer Lab:** Working.
  - **HCO:** Working.
  - **MET-Bridge:** Working.
  - **MICA (ADCP):** Working.
  - **IC Gyro:** Working.
  - **Jackstaff:** Working.
- **Comtrol:**
  - **Port side SSW:** Working.
  - **BioChem SSW:** Working.

- **Fiber Optic:**
  - **Computer Lab:** Working.
  - **HCO:** Working.
  - **MICA:** Working.
  - **IC Gyro:** Working.
  - **Potable Water:** Working.
  - **FWD:** Working.
- **RocketPorts (Computer Lab):** Working.
- **Perle:** CG systems that provide Gyro feeds working.
- **Time Servers:**
  - **HCO:** Working.
  - **Bridge:** Working.
- **Healy NAS:** Working, for DAS (SnagIt) and Data (collected mission data).
- **PSNHSVRDATA:** Working.
- **VSAT:** Working. C5I has applied a network rule to send all traffic to Atlassian tools via VSAT so that a UCSD VPN is not necessary to access them.
  - Back in range of service. Port antenna needs calibration says C5I
- **Starlink:** Worked when near shore in Seattle, with low latency. Starlink has been flapping inport in Dutch. VSAT as primary as of now.

Final Week - October 17-24, 2022

Science Systems

- **Seapath:** Working SBAS reenabled
    - **SeaTex MRU 5 (primary MRU)** Working.
- **SeaTex MRU6:** Not installed. Output feed and serial splitter moved to the Seapath 330+'s EM3000 feed.
- **PosMV:** Working with occasional dropouts, used as primary for the EM122 the past few days as Seapath cut in and out.
- **Ceesync 1 PPS:** Working
- **Trimble SPS 356:** Working.
- **Trimble ABX-Two:** Working.
- **MK39 Gyro:** Back to working since returning to lower latitudes
- **Multibeam EM-122:** Working well since leaving the ice. The failed BIST on the EM122 showed errors on TX36 and Power Tests, swapping a board resolved the issue and the most recent BIST just prior to pulling into port passed all tests.
    - **SIS:** Working, once below 86°N the grid engine displayed real-time map data again
        - Run Weekly BIST? Yes, most recent passed when pulling into Dutch Harbor.
    - **TRU/Pre-Amp:** Working
    - **Helmsman:** Used for displaying UHDAS data, per Lt. Ames. Helmsman-2 in use; Helmsman-1 is showing a CPU fan issue, although the fan is spinning.
- **Mosaic:** Tested and found to be working, not in use this mission.
- **Knudsen Echosounder:** Echo-01 is the primary. Working
    - **3.5 kHz:** Working as primary when water depth exceeds 300 meters
    - **12 kHz:** Working when shallower than 300 meters otherwise return display is very noisy. Knudsen Engineering team was made aware of this issue last year and results from our EchoSIM testing in April 022 and past line recordings are with them.
- **ADCP:** Working.
    - **UHDAS:** Working.
    - **OS 75:** Working.
    - **OS 150:** Working.
- **K-Sync:** Working.
- **Reference Hydrophone:** Working.
- **ArcGIS:** Working to display our trackline, station waypoints, ice imagery and NIC products for situational awareness
        - Ice Imagery Imported – Yes, though Canadian imagery is the exception
        - Remote Display Client – Mediacento with a Dell 3040 Wyse thin client
    - **Qimera:** Not used.
    - **Fledermaus:** Not used.

- **Hypack:** Not in use.
- **OpenCPN:** Had crashed prior to cruise. Completely wiped ctd02 of all traces of config files, downloaded Microsoft C++ runtime package, and reloaded the software starting at version 4.8. From there, we were able to add back in all charts, layers, GPS and AIS feeds, and upgrade back to version 5.2.4 – Working though did not display our location above 89 North.
- **AIS:** Working.
- **GeoMapApp:** Not used though a new version is available – recommend for 2023
- **Meteorological:**
    - **FWD JackStaff Sensors:** Working.
        - **Temperature/Relative Humidity**
            - RH sensor working.
        - **Ultrasonic Wind (METEK uSonic-2 HD) –** Working, heater is phenomenal
            - S/N: 0114038499
        - **Main Mast Sensors:**
            - **Ultrasonic Wind (Metek uSonic-2 HD) –** Working – no icing issues
                - PORT S/N 0113038032 - reconfigured for lower Quality Threshold to account for vibration and turbulence
                - STBD S/N 0113038052 – having issues establishing serial comms however the heater is working well and data are good
        - **Bridge Sensors:** Working. Relative humidity has been near or at 100% throughout time in science operations area. Came down to low 80's in the Bering Strait. SAMOS reports NaNs being filled in for many humidity readings- possibly a setting in the MET that fills in NaNs for consecutive 100% readings. Formula used to calculate humidity is not well suited for Arctic conditions – requires another analysis
            - **Relative Humidity/Temp (Vaisala HMP110)** Not installed
                - S/N - N/A
            - **Relative Humidity/Temp (E+E EE08-PFT1V11D6HCO1/T02)**: Working.
                - S/N - 171505000253F0
                - S/N – 17080500052093 – Replaces EE60 listed below. New Cal. File from July 2022 used.
                - Will show a NaN value intermittently
            - **Barometer (RM Young 61302V)**: Working.
                - Pressures appear to change with speed of the vessel even with gill plate…
                - S/N - BPA6176
            - **Temperature (RM Young 41342VC)**
                - S/N - 17609

        - **Temp / Relative Humidity (E+E EE33) –** Not Installed.
            - S/N – N/A
        - **Relative humidity (EE60)**
            - S/N – S86493 – Removed 8/28/2022 and replaced by another EE08. See above.
            - Sensor not showing values in line with other two sensors.
    - **HCO Sensors:** Working
        - **Surface PAR (Biospherical QSR2200):**
            - S/N- 20153
        - **Spectral Pyranometer (Eppley PSP/SPP):**
            - S/N- 35032F3
        - **Infrared Pyranometer (Eppley PIR):**
            - S/N 34463F3
    - **Seawater Intake Temperature Sensor:** Working.
        - SBE3+
            - S/N 034063
    - **Hull Temp Sensor:** Working - however sometimes values deviate from the intake temperature sensor which remains consistent. We are investigating possible causes during these time periods.
            - SBE 48 S/N- 0042
- **LCI-90i:** Working and will need to swap a Lurker LCI90i unit from Aft Conn to replace the local 9/16 unit in the winch room given the short that was experienced in the previous cruise report.
- **Scoreboards**: Working, switched between aft winches regularly between ops
- **CTD:** Air temperature warmed up as we completed our last stations and freezing prevention measures were no longer necessary. Our last stations were shallow enough that the UAF group put their SBE FastCat on the rosette each cast to have another data point for pressure/depth given the ongoing offset issues on the 9plus.
    - **Fish (SBE 9+):**
        - S/N- 0639 (LOST) to the deep
        - S/N – 638 Has significant pressure port issues sometimes linear and sometimes exponential differences from wire out during deep casts.
    - **Conductivity (SBE 4C):**
        - Primary S/N 2568
        - S/N- 2545 (LOST)
        - Secondary 2561
        - S/N- 2575 (LOST)
    - **Temperature (SBE 3+):**
        - Primary S/N 2796
        - S/N- 2841(LOST)
        - Secondary S/N 2855
        - S/N- 2824 (LOST)
    - **O2 (SBE 43):**
        - Primary S/N 0456

    - S/N 0459 (LOST)
    - Secondary S/N- (not installed)
- **Fluorometer (WetLabs ECO):** Zeroing out from 600 – 1115 m depth during down casts, returns on upcast and is believable – reasons unknown. Tests fine on deck, has been moved to a different voltage channel, and cable confirmed good. We have communicated to SeaBird and not had helpful recommendations back yet.
    - S/N- FTLRTD 074
    - 7624 (LOST)
- **Fluorometer (WetLabs CDOM)** maxing out to 5VDC between 600 – 1115 m during downcast. Data returns on upcast and is believable – reasons unknown. Tests fine on deck, has been moved to a different voltage channel, and cable confirmed good. We have communicated to SeaBird and not had helpful recommendations back yet.
    - S/N – FLCDRTD 2226
    - 7552 (new sensor install for this cruise) (LOST)
- **Transmissometer (WetLabs C-STAR): NONE**
    - S/N- CST-390DR (LOST)
- **Altimeter (Valeport VA500):** working with new custom-made cable
    - S/N- 65378
    - S/N- 60362? (LOST)
- **PAR (Biospherical QSP 2350):**
    - S/N- 70682
    - S/N 70112 (LOST)
- **Carousel (SBE 32):** working
    - S/N- 0116 end cap o-rings were replaced as last service was 2019, needed a sticky latch replaced
    - S/N – 0348 (LOST)
- **Pumps (SBE 5T):**
    - Primary S/N - 3115
    - S/N- 3114 (LOST)
    - Secondary S/N - 3112
    - S/N- 3116 (lOST)
- **Primary Deck Unit (SBE 11):**
    - S/N- 416
- **Secondary Deck Unit (SBE 11):**
    - S/N- 417
- **Niskin Bottles:** Some leaks found, monofilament lanyards on lower cap all replaced as they were very tight, most of the spigot o-rings needed to be replaced, a number of the cap o-rings were also replaced. Occasional bottom caps not seating properly after firing but never the same bottle twice.
- **Sippican MK21 Ethernet DAQ:** Working, DAQ successfully connects to the launcher via j-box above CL rack 6.
- **Sippican LMC16 DAQ:** Not used.

- **Launcher:** We had one conductor in our primary launch cable get pulled and we lost continuity between the DAQ and the launcher. We brought out the secondary unit, which worked for one cast before we were able to resplice the primary cable. The primary launcher was used for each cast after that.
- **XBT supply:** have been used regularly in lieu of science stations as we skip them to make up lost time, will have enough for RTHP transit
- **Science Sea Water (SSW):** Working and used for both water walls, supply to hoses on the back deck, and various lab sink instruments in Main Lab, Wet Lab, and Bio Lab. Inspected sensors and tubing on both waterwalls this past week and ran fresh water through during down period.
    - **Surface Temp: (SBE 3S)**
        - S/N - 4063
    - **Port Side:**
        - **Thermosalinograph: (SBE 45)**
            - S/N - 0215
        - **O2: (SBE 43)**
            - S/N - 0458
        - **WetStar Fluorometer**
            - S/N – 1648 installed.
        - **WetLabs C-STAR Transmissometer:**
            - S/N - CST-596PR
        - **Eco- Triplet Fluorometer:**
            - BBFL2 - 6484
        - **Optical Oxygen (SBE63)**
            - S/N - 2885be
        - **Additional Sensors for the Season**
            - Mini-TDGP: Working.
        - **Bio Chem Lab:** Working with BIOS sampler plumbed in.
            - **Thermosalinograph: (SBE 45)**
                - S/N - 0228
            - **O2 (SBE 43):**
                - S/N - 1307
            - **WetStar Fluorometer**
                - S/N – 1642
            - **Eco- Triplet Fluorometer**
                - S/N- 6865
- **Milli-Q:**
    - **Main Lab- IQ7000:** Working used heavily
    - **Wet Lab- IQ7000:** Working used heavily
- **pC02:** Working and have had to restart system a few times due to taking down SSW. Still need to adjust flow rates too often – requires a NOAA groom
    - **Tank pressures checked and recorded?** Yes.
    - **Atmospheric CO2:** Running. There is a second machine up forward brought by UMD scientist so 2 new sniffer housings were mounted to jackstaff in port and two new tubes run to forward machinery space.
- **Gravimeter (BGM-3):** Installed and working,

    - **Voltage Test Points checked?** Yes
    - **Entered in Google Drive?** No – out of internet range
- **Gravimeter (AT1M-19):** Not sailing in 2022.
- **AutoSal:** 2 serviced units onboard. Unit 65-715 was taken out of service on 9/25 as heater might be faulty. We put 65-743 into service and set up a water bath for science samples, but the lab space remained unstable in terms of ambient temperature and the UAF group will be taking salts back to process on shore as they had limited bottles of standard water.
- **Pingers:** New OIS 6000 pinger and additional 9/16 book clamps onboard, located in biolab, now though not tested yet. The obsolete Benthos 2216 pingers are stored in the warehouse and not onboard. MARSSAM pinger did not perform as expected, perhaps the batteries are low. OUS's other OIS 6000 pinger is deployed on the Multicorer and working well.

INFRASTRUCTURE

- **Intermapper:** Working.
- **E-LOG:** Using old R2R fitlet from Oceanus and configured to work on healy network. Was being used extensively throughout cruise with 1075 logged events.
- **Jira / Confluence:** Working and used extensively – will not be able to use anymore however due to high latitude
- **Console PC:** Working, with Windows 10 console-01 as the primary, and (older) console-pc as the backup. Displaying POSMV and Intermapper
- **STARC Surface Tablet:** Working and software updated. Stylus battery at 61%.
- **CTD/XBT PC:** Working, OpenCPN reverted to 5.2.4 on ctd-02 so that it can display layers.
- **Multibeam PC:** mb-01 working to run SIS; mb-02 not used.
- **Knudsen PC:** echo-01 is currently the primary. Migration to echo-03 as the primary was not performed because the hydrophone is still connected to echo-01 via a fiber-ethernet converter. Migration would require patching the fiber to the Computer Lab and moving the converter box.
- **K-Sync PC:** Working, with ksync-01 as the primary.
- **PCO2:** Working.
- **Hypack PC:** Not used.
- **ArcGIS VM:** ArcGIS updated with a new license. Ice imagery has been loaded for training purposes with NIC representative.
    - VM Host has been better documented to allow for easier troubleshooting in the future.
    - Graphics upgrade not possible due to limitations of VM Host
- **Future Lab Mac Mini:** Updated to macOS Monterrey and OpenCPN 5.2.4.
- **Bridge Met PC:** PC has failed; currently using a Raspberry Pi with option of displaying webpages of the MET and ADCP data displays.
    - **Helmsman1:** Working, but shows a fan error upon boot.
    - **Helmsman2:** Working, currently displaying ADCP webpage on the bridge monitor.
- **Linux Systems:**

    - **ADCP Computers:** Working.
        - **Currents 36:** Working.
        - **Currents 35:** Working, as the primary.
    - **Met Computers:** Occasional freezing occurred throughout the cruise resulting in some data dropouts.
- **Serial Logger:** Working.
- **KVM:** Mediacentos working. Spares stowed. Display04 has been replaced with an RX spare. Will warranty return it if the issue is determined to be the Mediacento unit.
    - Display 04 hasn't had any new problems since last report
    - An additional RX deployed to Aft Staging for benthic scientists to see data from their workbench
- **Displays:**
    - **Computer Lab:** Working.
    - **Aft Con:** Working. Reverted back to original
    - **Main Lab:** Working.
    - **Bridge:** Working.
    - **Aloft Con:** N/A, but possible to add a display when C5I installs a new switch.
    - **BioChem:** Working.
    - **Aft Staging:** New install displaying MET.
- **Web Cams:**
    - **IC Gyro:** Working.
    - **Port SSW:** Working.
    - **BioChem SSW:** Working.
    - **Stbd Staging:** Working.
    - **Science comm board:** Working.
- **Power/UPS:**
    - **Computer Lab (Eaton):** Working.
    - **Aft Con (APC):** Working to power winch network and CTD deck units.
    - **HCO (APC):** Working to power GPS and radiometer systems, switch.
    - **MICA Stores:**
        - **Eaton:** Working, for ADCP deck units, Advantech, and switch.
        - **Acumentrics:** Working:
            - Top Battery Pack
                - Model: ACG2500RiBSPC1
                - S/N: W380997113
            - Bottom Battery Pack
                - Model: ACG2500RiBSPC1
                - S/N: W380997112
            - **IC-Gyro (DRS)** Replaced with Acumentrics – working to power STARC and PSN systems, S/N: W211001711
        - **FWD/Jackstaff:** Parallel Acumentrics ACG2500 RUPS installed to power STARC MET, C5I switch, and scientist Picarro equipment in the forward machinery space. Top (not powered on) S/N: W380997111 Bottom (powered on) S/N: W091000106

NETWORK

- **Advantech:**
  - **Computer Lab:** Working.
  - **HCO:** Working.
  - **MET-Bridge:** Working.
  - **MICA (ADCP):** Working.
  - **IC Gyro:** Working.
  - **Jackstaff:** Working.
- **Comtrol:**
  - **Port side SSW:** Working.
  - **BioChem SSW:** Working.

- **Fiber Optic:**
  - **Computer Lab:** Working.
  - **HCO:** Working.
  - **MICA:** Working.
  - **IC Gyro:** Working.
  - **Potable Water:** Working.
  - **FWD:** Working.
- **RocketPorts (Computer Lab):** Working.
- **Perle:** CG systems that provide Gyro feeds working.
- **Time Servers:**
  - **HCO:** Working.
  - **Bridge:** Working.
- **Healy NAS:** Working, for DAS (SnagIt) and Data (collected mission data).
- **PSNHSVRDATA:** Working.
- **VSAT:** Working. C5I has applied a network rule to send all traffic to Atlassian tools via VSAT so that a UCSD VPN is not necessary to access them.
  - Back in range of service. Port antenna needs calibration says C5I
- **Starlink:** Worked when near shore in Seattle, with low latency. Starlink has been flapping inport in Dutch. VSAT as primary as of now.

Appendix C. Event Log

Station	Transect	Instrument	Action	GPS_Time	Latitude	Longitude	Seafloor (m)	Comment
0	CEO	Moooring	recover	9/9/22 3:16	71.599718	-161.50657	44	CEO1-20; on deck time
0	CEO	Moooring	recover	9/9/22 3:36	71.599912	-161.52592	44	CEO2-20; mooring released time
0	CEO	Moooring	recover	9/9/22 4:15	71.5938	-161.51917	46	CEO3t-21; mooring released time
0	CEO	Moooring	deploy	9/9/22 17:23	71.6007	-161.54085	46	CEO2-22;anchor drop time
0	CEO	Moooring	deploy	9/9/22 18:18	71.600433	-161.49957	46	CEO1-22;anchor drop time
0	CEO	Moooring	deploy	9/9/22 19:22	71.59095	-161.52248	46	CEO3-22;acoustic release time
0	CEO	CTD911	deploy	9/9/22 21:19	71.590833	-161.52933	46	
0	CEO	CTD911	recover	9/9/22 21:45				Time is an estimate
0	CEO	Optics	deploy	9/9/22 21:49	71.5908	-161.5287	48	CEO
0	CEO	Optics	recover	9/9/22 22:01	71.5908	-161.5287	48	CEO
0	CEO	Ring Net	deploy	9/9/22 22:25	71.590667	-161.5212	46.7	Winch Depth Readout not working, need to re-do
0	CEO	Ring Net	recover	9/9/22 22:29	71.58975	-161.52515	46.7	
0	CEO	Ring Net	deploy	9/9/22 22:45	71.589817	-161.52455	46.1	30 m cast depth
0	CEO	Ring Net	recover	9/9/22 22:51	71.58995	-161.52902	46.1	
0	CEO	Van Veen Grab	deploy	9/9/22 23:39	71.591133	-161.5269	46.2	CEO
0	CEO	Van Veen Grab	deploy	9/9/22 23:54	71.591617	-161.5451	45.8	CEO
0	CEO	Van Veen Grab	deploy	9/10/22 0:00	71.592783	-161.54082	45.8	CEO
0	CEO	Van Veen Grab	deploy	9/10/22 0:14	71.593517	-161.53152	46.5	CEO
0	CEO	Van Veen Grab	deploy	9/10/22 0:24	71.594067	-161.54383	46.2	CEO
0	CEO	HAPS Corer	deploy	9/10/22 0:54	71.597217	-161.54173	45.5	CEO
0	CEO	HAPS Corer	deploy	9/10/22 1:13	71.59805	-161.53452	45.7	CEO

0	CEO	HAPS Corer	deploy	9/10/22 1:33	71.597883	-161.56398	45.7	CEO
0	CEO	HAPS Corer	deploy	9/10/22 1:59	71.599267	-161.58108	46.1	CEO
0	CEO	HAPS Corer	deploy	9/10/22 2:15	71.600083	-161.61308	45	CEO
0	CEO	HAPS Corer	deploy	9/10/22 2:29	71.6003	-161.60098	45.2	CEO
1	EHS	CTD911	deploy	9/10/22 21:01	71.6003	-161.60098	50	Pshipton; instrument bottom depth
1	EHS	CTD911	recover	9/10/22 21:27				
1		Optics	deploy	9/10/22 21:38	71.6003	-161.60098	50	Station name EHS1
1		Optics	recover	9/10/22 21:50	71.6003	-161.60098	50	
1	EHS	VPR	deploy	9/10/22 22:07	71.6003	-161.60098	50	EHS1, 45 m w/o
1	EHS	Bongo Net	deploy	9/10/22 22:30	71.6003	-161.60098	50.2	Tow depth 48 m
1		Van Veen Grab	deploy	9/10/22 22:45	71.6003	-161.60098	50.5	EHS1
1		Van Veen Grab	deploy	9/10/22 22:55	71.6003	-161.60098	49.7	EHS1
1		Van Veen Grab	deploy	9/10/22 23:17	71.6003	-161.60098	49.5	EHS1
1		Van Veen Grab	deploy	9/10/22 23:30	71.6003	-161.60098	49.7	EHS1
1		Van Veen Grab	deploy	9/10/22 23:38	71.6003	-161.60098	50.2	EHS1
1	EHS	HAPS Corer	deploy	9/11/22 0:04	71.6003	-161.60098	50.8	
1	EHS	HAPS Corer	deploy	9/11/22 0:04	71.6003	-161.60098	49.5	
1	EHS	HAPS Corer	deploy	9/11/22 0:24	71.6003	-161.60098	49.9	
		Underway Seawater System	pointSample	9/11/22 18:14	71.404511	-157.1211		EDNA /POM
		PCO2	stop	9/11/22 21:39	71.891145	-157.08734		standards run and powered off in preparation for securing science seawater
		Underway Seawater System	service	9/11/22 21:44	71.903561	-157.08105		science seawater system secured for pump speed adjustment and cleaning
		Underway Seawater System	start	9/11/22 22:14	71.975743	-157.04039		science seawater flow returned
		PCO2	start	9/11/22 22:19	71.987336	-157.03245		system restarted after science seawater flow returned

		Underway Seawater System	pointSample	9/11/22 23:02	72.08849	-156.97435		EDNA /POM
1		HAPS Corer	deploy	9/11/22 23:59	72.186701	-157.14538	50.8	EHS1
1		HAPS Corer	deploy	9/11/22 23:59	72.186701	-157.14538	49.9	EHS1
1		HAPS Corer	deploy	9/11/22 23:59	72.186701	-157.14538	49.5	EHS1
		Underway Seawater System	pointSample	9/11/22 23:59	72.186701	-157.14538		EDNA /POM
		Underway Seawater System	pointSample	9/11/22 23:59	72.186701	-157.14538		EDNA /POM
		Underway Seawater System	pointSample	9/12/22 5:03	72.39827	-158.97907		EDNA /POM
2	EHS	CTD911	deploy	9/12/22 16:41	72.377636	-158.91885	52	Station "Name" - EHS2
2	EHS	CTD911	recover	9/12/22 16:51	72.377728	-158.91971	52	Station "Name" - EHS2 End time corrected from CTD logsheet
2		Optics	deploy	9/12/22 16:51	72.377728	-158.91971		Station name EHS2
2		Optics	recover	9/12/22 17:03	72.378158	-158.92639		
2	EHS	VPR	deploy	9/12/22 17:17	72.378737	-158.92402	52	45 m w/o, EHS2
2	EHS	VPR	recover	9/12/22 17:23	72.378873	-158.92482	52	
3	EHS	CTD911	deploy	9/12/22 18:12	72.479618	-158.8853	53	
3		Optics	deploy	9/12/22 18:23	72.479781	-158.88988		Station name EHS3
3	EHS	CTD911	recover	9/12/22 18:27	72.48005	-158.89194	53	
		Underway Seawater System	pointSample	9/12/22 18:27	72.480051	-158.89195		EDNA /POM
3		Optics	recover	9/12/22 18:29	72.480142	-158.89351		
3	EHS	VPR	deploy	9/12/22 18:34	72.480745	-158.89289	53	47 m w/o, EHS 3
3	EHS	VPR	recover	9/12/22 18:41	72.481237	-158.89378	53	
4	EHS	VPR	deploy	9/12/22 19:24	72.53962	-158.74696	61	55 m w/o, EHS 3.5
4	EHS	VPR	recover	9/12/22 19:29	72.539374	-158.74795	61	Bottom Depth 61
4	EHS	CTD911	deploy	9/12/22 19:40	72.538305	-158.74691	60	Station "Name" - EHS3.5
4	EHS	CTD911	recover	9/12/22 19:48	72.53848	-158.75099	60	Station "Name" - EHS3.5

4		Optics	deploy	9/12/22 19:52	72.538486	-158.75251		Station name EHS3.5
4		Optics	recover	9/12/22 19:59	72.538646	-158.75701		
5	EHS	CTD911	deploy	9/12/22 20:52	72.608948	-158.63223	117	Station "Name" - EHS4
5		Optics	deploy	9/12/22 21:21	72.611538	-158.64098		Station name EHS4
5	EHS	CTD911	recover	9/12/22 21:23	72.611823	-158.64261	117	Station "Name" - EHS4
5		Optics	recover	9/12/22 21:27	72.612129	-158.64555		
5	EHS	multinet	deploy	9/12/22 21:57	72.608909	-158.62378	119	Flow meter turned very little; wire speed ~26 m/min
5	EHS	multinet	recover	9/12/22 22:06	72.608441	-158.62577	119	
5	EHS	VPR	deploy	9/12/22 22:27	72.608502	-158.61625	118	113 m w/o
5	EHS	VPR	recover	9/12/22 22:39	72.609343	-158.61834	118	
5	EHS	Bongo Net	deploy	9/12/22 23:11	72.610153	-158.62432	119	EHS4; bottom variable
5	EHS	Bongo Net	recover	9/12/22 23:20	72.611054	-158.62474	119	113 m w/o; EHS4
		Underway Seawater System	pointSample	9/12/22 23:46	72.608806	-158.62392		EDNA /POM
5		Van Veen Grab	deploy	9/13/22 0:05	72.607111	-158.62451	116.2	EHS4
5		Van Veen Grab	deploy	9/13/22 0:20	72.606967	-158.62151	116.4	EHS4
5		Van Veen Grab	deploy	9/13/22 0:35	72.609217	-158.62555	119.6	EHS4
5		Van Veen Grab	deploy	9/13/22 0:52	72.608421	-158.63048	122.7	EHS4
5		Van Veen Grab	deploy	9/13/22 1:09	72.607653	-158.6284	116.5	EHS4
		Underway Seawater System	pointSample	9/13/22 1:33	72.606917	-158.62637		7002
5		HAPS Corer	deploy	9/13/22 1:35	72.607095	-158.62647	114.5	EHS4
5		HAPS Corer	deploy	9/13/22 2:04	72.607563	-158.62993	116.5	EHS4
5		HAPS Corer	deploy	9/13/22 2:35	72.607953	-158.63671	115.2	EHS4
		Underway Seawater System	pointSample	9/13/22 5:03	72.605923	-158.65359		EDNA /POM
		Multibeam	stop	9/13/22 6:33	72.675387	-158.69173		stopped acquisition to run diagnostics on poor signal quality

		Echosounder12	stop	9/13/22 6:34	72.675618	-158.68948		poor signal quality, switching to 3.5kHz temporarily
		Echosounder3.5	start	9/13/22 6:34	72.675861	-158.68708		
		Underway Seawater System	pointSample	9/13/22 19:06	72.703954	-158.75739		EDNA /POM
6		CTD911	other	9/13/22 20:30	72.694048	-158.64956	200m	had to re-terminate 0.322 due to kink developed on deployment
6	EHS	Bongo Net	deploy	9/13/22 20:44	72.701672	-158.62668	205	EHS5. 190 m w/o, 148m net depth, high winds, towing a bit
6	EHS	Bongo Net	deploy	9/13/22 20:44	72.701672	-158.62668	207	EHS5, 190 m w/o, Net depth 148 m
6	EHS	Bongo Net	recover	9/13/22 20:50	72.701005	-158.62453	207	
6	EHS	Bongo Net	recover	9/13/22 20:50	72.701005	-158.62453	207	
6	EHS	VPR	recover	9/13/22 21:21	72.699998	-158.65267	195	High winds, at an angle, 180 m w/o
6	EHS	VPR	deploy	9/13/22 21:21	72.699998	-158.65267	195	w/o 180 m
6		Van Veen Grab	deploy	9/13/22 21:58	72.700104	-158.637	198.4	EHS5
6		Van Veen Grab	deploy	9/13/22 22:20	72.699552	-158.63021	200.1	EHS5
6		Van Veen Grab	deploy	9/13/22 22:39	72.700896	-158.63136	200.2	EHS5
6		Van Veen Grab	deploy	9/13/22 22:57	72.699943	-158.63255	199.8	EHS5
		Underway Seawater System	pointSample	9/13/22 23:07	72.699451	-158.63176		EDNA /POM
6		Van Veen Grab	deploy	9/13/22 23:13	72.69881	-158.63087	198.7	EHS5
6		HAPS Corer	deploy	9/14/22 0:00	72.704015	-158.64427	200.8	EHS5
6		HAPS Corer	deploy	9/14/22 0:35	72.705842	-158.64746	201.6	EHS5
6	EHS	CTD911	deploy	9/14/22 1:07	72.704816	-158.618	204m	Choppy seas
6	EHS	CTD911	recover	9/14/22 1:45	72.71642	-158.63966	212	Station "Name" EHS5
7	EHS	VPR	deploy	9/14/22 3:15	72.751008	-158.45756	257	230 m w/o
7	EHS	VPR	recover	9/14/22 3:30	72.748924	-158.47106	257	
7	EHS	CTD911	deploy	9/14/22 3:44	72.747809	-158.47067	252	

7	EHS	CTD911	recover	9/14/22 4:07	72.751994	-158.48305	258	dry ctd
		Underway Seawater System	pointSample	9/14/22 4:57	72.819653	-158.30087		EDNA /POM
8	EHS	CTD911	deploy	9/14/22 4:59	72.820179	-158.30122	396	
8		Multibeam	start	9/14/22 5:42	72.828468	-158.30861		logging/pinging on EM122 after some troubleshooting and power cycling of TRU
8	EHS	CTD911	recover	9/14/22 5:54	72.830692	-158.31507	459	
8	EHS	Bongo Net	deploy	9/14/22 6:16	72.819296	-158.30353	395	210 m w/o, Net depth153 m
8	EHS	Bongo Net	recover	9/14/22 6:30	72.815539	-158.31124	395	
8		HAPS Corer	deploy	9/14/22 6:48	72.819097	-158.29311	398	EHS6
8		HAPS Corer	deploy	9/14/22 7:40	72.81926	-158.27778	398	EHS6
8		HAPS Corer	deploy	9/14/22 8:36	72.825046	-158.28754	414	EHS6
9	EHS	CTD911	deploy	9/14/22 10:57	72.874692	-158.32603	1120	
9	EHS	CTD911	other	9/14/22 11:37	72.872231	-158.36248	975	CTD lost when props hit sea cable. CTD at pressure 725 dbar.
		Underway Seawater System	pointSample	9/14/22 12:18	72.881706	-158.32824		7003
		XBT	release	9/14/22 13:27	72.925516	-158.19281	1240	XBT SN 036504
		XBT	release	9/14/22 13:57	72.995085	-158.04064	1440	XBT SN 036508
		Underway Seawater System	pointSample	9/14/22 14:01	73.003332	-158.03134		7004
		Underway Seawater System	pointSample	9/14/22 14:17	73.046566	-158.0584		7005
		XCTD	deploy	9/14/22 14:18	73.049911	-158.06013	1576	XCTD 1N21117926
		XBT	release	9/14/22 15:15	73.20167	-158.20295	1952	XBT SN 036512
		Underway Seawater System	pointSample	9/14/22 15:16	73.204378	-158.20539		7006
		XCTD	deploy	9/14/22 15:55	73.313693	-158.30876	2218	XCTD 1N21117927

Underway Seawater System	pointSample	9/14/22 15:58	73.321391	-158.31717		7007
XBT	release	9/14/22 16:39	73.43527	-158.41609	2469	XBT SN 036505
Underway Seawater System	pointSample	9/14/22 16:41	73.438988	-158.41749		7008
Underway Seawater System	pointSample	9/14/22 17:43	73.571156	-158.54765		7009
XBT	release	9/14/22 17:43	73.572426	-158.54932		XBT SN 036509
XBT	release	9/14/22 18:26	73.692119	-158.67774	3026	XBT SN 036513
Underway Seawater System	pointSample	9/14/22 18:29	73.699726	-158.68443		7010
Underway Seawater System	pointSample	9/14/22 19:03	73.789992	-158.77173		EDNA /POM
XCTD	deploy	9/14/22 19:21	73.823359	-158.79184	3304	XCTD SN 1N21117928
Underway Seawater System	pointSample	9/14/22 19:23	73.82679	-158.79801		7011
XBT	release	9/14/22 20:28	73.948316	-158.97169	3370	XBT SN 036622
Underway Seawater System	pointSample	9/14/22 20:31	73.956221	-158.97027		7012
Underway Seawater System	pointSample	9/14/22 22:15	74.077056	-159.06585		7013
XBT	release	9/14/22 22:20	74.07979	-159.04491	2689	XBT SN 036623
Underway Seawater System	pointSample	9/14/22 22:59	74.131588	-159.08548		EDNA /POM
XBT	release	9/14/22 23:36	74.227292	-159.20355	779	XBT SN 036630
Underway Seawater System	pointSample	9/14/22 23:36	74.227292	-159.20355		7014
XCTD	deploy	9/15/22 0:17	74.345052	-159.32205	724	XCTD SN 1N21117930; lost conductivity sensor at 700m
Underway Seawater System	pointSample	9/15/22 0:18	74.346798	-159.32362		7015
XBT	release	9/15/22 1:04	74.475905	-159.45535	840	XBT SN 036627
Underway Seawater System	pointSample	9/15/22 1:06	74.479251	-159.45887		7016

XBT	release	9/15/22 1:46	74.596473	-159.57912	1689	XBT SN 036631
Underway Seawater System	pointSample	9/15/22 1:54	74.616184	-159.59936		7017
XBT	release	9/15/22 2:31	74.720615	-159.70747	1647	XBT SN 036624
Underway Seawater System	pointSample	9/15/22 2:42	74.748412	-159.73628		7018
XCTD	deploy	9/15/22 3:20	74.852512	-159.85657		XCTD SN 1N21117929
Underway Seawater System	pointSample	9/15/22 3:24	74.860429	-159.86605		7019
XCTD	deploy	9/15/22 4:18	74.993747	-159.99388	1976	XCTD SN 1N21117931
Underway Seawater System	pointSample	9/15/22 4:28	75.015159	-159.98742		7020
Underway Seawater System	pointSample	9/15/22 4:28	75.015159	-159.98742		7020
Underway Seawater System	pointSample	9/15/22 5:08	75.099759	-159.90166		EDNA /POM
XBT	release	9/15/22 5:32	75.151295	-159.8508	1977	XBT SN 036628
Underway Seawater System	pointSample	9/15/22 5:33	75.152858	-159.8491		7021
XBT	release	9/15/22 6:45	75.318253	-159.68442	1442	XBT SN 036632
Underway Seawater System	pointSample	9/15/22 6:50	75.329487	-159.67317		7022
XBT	release	9/15/22 7:50	75.490744	-159.51199	1497	XBT SN 036625
Underway Seawater System	pointSample	9/15/22 7:53	75.497334	-159.50534		7023
Underway Seawater System	pointSample	9/15/22 8:53	75.65403	-159.34673		7024
XCTD	deploy	9/15/22 8:53	75.655996	-159.3448	1176	XCTD SN 1N21117932
XBT	release	9/15/22 10:00	75.821219	-159.18027	754	XBT SN 036629 Terminal depth 749m depth
Underway Seawater System	pointSample	9/15/22 10:02	75.826549	-159.17501		7025
XBT	release	9/15/22 11:04	75.997697	-159.00279	797	XBT SN 036633 783 m max depth

	Underway Seawater System	pointSample	9/15/22 11:06	76.001791	-158.99861		7026
	SIO MET-System	other	9/15/22 11:44	76.107439	-158.89415		Met data for shipboard systems did not log from 1144 to 1401 UTC. Still investigating cause.
	Underway Seawater System	pointSample	9/15/22 11:44	76.107439	-158.89415		7028 - need to double check time
	XBT	release	9/15/22 12:15	76.191926	-158.8096	739	XBT 16 SN 036598
	XCTD	deploy	9/15/22 13:03	76.324549	-158.67663	631	XCTD SN 1N21117933 max depth 652.7m
	XBT	release	9/15/22 14:11	76.505317	-158.49658	491	XBT SN 036602 488 m depth
	Underway Seawater System	pointSample	9/15/22 14:13	76.510622	-158.49093		7029
	XBT	release	9/15/22 15:08	76.662813	-158.33774	754	XBT SN 036606 755 m max depth
	Underway Seawater System	pointSample	9/15/22 15:09	76.66559	-158.33479		7030
	XBT	release	9/15/22 16:12	76.840417	-158.16102	1105	XBT 19 SN 036599
	Underway Seawater System	pointSample	9/15/22 16:13	76.843398	-158.15803		7031
	Underway Seawater System	pointSample	9/15/22 17:12	77.001372	-157.9986		EDNA /POM
WPT 27	CTD911	deploy	9/15/22 17:58	77.000418	-157.99896	1048	Test new CTD Deployment time from 010 hex start time
WPT 27	CTD911	recover	9/15/22 18:06	77.001388	-158.0015	1048	Test CTD end time from last bottle file
10	CTD911	deploy	9/15/22 19:54	76.998392	-157.99213	1081	new CTD to near bottom
10	Optics	deploy	9/15/22 21:13	77.013159	-158.03387		
10	Optics	recover	9/15/22 21:19	77.013407	-158.03096		
10	CTD911	recover	9/15/22 21:20	77.013448	-158.031	1035	no altimeter and questionable pressure. Went to 50 above bottom
10	multinet	deploy	9/15/22 21:54	77.001757	-157.98677	1089	

	Underway Seawater System	pointSample	9/15/22 23:03	77.002051	-157.97983		EDNA /POM
10	multinet	recover	9/15/22 23:18	77.002477	-157.97844	1089	Net Depth 1050
10	CTD911	deploy	9/15/22 23:46	77.002786	-157.98207	1099	Calibration cast with SBE-37SMP SN 22256
10	CTD911	recover	9/16/22 0:12	77.006346	-157.98251	1109	6 bottles fired
10	VPR	deploy	9/16/22 0:25	77.005936	-157.98031	1114	300 m cast
10	VPR	recover	9/16/22 0:47	77.003578	-157.977	1114	
10	Bongo Net	deploy	9/16/22 0:57	77.002613	-157.97462	1112.7	Net Depth 200 m
10	Bongo Net	recover	9/16/22 1:15	77.000782	-157.96843	1112.7	
10	LargeVolumePump	deploy	9/16/22 2:08	77.000366	-157.97954		
10	LargeVolumePump	startSample	9/16/22 2:53	77.000811	-157.98824	1090.6	
	Underway Seawater System	pointSample	9/16/22 5:07	77.001491	-157.97744		EDNA /POM
10	LargeVolumePump	stopSample	9/16/22 6:53	77.001304	-157.97829		
10	LargeVolumePump	recover	9/16/22 7:43	77.009529	-158.01788		
10	Multicorer	deploy	9/16/22 8:52	76.998782	-157.9851	1091	
	XBT	release	9/16/22 13:16	77.32623	-157.67413	1880	XBT SN 036181
	Underway Seawater System	pointSample	9/16/22 13:18	77.329339	-157.67083		7032
	Underway Seawater System	pointSample	9/16/22 14:45	77.673994	-157.32635		7033
	XBT	release	9/16/22 14:46	77.678611	-157.32187	1787	XBT SN 036182
11	CTD911	deploy	9/16/22 15:51	77.941851	-157.05432	1533	
11	Optics	deploy	9/16/22 17:27	78.018807	-157.01727		
11	CTD911	recover	9/16/22 17:28	78.019213	-157.01793	1533	
11	Optics	abort	9/16/22 17:31	78.020071	-157.01985		Aborted due to strong current
	Underway Seawater System	pointSample	9/16/22 17:38	78.023841	-157.00873		EDNA /POM
11	VPR	deploy	9/16/22 18:11	77.986796	-156.94623	1591	Wire out 300 m

11	VPR	recover	9/16/22 18:35	77.983866	-156.94976	1591	
	XCTD	deploy	9/16/22 20:12	78.000024	-155.86574	2150	XCTD SN 1N21117934
	Underway Seawater System	pointSample	9/16/22 20:14	78.000038	-155.8463		7034
	Underway Seawater System	pointSample	9/16/22 21:39	78.000051	-154.68465		7035
	XCTD	deploy	9/16/22 21:41	78.000025	-154.64806	1139	XCTD SN 1N21117936
	Underway Seawater System	pointSample	9/16/22 23:06	78.000022	-153.72511		EDNA /POM
12	CTD911	deploy	9/16/22 23:47	77.99745	-153.49645	1725	
12	Optics	deploy	9/17/22 0:27	77.999972	-153.49502		
12	Optics	recover	9/17/22 0:36	78.000856	-153.49815		
12	CTD911	recover	9/17/22 0:36	78.000966	-153.4987	1720	20 bottles fired
12	VPR	deploy	9/17/22 0:49	78.000709	-153.49721	1719.4	300 m w/o
12	VPR	recover	9/17/22 1:10	77.999192	-153.49676	1719.4	
	SIO MET-System	stop	9/17/22 2:12	78.000021	-153.02409		stopped logging Met to reboot computer due to data loss yesterday
	SIO MET-System	start	9/17/22 2:17	78.000006	-152.97725		Met data acquisition restarted
	XCTD	deploy	9/17/22 3:28	78.000006	-152.34678	3475	XCTD 1N21117937
	Underway Seawater System	pointSample	9/17/22 3:29	78.000045	-152.33795		7036
	Underway Seawater System	pointSample	9/17/22 5:05	78.000071	-151.54025		EDNA /POM
	Underway Seawater System	pointSample	9/17/22 5:46	77.999985	-151.20443		7037
	XCTD	deploy	9/17/22 5:52	78.000083	-151.15575	4090	XCTD 1N21117935
13	CTD911	deploy	9/17/22 15:41	78.00628	-149.99948	3826	
13	Optics	deploy	9/17/22 18:59	78.04393	-150.2402		
13	CTD911	recover	9/17/22 19:04	78.045031	-150.246	3826	
13	Optics	recover	9/17/22 19:07	78.045879	-150.24937		

13	Bongo Net	deploy	9/17/22 19:38	78.047723	-150.20233	3829	Net depth 200 m, 199.8 m w/o
13	Bongo Net	recover	9/17/22 19:52	78.045195	-150.21589	3829	
	Underway Seawater System	pointSample	9/17/22 20:06	78.044954	-150.21682		EDNA /POM
13	LargeVolumePump	deploy	9/17/22 20:30	78.042191	-150.21356		
13	LargeVolumePump	startSample	9/17/22 21:52	78.045942	-150.21172	3716.2	
	Underway Seawater System	pointSample	9/17/22 23:36	78.046955	-150.24018		EDNA/ POM
13	LargeVolumePump	stopSample	9/18/22 1:52	78.048361	-150.21658		
13	LargeVolumePump	recover	9/18/22 2:37	78.050863	-150.20521		
13	VPR	deploy	9/18/22 2:48	78.0484	-150.19925	3829	300.9 m w/o
13	VPR	recover	9/18/22 3:12	78.049753	-150.19355	3829	
13	multinet	deploy	9/18/22 3:33	78.051774	-150.1975	3830	Net Depth 1000 m
	Underway Seawater System	pointSample	9/18/22 5:35	78.051787	-150.19387		EDNA/ POM
13	multinet	recover	9/18/22 5:53	78.051843	-150.18799	3830	
13	Multicorer	maxDepth	9/18/22 8:03	78.0546	-150.16033	3829	W36
	Underway Seawater System	pointSample	9/18/22 12:52	78.284738	-150.00944		7038
	XBT	release	9/18/22 13:58	78.444468	-150.0029	3828	XBT SN 036183
	Underway Seawater System	pointSample	9/18/22 14:02	78.45455	-150.00651		7039
	XBT	release	9/18/22 14:48	78.584862	-150.01537	3831	Deep Blue XBT SN 1179146
	Underway Seawater System	pointSample	9/18/22 15:23	78.676754	-150.00639		7040
14	CTD911	deploy	9/18/22 17:13	78.99284	-150.00545	3827	To 300 m
14	Optics	deploy	9/18/22 17:52	79.003604	-150.03491		
14	CTD911	recover	9/18/22 17:55	79.004511	-150.03626	3826	
14	Optics	recover	9/18/22 17:58	79.005145	-150.03904		

14	VPR	deploy	9/18/22 18:07	79.007937	-150.03355	3826.1	w/o to 300 m but read -58 when at surface at end of cast
14	VPR	recover	9/18/22 18:34	79.008318	-150.03194	3826.1	
	Underway Seawater System	pointSample	9/18/22 19:22	79.077924	-150.03202		EDNA/ POM
	Underway Seawater System	pointSample	9/18/22 21:56	79.312499	-150.01311		7041
	Underway Seawater System	pointSample	9/18/22 23:01	79.420419	-149.96885		EDNA/ POM
15	CTD911	deploy	9/19/22 0:03	79.471842	-149.96514	3820	
15	Optics	deploy	9/19/22 0:51	79.473488	-149.97056		
15	CTD911	recover	9/19/22 0:53	79.473552	-149.97086	3821	
15	Optics	recover	9/19/22 0:58	79.4737	-149.97145		
15	VPR	deploy	9/19/22 1:10	79.474045	-149.97277	3877	w/o 300 m
15	VPR	recover	9/19/22 1:33	79.474565	-149.976	3877	
	Underway Seawater System	pointSample	9/19/22 3:50	79.671739	-150.04484		7042
	Underway Seawater System	pointSample	9/19/22 5:02	79.806185	-149.99073		7043
	Underway Seawater System	pointSample	9/19/22 5:31	79.860502	-150.00707		EDNA/ POM
	Underway Seawater System	pointSample	9/19/22 6:22	79.949223	-149.99813		7044
WPT42	XBT	release	9/19/22 6:58	79.995181	-149.98083	3328	XBT Fast Deep sn 036184
	Underway Seawater System	pointSample	9/19/22 9:02	80.174702	-150.04905		7045
	Underway Seawater System	pointSample	9/19/22 12:12	80.501944	-150.02707		7046
16	CTD911	deploy	9/19/22 16:20	80.837904	-149.98553	3684	3.5 Knudsen depth 3684, MB reading 3806 but has been sporadic in ice today.

	Underway Seawater System	other	9/19/22 17:59	80.843168	-150.03055		PSSW TSG reads higher temps than BioLab. Could be related to heater unit in passageway next to SSW intake piping. Will monitor trends now that heater is no longer blasting.
	Underway Seawater System	pointSample	9/19/22 18:48	80.846442	-150.05251		EDNA/ POM
16	CTD911	recover	9/19/22 19:31	80.849629	-150.0699	3796	
16	Optics	deploy	9/19/22 19:31	80.849629	-150.0699		
16	Optics	recover	9/19/22 19:36	80.850034	-150.07171		
16	Bongo Net	deploy	9/19/22 19:52	80.852039	-150.07677	3798	Tow depth 203 m
16	Bongo Net	deploy	9/19/22 20:08	80.853321	-150.0818	3798	
16	LargeVolumePump	deploy	9/19/22 20:30	80.855088	-150.08815		
16	LargeVolumePump	startSample	9/19/22 21:37	80.859997	-150.10487	3788.1	
	Underway Seawater System	pointSample	9/19/22 22:11	80.862505	-150.11208		EDNA/ POM
16	LargeVolumePump	stopSample	9/20/22 1:37	80.874988	-150.16038		
16	LargeVolumePump	recover	9/20/22 2:10	80.877022	-150.17069		
16	VPR	deploy	9/20/22 2:25	80.87792	-150.17573	3794	300 m w/o
16	VPR	recover	9/20/22 2:48	80.879196	-150.18352	3794	
16	multinet	deploy	9/20/22 3:09	80.880285	-150.19091	3795	Winch failed in the middle of the cast. Delayed retrieval by 45 minutes
	Underway Seawater System	pointSample	9/20/22 4:02	80.88304	-150.21174		EDNA/ POM
16	multinet	other	9/20/22 4:41	80.885287	-150.22929		aft 0.322 winch lost control at AftConn station on upcast and wire paid back out 11m in 1 minute before brake applied locally to winch. Troubleshooting the error.
16	multinet	recover	9/20/22 5:50	80.89009	-150.2626	3795	

16	Multicorer	deploy	9/20/22 8:15	80.903858	-150.32735	3801.5	
	Underway Seawater System	pointSample	9/20/22 16:40	81.045868	-149.99965		7047
	Underway Seawater System	pointSample	9/20/22 17:06	81.055616	-150.02446		EDNA/ POM
	Underway Seawater System	pointSample	9/20/22 22:03	81.077194	-150.18745		EDNA/ POM
	PCO2	stop	9/21/22 2:06	81.129446	-150.44621		stopped to reset equilibrator flow and N2 flow rate
	PCO2	start	9/21/22 2:35	81.167354	-150.29963		startup SOP completed and standards run
	Underway Seawater System	pointSample	9/21/22 3:59	81.260307	-150.13273		EDNA/ POM
	Underway Seawater System	pointSample	9/21/22 5:59	81.397613	-150.01477		7048
	Underway Seawater System	pointSample	9/21/22 6:59	81.492124	-150.18893		7049
WPT 46.5	XBT	release	9/21/22 7:12	81.497449	-150.19006	3533	XBT T5 sn 252164DOM
	Underway Seawater System	pointSample	9/21/22 9:07	81.618177	-150.19774		7050
	Underway Seawater System	pointSample	9/21/22 11:28	81.795008	-150.15169		7051
17	CTD911	deploy	9/21/22 15:38	81.951616	-149.87995	3257	start time from CTD cast sheet
17	Optics	deploy	9/21/22 18:18	81.959941	-149.93713		
17	CTD911	recover	9/21/22 18:21	81.960211	-149.93977	3257	time from CTD log sheet
17	Optics	recover	9/21/22 18:24	81.960452	-149.94317		
17	LargeVolumePump	deploy	9/21/22 18:55	81.963582	-149.96146		
	Underway Seawater System	pointSample	9/21/22 19:03	81.964698	-149.96593		EDNA/ POM
17	LargeVolumePump	startSample	9/21/22 19:34	81.96651	-149.97537	3189.9	
17	Bongo Net	deploy	9/21/22 20:00	81.968327	-149.98336	3203.8	Tow Depth 194 m
17	Bongo Net	recover	9/21/22 20:15	81.969369	-149.98724	3203.8	

	Underway Seawater System	pointSample	9/21/22 21:56	81.976502	-150.00725		EDNA/ POM
17	LargeVolumePump	stopSample	9/21/22 23:34	81.982735	-150.01971		
17	LargeVolumePump	recover	9/22/22 0:15	81.985088	-150.02456		
17	VPR	deploy	9/22/22 2:13	81.99024	-150.04092	3167	
17	VPR	recover	9/22/22 2:33	81.991025	-150.04445	3167	Approximate Time
17	multinet	deploy	9/22/22 2:51	81.991663	-150.04795	3168	
	Underway Seawater System	pointSample	9/22/22 4:05	81.994114	-150.06478		EDNA/ POM
17	multinet	recover	9/22/22 4:48	81.995572	-150.07583	3168	
	Underway Seawater System	pointSample	9/22/22 6:49	82.030649	-150.04699		7052
	Underway Seawater System	pointSample	9/22/22 8:05	82.157476	-150.03123		7053
	Underway Seawater System	pointSample	9/22/22 9:51	82.282187	-150.03697		7054
	Underway Seawater System	pointSample	9/22/22 12:15	82.428864	-150.03067		7027
	Underway Seawater System	pointSample	9/22/22 12:21	82.435868	-150.04872		7055
	XBT	release	9/22/22 13:06	82.495312	-150.04516	2928	XBT (T5) 349213 -- probe failed before terminal depth
	XBT	release	9/22/22 13:14	82.495485	-150.04587	2928	XBT (T5) 349220 -- probe failed before terminal depth
	XBT	release	9/22/22 13:24	82.495723	-150.04672	2928	XBT SN 036188
	Underway Seawater System	pointSample	9/22/22 14:39	82.563993	-149.99718		7056
	Underway Seawater System	pointSample	9/22/22 16:20	82.64785	-150.19765		EDNA/ POM
	Underway Seawater System	pointSample	9/22/22 17:06	82.698346	-150.10253		7057
18	CTD911	deploy	9/22/22 20:50	82.755703	-149.98178	2724	
18	CTD911	recover	9/22/22 21:58	82.758233	-149.98864	2724	

18	Optics	deploy	9/22/22 22:03	82.758383	-149.98895		
18	Optics	recover	9/22/22 22:09	82.758595	-149.98936		
	Underway Seawater System	pointSample	9/22/22 23:12	82.760612	-149.99292		EDNA/ POM
18	Multicorer	deploy	9/23/22 2:02	82.764278	-149.99782	2724.5	
	Underway Seawater System	pointSample	9/23/22 4:02	82.765497	-150.00696		EDNA/ POM
	XBT	release	9/23/22 11:10	83.25813	-150.0609	2831	XBT (T5) SN 349219
	Underway Seawater System	pointSample	9/23/22 12:09	83.278112	-150.18412		7059
19	CTD911	recover	9/23/22 15:30	83.311876	-149.80777	2948	Bottom of 3020 by multibeam when at depth
19	CTD911	deploy	9/23/22 15:35	83.311682	-149.80787	2948	bottom depth from 3.5 Khz
	Underway Seawater System	pointSample	9/23/22 16:58	83.308426	-149.81334		EDNA/ POM
19	Optics	deploy	9/23/22 18:07	83.30565	-149.82199		
19	Optics	recover	9/23/22 18:13	83.305404	-149.82283		
19	Bongo Net	deploy	9/23/22 20:15	83.300323	-149.83796	3043	Tow depth 200 m
19	Bongo Net	recover	9/23/22 20:29	83.299762	-149.83931	3043	
19	LargeVolumePump	deploy	9/23/22 20:30	83.299753	-149.83933		
19	LargeVolumePump	startSample	9/23/22 21:22	83.297786	-149.84241	3043.6	
	Underway Seawater System	pointSample	9/23/22 23:31	83.292655	-149.83704		EDNA/ POM
19	LargeVolumePump	stopSample	9/24/22 1:22	83.286336	-149.82563		
19	LargeVolumePump	recover	9/24/22 2:07	83.283268	-149.82078		
19	VPR	deploy	9/24/22 2:55	83.27949	-149.81439	3057	300 m w/o
19	VPR	recover	9/24/22 3:10	83.278202	-149.81213	3057	
19	multinet	deploy	9/24/22 3:33	83.276259	-149.8083	3062	Cast Depth 2000 m
	Underway Seawater System	pointSample	9/24/22 3:58	83.274116	-149.80406		EDNA/ POM

19	multinet	recover	9/24/22 5:41	83.26393	-149.78596	3062	
19	Multicorer	abort	9/24/22 9:23	83.224817	-149.70601	3053	Cast aborted due to ice floes threatening wire
	Underway Seawater System	pointSample	9/24/22 11:18	83.254062	-149.86019		7060
	Underway Seawater System	pointSample	9/24/22 14:12	83.419903	-150.00447		7061
	Underway Seawater System	pointSample	9/24/22 17:21	83.611232	-149.86847		7062
	Underway Seawater System	pointSample	9/24/22 17:32	83.620489	-149.82627		EDNA/ POM
	Underway Seawater System	pointSample	9/24/22 20:54	83.67498	-149.74121		7063
	Underway Seawater System	pointSample	9/24/22 21:57	83.741775	-149.46181		EDNA/ POM
	XBT	release	9/24/22 22:08	83.747535	-149.4258	2590	XBT SN 036507
	Underway Seawater System	pointSample	9/24/22 22:18	83.747564	-149.4167		7064
	Underway Seawater System	other	9/25/22 0:28	83.843432	-149.07117		Flow to PSSW dropped to 1.72 LPM due to pump VFD adjustment
	Underway Seawater System	other	9/25/22 0:41	83.857433	-149.00634		Flow rate to PSSW returned to 2.9 LPM
	Underway Seawater System	other	9/25/22 2:07	83.881331	-149.60728		SSW flow disrupted to energize ice separator pumps. Erratic spikes occurred over 30 min then stabilized.
	Underway Seawater System	pointSample	9/25/22 3:59	83.935521	-149.944		EDNA/ POM
	Underway Seawater System	pointSample	9/25/22 4:00	83.936539	-149.92928		7065
	Underway Seawater System	pointSample	9/25/22 6:57	84.0779	-149.96228		7066
	Underway Seawater System	pointSample	9/25/22 9:14	84.261131	-149.5217		7067
WPT 54.5	XCTD	deploy	9/25/22 9:22	84.264782	-149.52875	1963	sn21117952 - cut by ice at 125m

WPT							
54.5	XCTD	deploy	9/25/22 9:25	84.264642	-149.52879	1963	sn21117950 -lost coms at 400m
	Underway Seawater System	pointSample	9/25/22 11:24	84.425605	-149.18691		7068
	Underway Seawater System	pointSample	9/25/22 13:11	84.554761	-148.67158		7069
	Underway Seawater System	pointSample	9/25/22 15:18	84.749796	-148.28662		7070
	XBT	release	9/25/22 17:09	84.903331	-147.83268	3121	XBT SN 036192
	Underway Seawater System	pointSample	9/25/22 17:09	84.903331	-147.83268		7071
	Underway Seawater System	pointSample	9/25/22 18:15	84.941009	-148.68677		EDNA/ POM
	Underway Seawater System	pointSample	9/25/22 23:35	85.044077	-149.52249		EDNA/ POM
	Underway Seawater System	pointSample	9/26/22 0:34	85.098817	-149.8005		7072
	Underway Seawater System	stop	9/26/22 2:25	85.099335	-149.65902		Secured due to black water discharge overboard while stationary
	PCO2	stop	9/26/22 2:36	85.098416	-149.63501		stopped due to black water discharge that required SSW securing and flushing
	Underway Seawater System	start	9/26/22 2:50	85.10491	-149.49293		flow returned after 10 min of flushing overboard
	PCO2	start	9/26/22 3:55	85.168699	-149.39336		started after SSW flow returned
	Underway Seawater System	pointSample	9/26/22 5:12	85.165032	-149.27789		EDNA/ POM
	Underway Seawater System	pointSample	9/26/22 6:29	85.222003	-149.40807		7073
	Underway Seawater System	pointSample	9/26/22 10:04	85.335572	-149.20553		7074
	XCTD	deploy	9/26/22 16:33	85.501144	-148.24683	2406	XCTD SN 7951
	Underway Seawater System	pointSample	9/26/22 16:46	85.506514	-148.20999		7075

	Underway Seawater System	stop	9/26/22 18:40	85.621661	-148.19049		lost SSW flow and both water walls secured until we could bring pressure up and flush
	PCO2	stop	9/26/22 18:45	85.621985	-148.19053		sec'd until SSW flow stable
	Underway Seawater System	pointSample	9/26/22 18:49	85.621891	-148.18981		7076
	Underway Seawater System	pointSample	9/26/22 19:02	85.627248	-148.19459		EDNA/ POM
	Underway Seawater System	start	9/26/22 20:30	85.688959	-147.25518		Both water walls open. Flow still unstable but tracking pump speeds and adjusting as needed
	Underway Seawater System	pointSample	9/26/22 20:37	85.695437	-147.16501		Radium Ra-01
	PCO2	start	9/26/22 20:40	85.69927	-147.14766		system started after SSW flow return
	Underway Seawater System	pointSample	9/26/22 22:30	85.78252	-147.8017		7077
	Underway Seawater System	pointSample	9/27/22 0:57	85.902943	-147.63719		EDNA/ POM
20	CTD911	deploy	9/27/22 1:50	85.899134	-147.58394	2624	Short plus station 1000m
20	Optics	deploy	9/27/22 3:08	85.893929	-147.50827		
20	CTD911	recover	9/27/22 3:15	85.89341	-147.50073	2609	
20	Optics	recover	9/27/22 3:18	85.893265	-147.49858		
20	Bongo Net	deploy	9/27/22 3:49	85.891096	-147.46647	2606	Cast depth 201 m
20	Multicorer	abort	9/27/22 4:00	85.890444	-147.45521	2630	Cast aborted via Capt.
20	Bongo Net	recover	9/27/22 4:04	85.890212	-147.45129	2606	
	Underway Seawater System	pointSample	9/27/22 4:59	85.88929	-147.3792		EDNA/ POM
	Underway Seawater System	pointSample	9/27/22 8:40	85.97422	-147.49758		7078
	Underway Seawater System	pointSample	9/27/22 12:34	86.120891	-146.14149		7079
	Underway Seawater System	pointSample	9/27/22 17:15	86.186601	-145.79349		EDNA/ POM

Underway Seawater System	pointSample	9/27/22 21:14	86.283995	-145.3539		7080
Underway Seawater System	pointSample	9/27/22 21:41	86.304111	-144.8745		Radium Ra-02
Underway Seawater System	pointSample	9/27/22 21:59	86.309427	-144.84672		EDNA/ POM
XBT	release	9/28/22 1:16	86.414152	-144.33414	2926	XBT T5 SN 349222 Lost at 1000m
Underway Seawater System	pointSample	9/28/22 1:53	86.432437	-144.29581		7081
Underway Seawater System	pointSample	9/28/22 3:26	86.482493	-144.38093		EDNA/ POM
Underway Seawater System	pointSample	9/28/22 5:19	86.583838	-143.49274		7082
Underway Seawater System	pointSample	9/28/22 5:19	86.584241	-143.48836		7082
Underway Seawater System	pointSample	9/28/22 8:07	86.747247	-140.92341		7083
Underway Seawater System	pointSample	9/28/22 8:08	86.747469	-140.90873		7083
Underway Seawater System	pointSample	9/28/22 10:01	86.846474	-140.60835		7084
XCTD	deploy	9/28/22 12:16	86.913502	-140.4706	2691	XCTD SN 7953
Underway Seawater System	pointSample	9/28/22 12:17	86.914521	-140.46521		7085
Underway Seawater System	pointSample	9/28/22 16:45	87.073133	-139.40359		7086
Underway Seawater System	pointSample	9/28/22 20:00	87.186399	-142.58409		7087
Underway Seawater System	pointSample	9/28/22 20:24	87.188914	-143.3588		Radium Ra-03
Underway Seawater System	pointSample	9/28/22 22:51	87.286192	-143.1354		7088
Underway Seawater System	pointSample	9/28/22 23:31	87.334285	-142.47715		EDNA/ POM
XBT	release	9/29/22 1:49	87.426409	-142.75145	3445	XBT T5 SN 349221 Data suspect due to presence of slush

	XBT	release	9/29/22 1:57	87.426792	-142.74477	3445	XBT T5 352163
	Underway Seawater System	pointSample	9/29/22 2:07	87.429011	-142.73915		7089
	Underway Seawater System	pointSample	9/29/22 4:26	87.645828	-142.14248		EDNA/ POM
	Underway Seawater System	pointSample	9/29/22 5:00	87.682691	-141.93594		7090
	Underway Seawater System	pointSample	9/29/22 9:42	87.774374	-141.91976		7091
	XCTD	deploy	9/29/22 11:53	87.895429	-141.34297	3466	XCTD SN 7954
	Underway Seawater System	pointSample	9/29/22 11:54	87.896154	-141.31663		7092
	Underway Seawater System	pointSample	9/29/22 14:06	88.117667	-135.14788		7093
	Underway Seawater System	pointSample	9/29/22 17:36	88.289708	-131.38308		EDNA/ POM
	Underway Seawater System	pointSample	9/29/22 18:46	88.35019	-128.79995		7094
	XBT	release	9/29/22 19:10	88.368487	-128.61052	3568	XBT 036187
	Underway Seawater System	pointSample	9/29/22 21:00	88.526619	-126.24878		7095
	Underway Seawater System	pointSample	9/29/22 21:30	88.593216	-126.04071		Radium Ra-04
	Underway Seawater System	pointSample	9/29/22 22:29	88.705798	-126.53476		7096
	Underway Seawater System	pointSample	9/29/22 23:04	88.757947	-128.37416		EDNA/ POM
	Underway Seawater System	pointSample	9/30/22 0:22	88.869216	-131.93238		7097
	Underway Seawater System	pointSample	9/30/22 0:22	88.869216	-131.93238		7097
88 53.73	XCTD	deploy	9/30/22 0:31	88.883975	-132.18499	4470	XCTD sn 1N21117955
	Underway Seawater System	service	9/30/22 1:50	88.991501	-135.30764		Bio Lab system taken down for cleaning

	Underway Seawater System	pointSample	9/30/22 2:03	89.013669	-135.30382		7098
	Underway Seawater System	pointSample	9/30/22 3:23	89.138663	-141.98038		EDNA/ POM
89 deg 9'	XCTD	deploy	9/30/22 3:33	89.146963	-142.02669	4504	XCTD sn 1N21117956
	Underway Seawater System	pointSample	9/30/22 4:42	89.188847	-143.09335		7099
	Underway Seawater System	pointSample	9/30/22 4:42	89.188847	-143.09335		7099
	Underway Seawater System	pointSample	9/30/22 7:46	89.324326	-144.82005		7100
	Underway Seawater System	pointSample	9/30/22 7:48	89.326361	-144.80828		7100
"89 23' "	XCTD	deploy	9/30/22 10:11	89.37487	-145.90445	3681	XCTD sn 1N21117957
	Underway Seawater System	pointSample	9/30/22 13:58	89.529792	-147.97819		7101
	Underway Seawater System	pointSample	9/30/22 16:38	89.671938	-142.42695		7102
	XBT	release	9/30/22 17:29	89.683617	-143.40405	4904	XBT T5 349233
	Underway Seawater System	pointSample	9/30/22 17:36	89.683692	-143.37421		EDNA/ POM
	Underway Seawater System	pointSample	9/30/22 18:36	89.731716	-153.07469		Radium Ra-05
	Underway Seawater System	pointSample	9/30/22 19:56	89.824818	-144.47798		7103
	Underway Seawater System	stop	9/30/22 20:10	89.845456	-142.80966		secured for sewage pumping
	PCO2	stop	9/30/22 20:12	89.849185	-142.65381		Secured when science seawater was secured. No samples run.
	Underway Seawater System	pointSample	9/30/22 23:07	89.995542	46.109408		EDNA/ POM
21	CTD911	deploy	10/1/22 0:11	89.988215	45.660583	4102	North Pole long station
21	Optics	deploy	10/1/22 3:58	89.963786	43.67405		

21	CTD911	recover	10/1/22 4:01	89.963493	43.702714	4240	
21	multinet	deploy	10/1/22 4:04	89.963238	43.727846	4242	North Pole, Very cold
21	Optics	recover	10/1/22 4:07	89.96298	43.775276		
21	multinet	recover	10/1/22 6:50	89.949181	46.819078	4242	
21	VPR	deploy	10/1/22 7:05	89.947816	47.175975	4249	North Pole
21	VPR	recover	10/1/22 7:35	89.945118	47.860542	4249	
21	Bongo Net	deploy	10/1/22 7:40	89.944631	47.971684	4245	North Pole!
21	Bongo Net	recover	10/1/22 7:54	89.943297	48.282028	4245	
	Underway Seawater System	pointSample	10/1/22 16:45	89.951356	57.151741		7104
	Underway Seawater System	pointSample	10/1/22 17:12	89.987263	37.967841		EDNA/ POM
21	LargeVolumePump	deploy	10/1/22 18:59	89.946919	-92.33361		
21	LargeVolumePump	startSample	10/1/22 19:45	89.950187	-92.376878	4228.2	
	Underway Seawater System	pointSample	10/1/22 22:47	89.96507	-86.179307		EDNA/ POM
21	LargeVolumePump	stopSample	10/1/22 23:45	89.968922	-80.269653		
21	LargeVolumePump	recover	10/2/22 0:30	89.97108	-74.461992		
21	Multicorer	deploy	10/2/22 2:48	89.974491	-53.444959	4237.3	North Pole Station
	Underway Seawater System	pointSample	10/2/22 5:30	89.979555	-43.656515		EDNA/ POM
	Underway Seawater System	pointSample	10/3/22 4:21	89.770355	143.274519		EDNA/ POM
	Underway Seawater System	pointSample	10/3/22 7:11	89.629812	161.020064		7105
	Underway Seawater System	pointSample	10/3/22 9:33	89.461541	167.7779		7106
	Underway Seawater System	pointSample	10/3/22 11:29	89.317478	172.355218		7107
	Underway Seawater System	pointSample	10/3/22 17:28	89.174522	159.7716		7108

	Underway Seawater System	pointSample	10/3/22 20:27	89.137403	162.007637		Radium Ra-06
	Underway Seawater System	pointSample	10/3/22 22:45	89.062266	163.014742		EDNA/ POM
	Underway Seawater System	pointSample	10/4/22 2:47	88.841629	168.485751		7109
	Underway Seawater System	pointSample	10/4/22 4:47	88.660076	173.207275		EDNA/ POM
	Underway Seawater System	pointSample	10/4/22 4:56	88.643266	173.136406		7110
	Underway Seawater System	pointSample	10/4/22 6:08	88.503278	176.247769		7111
	Underway Seawater System	pointSample	10/4/22 8:36	88.326969	178.536888		7112
	Underway Seawater System	pointSample	10/4/22 10:13	88.144137	177.179991		7113
	Underway Seawater System	pointSample	10/4/22 13:28	87.947292	179.504521		7114
22	CTD911	deploy	10/4/22 15:41	87.953292	179.291855	3921	
	Underway Seawater System	pointSample	10/4/22 17:43	87.955601	179.14022		EDNA/ POM
	Underway Seawater System	pointSample	10/4/22 18:11	87.955979	179.08935		Radium Ra-07
22	Optics	deploy	10/4/22 19:02	87.956701	178.981998		
22	CTD911	recover	10/4/22 19:04	87.956748	178.975774	3921	
22	Optics	recover	10/4/22 19:09	87.956828	178.965617		
22	Bongo Net	deploy	10/4/22 19:35	87.957322	178.90263	3938	Cast Depth 200 m
22	Bongo Net	recover	10/4/22 19:51	87.957703	178.865602	3938	
22	LargeVolumePump	deploy	10/4/22 20:00	87.957933	178.845408		
22	LargeVolumePump	startSample	10/4/22 20:50	87.959504	178.736259	4184.7	
	Underway Seawater System	pointSample	10/4/22 22:29	87.963925	178.538436		EDNA/ POM
22	LargeVolumePump	stopSample	10/5/22 0:51	87.972187	178.322202		

22	LargeVolumePump	recover	10/5/22 1:25	87.974003	178.288526		
22	VPR	deploy	10/5/22 1:27	87.974133	178.286209	3949	cast depth 300 m
22	VPR	recover	10/5/22 1:47	87.975087	178.268026	3949	
22	multinet	deploy	10/5/22 2:03	87.975752	178.254115	4188	cast de[tj 2000
	Underway Seawater System	pointSample	10/5/22 3:59	87.978163	178.143876		EDNA/ POM
22	multinet	recover	10/5/22 3:59	87.978163	178.143284	4188	
22	Multicorer	deploy	10/5/22 6:42	87.976249	177.819428	3943	CBL12
	Underway Seawater System	pointSample	10/5/22 12:44	87.792562	178.348935		7115
	XBT	release	10/5/22 15:04	87.459669	179.996108	4159	xbt 329229 failed
	XBT	release	10/5/22 15:13	87.450474	179.905964	4089	349225
	Underway Seawater System	pointSample	10/5/22 15:13	87.450332	179.906464		7116
	Underway Seawater System	pointSample	10/5/22 17:24	87.251861	-179.69022		7117
	Underway Seawater System	pointSample	10/5/22 17:38	87.23114	-179.62558		EDNA/ POM
	Underway Seawater System	pointSample	10/5/22 20:21	87.076298	-179.57037		7118
23	CTD911	deploy	10/5/22 20:56	87.078231	-179.43722	3915	Test for sensors possible freeze yesterday.
	Underway Seawater System	pointSample	10/5/22 22:37	87.082995	-179.44466		EDNA/ POM
23	Optics	deploy	10/5/22 23:14	87.085133	-179.44311		
23	CTD911	recover	10/5/22 23:14	87.085163	-179.44316	3922	Wire out = 10m @ surface
23	Optics	recover	10/5/22 23:29	87.086041	-179.44299		
	Underway Seawater System	pointSample	10/6/22 3:07	86.803931	178.875169		7119
	PCO2	stop	10/6/22 3:25	86.803094	178.842898		Shutdown and standards run due to SSW being off.

	Underway Seawater System	stop	10/6/22 3:25	86.803322	178.847903		Secured due to iced overboarding piping, which caused vent in BioLab to burst. Both water walls of sensors flushed with Potable.
	XBT	release	10/6/22 7:55	86.495808	175.105757	2881	Xbt T5 349228
	XCTD	deploy	10/6/22 22:25	86.005985	169.408646	3577	XCTD 1N21117959
	XBT	release	10/7/22 3:03	85.644371	172.969135	3537	XBT T5 349234 bad data at 100m
	XBT	release	10/7/22 3:09	85.642681	172.994613	3017	XBT T5 349230 bad data at 440m
	XBT	release	10/7/22 3:13	85.637543	173.0302	3699	XBT T5 349226 lost coms at 160m
	XBT	release	10/7/22 3:24	85.625592	173.100753	3292	XBT T5 349235 bad data at 100m
	XBT	release	10/7/22 8:39	85.33915	172.69192	349231	XBT T5 349231 suspect data below ~750m
24	CTD911	deploy	10/7/22 15:40	85.118021	170.930423	3150	Fast cast. Poor wx.
24	CTD911	recover	10/7/22 16:25	85.117144	170.837883	3150	
	Underway Seawater System	pointSample	10/7/22 19:53	84.853943	174.239724		7120
	XBT	release	10/7/22 21:13	84.742517	174.90741	3173	SN 349232
	XBT	release	10/7/22 21:22	84.742329	174.94176	2939	T5 SN 349236
	Underway Seawater System	pointSample	10/7/22 22:44	84.626754	175.523724		EDNA/ POM
	XBT	release	10/8/22 1:08	84.372612	177.125439	3038	XBT T5 350085
	Underway Seawater System	pointSample	10/8/22 2:26	84.213447	177.868614		Radium Ra-08
	Underway Seawater System	pointSample	10/8/22 3:54	84.083776	178.459552		EDNA/ POM
	Underway Seawater System	pointSample	10/8/22 4:03	84.06926	178.450925		7121
	Underway Seawater System	pointSample	10/8/22 13:52	84.019628	177.959886		7122
25	CTD911	deploy	10/8/22 16:15	84.013853	177.823269	2446	

	Underway Seawater System	pointSample	10/8/22 17:16	84.012715	177.786537		EDNA/ POM
25	CTD911	recover	10/8/22 18:36	84.011354	177.722053	2462	
25	multinet	deploy	10/8/22 19:43	84.011038	177.666856	2467	Cast Depth 2000 m
25	multinet	recover	10/8/22 21:55	84.01208	177.572955	2467	
25	Optics	deploy	10/8/22 22:08	84.012242	177.565665		
25	Optics	recover	10/8/22 22:18	84.012398	177.560256		
25	LargeVolumePump	deploy	10/8/22 22:20	84.012438	177.559064		
25	LargeVolumePump	startSample	10/8/22 23:05	84.013366	177.537956	2450.6	
	Underway Seawater System	pointSample	10/8/22 23:18	84.013709	177.532995		EDNA/ POM
25	LargeVolumePump	stopSample	10/9/22 3:05	84.020404	177.520262		
25	LargeVolumePump	recover	10/9/22 3:36	84.021357	177.528443		
25	VPR	deploy	10/9/22 3:36	84.021367	177.528489	2476	Cast Depth 300 m
25	VPR	recover	10/9/22 3:59	84.02216	177.535552	2476	
25	Bongo Net	deploy	10/9/22 4:08	84.022432	177.538491	2478	Cast Depth 205 m
25	Bongo Net	recover	10/9/22 4:23	84.022857	177.545413	2478	
	Underway Seawater System	pointSample	10/9/22 4:46	84.023523	177.559726		EDNA/ POM
25	Multicorer	deploy	10/9/22 5:57	84.02555	177.605616	2499	CBL15
	Underway Seawater System	pointSample	10/9/22 12:26	83.693616	177.567141		7123
	XBT	release	10/9/22 12:41	83.667862	177.620437	2891	XBT T5 SN 350081
	Underway Seawater System	pointSample	10/9/22 14:29	83.509853	177.773796		7124
	XBT	release	10/9/22 16:22	83.343346	177.762992	2633	XBT T5 SN 350077
	Underway Seawater System	pointSample	10/9/22 16:33	83.329103	177.722461		7125
	Underway Seawater System	pointSample	10/9/22 17:38	83.270142	177.526119		EDNA/ POM

	Underway Seawater System	pointSample	10/9/22 21:42	83.161606	177.12382		7126
	Underway Seawater System	pointSample	10/9/22 22:57	83.163461	177.081451		EDNA/ POM
26	CTD911	deploy	10/9/22 23:06	83.163768	177.075699	1754	Short station 700m
26	Optics	deploy	10/10/22 0:07	83.16687	177.027004		
26	CTD911	recover	10/10/22 0:14	83.167259	177.021317	1769	
26	Optics	recover	10/10/22 0:18	83.16744	177.018627		
	Underway Seawater System	pointSample	10/10/22 0:39	83.160483	176.985187		Radium Ra-09
	Underway Seawater System	pointSample	10/10/22 2:37	83.013487	177.702306		7127
	Underway Seawater System	pointSample	10/10/22 5:10	82.751684	178.259077		EDNA/ POM
	Underway Seawater System	pointSample	10/10/22 5:36	82.696581	178.302555		7128
	XBT	release	10/10/22 6:05	82.651761	178.367486	2410	XBT T5 350082 Good until 1600m time of drop 05:50:16 bad GPS at time of drop
	Underway Seawater System	pointSample	10/10/22 8:22	82.441409	179.088421		7219
	XBT	release	10/10/22 9:23	82.34002	179.042561	2319	XBT T5 350086 Bad data repeated cast
	XBT	release	10/10/22 9:35	82.334691	179.035358	2298	XBT T5 350078 Lost connection at 1000m
	Underway Seawater System	pointSample	10/10/22 10:53	82.225196	179.034244		7130
	Underway Seawater System	pointSample	10/10/22 14:09	82.036489	179.034304		7131
27	CTD911	deploy	10/10/22 15:42	82.039679	178.956547	2285	
27	CTD911	recover	10/10/22 17:56	82.037644	178.880722	2285	
	Underway Seawater System	pointSample	10/10/22 18:12	82.036894	178.868291		EDNA/ POM

27	multinet	deploy	10/10/22 18:13	82.036872	178.867904	2268	Cast Depth 2000 m
27	multinet	recover	10/10/22 20:20	82.035288	178.723884	2268	
27	VPR	deploy	10/10/22 20:31	82.035643	178.709983	2207	Cast Depth 310
27	VPR	recover	10/10/22 20:54	82.036755	178.679539	2207	
27	Optics	deploy	10/10/22 20:55	82.036814	178.678217		
27	Optics	recover	10/10/22 21:06	82.037517	178.6637		
27	LargeVolumePump	deploy	10/10/22 21:10	82.037786	178.658649		
27	LargeVolumePump	startSample	10/10/22 21:55	82.041565	178.601054	2206.2	
	Underway Seawater System	pointSample	10/11/22 0:00	82.056661	178.48569		EDNA/ POM
27	LargeVolumePump	stopSample	10/11/22 1:55	82.067756	178.471691		
27	LargeVolumePump	recover	10/11/22 2:30	82.069614	178.478595		
27	Bongo Net	deploy	10/11/22 2:31	82.069651	178.478856	2295	Cast Depth 200 m
27	Bongo Net	recover	10/11/22 2:46	82.070204	178.482701	2295	
27	Drifter	deploy	10/11/22 3:44	82.070891	178.496551	2307	Ice Ball 0070 deployed on ice
27	Multicorer	deploy	10/11/22 4:08	82.07044	178.500997	2358	CBL17
	Underway Seawater System	pointSample	10/11/22 6:02	82.063794	178.494379		EDNA/ POM
	Underway Seawater System	pointSample	10/11/22 9:30	81.842184	178.859569		7132
	Underway Seawater System	pointSample	10/11/22 10:55	81.705201	179.136849		7133
	XBT	release	10/11/22 11:14	81.672275	179.21288	2699	XBT T5 SN 350079
	Underway Seawater System	pointSample	10/11/22 12:41	81.524464	179.493014		7134
	Underway Seawater System	pointSample	10/11/22 14:18	81.322623	179.797838		7135
	XBT	release	10/11/22 14:29	81.3013	179.849737	2192	XBT T5 SN 350083 (lost it at 250m)
	XBT	release	10/11/22 14:34	81.296254	179.847482	2192	XBT T5 SN 350080

	Underway Seawater System	pointSample	10/11/22 15:50	81.147003	179.970269		7136
	XBT	release	10/11/22 17:27	80.987133	-179.59848	1582	XBT T5 SN 350087
	XBT	release	10/11/22 17:30	80.984607	-179.59541	2962	XBT Fast Deep SN 036191
	Underway Seawater System	pointSample	10/11/22 18:23	80.891438	-179.65687		7137
	Underway Seawater System	pointSample	10/11/22 18:41	80.857938	-179.62964		EDNA/ POM
28	CTD911	deploy	10/11/22 20:35	80.808611	-179.80987	1714	
28	Optics	deploy	10/11/22 21:32	80.809899	-179.84962		
28	CTD911	recover	10/11/22 21:40	80.810333	-179.85447	1719	
28	Optics	recover	10/11/22 21:41	80.810392	-179.85506		
	Underway Seawater System	pointSample	10/11/22 23:41	80.636655	-179.44964		7138
	XBT	release	10/11/22 23:55	80.613551	-179.4982	1804	XBT T5 350084
	Underway Seawater System	pointSample	10/12/22 0:03	80.609429	-179.5428		EDNA/ POM
	Underway Seawater System	pointSample	10/12/22 1:09	80.477795	-179.50265		7139
	Underway Seawater System	pointSample	10/12/22 2:42	80.310134	-179.21153		7140
	XBT	release	10/12/22 3:07	80.280244	-179.09682	1518	XBT T5 350088
	Underway Seawater System	other	10/12/22 3:59	80.201781	-178.84009		low flow below 2.0 LPM on PSSW 0400-0730
	Underway Seawater System	pointSample	10/12/22 4:43	80.123905	-178.71249		7141
	XCTD	deploy	10/12/22 5:51	80.001677	-178.58554	1745	1N21117958 Bad data
	XBT	release	10/12/22 6:08	80.002186	-178.57254	1745	XBT Deep Blue 1179152 Good to 500m
	Underway Seawater System	pointSample	10/12/22 6:43	79.965278	-178.4729		7142
	Underway Seawater System	pointSample	10/12/22 7:14	79.960535	-178.43569		EDNA/ POM

	Underway Seawater System	pointSample	10/12/22 8:52	79.809166	-178.38052		7143
	XBT	release	10/12/22 10:13	79.664534	-178.35093	1661	XBT T5 352168
	Underway Seawater System	pointSample	10/12/22 10:38	79.618825	-178.38493		7144
	Underway Seawater System	pointSample	10/12/22 14:02	79.489082	-178.56646		7145
29	CTD911	deploy	10/12/22 15:41	79.493117	-178.61472	1397	
29	CTD911	recover	10/12/22 17:34	79.50022	-178.60985	1427	
29	multinet	deploy	10/12/22 17:56	79.501076	-178.60176	1433	Cast depth 1300.8
29	multinet	recover	10/12/22 19:29	79.499402	-178.55341	1433	
29	VPR	deploy	10/12/22 19:44	79.498243	-178.54556	1417.6	Cast Depth 300 m
29	VPR	recover	10/12/22 20:06	79.496078	-178.53455	1417.6	
29	Optics	deploy	10/12/22 20:09	79.495761	-178.53318		
29	Optics	recover	10/12/22 20:17	79.494863	-178.52972		
29	LargeVolumePump	deploy	10/12/22 20:19	79.494634	-178.52888		
29	LargeVolumePump	startSample	10/12/22 21:08	79.488126	-178.51238	1423.9	
	Underway Seawater System	pointSample	10/12/22 22:56	79.471567	-178.51783		EDNA/ POM
29	LargeVolumePump	stopSample	10/13/22 1:08	79.458729	-178.58983		
29	LargeVolumePump	recover	10/13/22 1:30	79.458021	-178.60381		
29	Bongo Net	deploy	10/13/22 1:42	79.457826	-178.61154	1253.7	Cast Depth 197.8
29	Bongo Net	recover	10/13/22 1:56	79.457772	-178.61998	1253.7	
29	Multicorer	deploy	10/13/22 2:58	79.459572	-178.65099	1232	CBL19
	Underway Seawater System	pointSample	10/13/22 5:56	79.430761	-178.7313		EDNA/ POM
	Underway Seawater System	other	10/13/22 6:04	79.422981	-178.73991		periods of low flow below 2.0 LPM on PSSW 0600-1300
	Underway Seawater System	pointSample	10/13/22 7:49	79.315697	-178.6642		7146

	XBT	release	10/13/22 9:36	79.163078	-178.67845	1813	XBT T5 352176 good data until about 550m
	XBT	release	10/13/22 9:41	79.158859	-178.66516	1814	XBT T5 353172 bad data at 250m
	Underway Seawater System	pointSample	10/13/22 9:56	79.136996	-178.62275		7147
	Underway Seawater System	pointSample	10/13/22 12:39	78.978037	-178.52276		7148
	Underway Seawater System	pointSample	10/13/22 14:23	78.809433	-178.36226		7149
	XBT	release	10/13/22 14:39	78.79275	-178.33438	1054	XBT Fast Deep SN 036185
	Underway Seawater System	pointSample	10/13/22 16:27	78.614415	-178.16294		7150
	XBT	release	10/13/22 17:21	78.49383	-178.10221	1603	XBT T5 SN 352175
	Underway Seawater System	pointSample	10/13/22 17:32	78.480662	-178.0669		EDNA/ POM
	Underway Seawater System	pointSample	10/13/22 17:53	78.453187	-177.85415		7151
30	CTD911	deploy	10/13/22 20:03	78.426294	-177.82171	1426	
30	Optics	deploy	10/13/22 20:52	78.419757	-177.81258		
30	CTD911	recover	10/13/22 20:59	78.418936	-177.81166	1430	
30	Optics	recover	10/13/22 21:02	78.418449	-177.81114		
	Underway Seawater System	pointSample	10/13/22 22:49	78.230093	-177.68517		EDNA/ POM
	Underway Seawater System	pointSample	10/13/22 22:54	78.218726	-177.67654		7152
	Underway Seawater System	other	10/14/22 0:00	78.123353	-177.41391		periods of low PSSW flow below 2.0 LPM 0000-1520
	Underway Seawater System	pointSample	10/14/22 0:32	78.088496	-177.17251		7153
	XBT	release	10/14/22 1:34	78.012642	-176.72298	1158	XBT T5 352174 Bad data
	XBT	release	10/14/22 1:39	78.010536	-176.72625	1158	XBT T5 352171 Bad data
	XBT	release	10/14/22 1:42	78.010315	-176.72478	1162	XBT Fast Deep 036190 Bad data

	XBT	release	10/14/22 1:47	78.009342	-176.72405	1168	XBT T5 352167 Good to 800m
	Underway Seawater System	pointSample	10/14/22 3:19	77.908912	-176.24028		7154
	Underway Seawater System	service	10/14/22 3:50	77.862102	-176.11377		PSSW secured for cleaning 0350-0402
	Underway Seawater System	pointSample	10/14/22 4:47	77.776081	-175.92078		EDNA/ POM
	Underway Seawater System	pointSample	10/14/22 5:18	77.730041	-175.9543		7155
	XBT	release	10/14/22 5:55	77.677119	-175.91678	1345	XBT T5 352166 Bad data
	XBT	release	10/14/22 6:05	77.674657	-175.91827	1345	XBT T5 352165 Good to 900m
	Underway Seawater System	pointSample	10/14/22 7:35	77.54415	-175.95815		7156
	Underway Seawater System	pointSample	10/14/22 8:38	77.41516	-176.05959		7157
	XBT	release	10/14/22 9:16	77.338689	-176.0602	1226	XBT T5 352170 Good to 600m
	Underway Seawater System	pointSample	10/14/22 10:02	77.249086	-176.05778		7158
	Underway Seawater System	pointSample	10/14/22 11:35	77.0601	-175.93046		7159
31	CTD911	deploy	10/14/22 15:37	77.073985	-175.82064	1734	
31	CTD911	recover	10/14/22 17:37	77.069	-175.77234	1773	
31	multinet	deploy	10/14/22 18:03	77.066941	-175.76863	1778	Cast Depth 1725
31	multinet	recover	10/14/22 19:45	77.059658	-175.78155	1778	
31	VPR	deploy	10/14/22 19:58	77.058971	-175.7858	1773	Cast Depth 300 m
31	VPR	recover	10/14/22 20:20	77.058049	-175.7942	1773	
31	Optics	deploy	10/14/22 20:24	77.057976	-175.79633		
31	Optics	recover	10/14/22 20:31	77.057816	-175.79991		
31	LargeVolumePump	deploy	10/14/22 20:50	77.057252	-175.80723		
31	LargeVolumePump	startSample	10/14/22 21:25	77.056931	-175.82254	1739.9	
	Underway Seawater System	pointSample	10/15/22 0:04	77.067388	-175.87359		EDNA/ POM

	Underway Seawater System	other	10/15/22 0:14	77.068431	-175.87428		periods of low flow under 2.5 LPM off and on all day - 0014-2100
31	LargeVolumePump	stopSample	10/15/22 1:25	77.075722	-175.86771		
31	LargeVolumePump	recover	10/15/22 1:46	77.077576	-175.8628		
31	Bongo Net	deploy	10/15/22 2:01	77.078916	-175.85994	1702	Cast Depth 200 m
31	Bongo Net	recover	10/15/22 2:15	77.079785	-175.85416	1702	
31	Multicorer	deploy	10/15/22 3:22	77.082783	-175.8316	1720.3	CBL21
	Underway Seawater System	pointSample	10/15/22 5:09	77.082596	-175.80417		EDNA/ POM
	Underway Seawater System	pointSample	10/15/22 8:13	76.908599	-174.81195		7160
	Underway Seawater System	pointSample	10/15/22 10:35	76.736739	-173.51649		7161
	XBT	release	10/15/22 10:54	76.715227	-173.34853	2522	XBT T5 SN 352169 Bad at ~200m
	XBT	release	10/15/22 10:58	76.713545	-173.33452	2522	XBT T5 SN 352173 Bad at ~500m
	Underway Seawater System	pointSample	10/15/22 12:59	76.584274	-172.34529		7162
	Underway Seawater System	pointSample	10/15/22 14:45	76.438712	-171.63281		7163
	XBT	release	10/15/22 15:45	76.34527	-171.3293	2140	XBT T5 352140
	XBT	release	10/15/22 15:48	76.34404	-171.32946	2134	XBT T5 352134
	Underway Seawater System	pointSample	10/15/22 17:34	76.146253	-171.03464		EDNA/ POM
	XCTD	deploy	10/15/22 18:24	76.057385	-170.82067	1750	XCTD SN 1N21117960
	Underway Seawater System	pointSample	10/15/22 18:46	76.03376	-170.75246		7164
	Underway Seawater System	pointSample	10/15/22 19:46	75.912993	-170.44724		7165
	Underway Seawater System	pointSample	10/15/22 21:04	75.746638	-169.98468		7166
	XBT	release	10/15/22 21:43	75.669471	-169.69188	548	XBT Deep Blue SN 1179142

	Underway Seawater System	service	10/15/22 21:51	75.662154	-169.6233		PSSW secured to replace valve and fittings 2152-2252
	Underway Seawater System	pointSample	10/15/22 22:15	75.581324	-169.41394		7167
	Underway Seawater System	pointSample	10/15/22 23:05	75.402029	-168.96478		EDNA/ POM
	Underway Seawater System	pointSample	10/15/22 23:07	75.394871	-168.94671		7168
	XBT	release	10/15/22 23:30	75.326156	-168.76779	218	XBT Deep Blue 1179151 hit bottom
	Underway Seawater System	pointSample	10/15/22 23:52	75.254961	-168.59343		7169
	Underway Seawater System	pointSample	10/16/22 0:39	75.084928	-168.19235		7170
32	CTD911	deploy	10/16/22 1:35	75.006226	-167.96496	167	
32	Optics	deploy	10/16/22 2:02	75.006525	-167.96944		
32	CTD911	recover	10/16/22 2:06	75.00654	-167.97082	165	
32	Optics	recover	10/16/22 2:11	75.006522	-167.97312		
32	LargeVolumePump	deploy	10/16/22 2:30	75.008329	-167.97283		
32	LargeVolumePump	startSample	10/16/22 2:45	75.008195	-167.96761	164	2 pumps for 2 hours
	Underway Seawater System	service	10/16/22 3:03	75.008012	-167.96148		PSSW secured for cleaning 0304-0317
32	LargeVolumePump	stopSample	10/16/22 4:45	75.008552	-167.92444		
32	LargeVolumePump	recover	10/16/22 4:59	75.00829	-167.91991		
32	VPR	deploy	10/16/22 5:09	75.008263	-167.91774	176	Cast Depth 158
	Underway Seawater System	pointSample	10/16/22 5:15	75.008323	-167.91637		EDNA/ POM
32	VPR	deploy	10/16/22 5:18	75.00843	-167.9155	176	
32	Bongo Net	deploy	10/16/22 5:20	75.008515	-167.9148	161	Cast Depth 148 m
32	Bongo Net	recover	10/16/22 5:39	75.008564	-167.90941	161	
32	Van Veen Grab	deploy	10/16/22 5:52	75.008318	-167.90554	162.6	CBL22

32	Van Veen Grab	deploy	10/16/22 6:04	75.007789	-167.90336	169.4	CBL22
32	Van Veen Grab	deploy	10/16/22 6:16	75.007298	-167.90059	172.2	CBL22
32	Van Veen Grab	deploy	10/16/22 6:29	75.00628	-167.89477	167.4	CBL22
32	HAPS Corer	deploy	10/16/22 6:45	75.005551	-167.88799	168.9	CBL22
32	Multicorer	deploy	10/16/22 7:19	75.005268	-167.876	171.9	CBL22
	Underway Seawater System	pointSample	10/16/22 9:55	74.815186	-167.98721		7171
	XBT	release	10/16/22 10:49	74.681667	-167.95904	262	XBT Deep Blue SN 1179143
	Underway Seawater System	pointSample	10/16/22 11:02	74.649519	-167.94985		7172
	Underway Seawater System	pointSample	10/16/22 12:02	74.502938	-167.90853		7173
	Underway Seawater System	pointSample	10/16/22 13:07	74.349316	-167.8656		7174
	XBT	release	10/16/22 13:11	74.341073	-167.86327	258	XBT Deep Blue SN 1179147
	Underway Seawater System	pointSample	10/16/22 14:07	74.186948	-167.82056		7175
	Underway Seawater System	pointSample	10/16/22 15:11	74.009258	-167.77173		7176
	XBT	release	10/16/22 15:12	74.005764	-167.77073	207	XBT Depp Blue SN 1179144
	Underway Seawater System	pointSample	10/16/22 16:37	73.784198	-167.71078		7177
	XBT	release	10/16/22 17:40	73.690052	-167.217	155	XBT Deep Blue SN 1179148
	Underway Seawater System	pointSample	10/16/22 18:19	73.643947	-166.86027		7178
	XBT	release	10/16/22 19:59	73.55195	-165.95389	104	XBT Deep Blue SN 1179145
	Underway Seawater System	pointSample	10/16/22 20:20	73.592665	-165.80531		7179
	XBT	release	10/16/22 20:53	73.666395	-165.61048	124	Deep blue 1179149
	Underway Seawater System	pointSample	10/16/22 21:53	73.802708	-165.24737		7180
	XBT	release	10/16/22 22:45	73.907925	-164.96515	170.7	352139 T5

	Underway Seawater System	pointSample	10/16/22 23:31	74.005303	-164.70222		7181
	XBT	release	10/16/22 23:48	74.041018	-164.60533	238	XBT Deep Blue 1178986
	XBT	release	10/17/22 0:45	74.161246	-164.27806	290	XBT Deep Blue 1178990 bad data at 100m
	XBT	release	10/17/22 0:48	74.166937	-164.26242	292	XBT Deep Blue 1178994 no data at launch
	XBT	release	10/17/22 0:51	74.173198	-164.24533	304	XBT Deep Blue 1178987
	Underway Seawater System	pointSample	10/17/22 1:13	74.22023	-164.11654		7182
	XBT	release	10/17/22 1:42	74.27991	-163.95255	390	XBT Deep Blue 1178991 Good to 300m
	XBT	release	10/17/22 2:44	74.405169	-163.60632	803	XBT T5 352138
	Underway Seawater System	pointSample	10/17/22 3:50	74.511207	-163.15268		7187
	Underway Seawater System	pointSample	10/17/22 3:55	74.513885	-163.10599		7183
	XBT	release	10/17/22 4:11	74.521978	-162.96498	1239	XBT T5 352135 good data until bottom
	XBT	release	10/17/22 5:02	74.548029	-162.52037	1539	XBT T5 352136 Good to 1450m
	Underway Seawater System	pointSample	10/17/22 6:10	74.39498	-162.40481		7184
	XBT	release	10/17/22 6:31	74.357788	-162.38468	1358	XBT T5 352137
	Underway Seawater System	pointSample	10/17/22 7:53	74.209399	-162.29597		7185
	XBT	release	10/17/22 8:26	74.162536	-162.2682	1001	XBT T5 352133 good to 1000m
	Underway Seawater System	pointSample	10/17/22 9:48	74.035771	-162.19658		7186
	XBT	release	10/17/22 10:15	73.994313	-162.16926	362	XBT Deep Blue SN 1178995
	Underway Seawater System	pointSample	10/17/22 17:06	73.829096	-162.06258		EDNA/ POM
33	CTD911	deploy	10/17/22 17:41	73.833136	-162.03988	291	cast cancelled due to ship drift in wind

33	HC	VPR	deploy	10/17/22 19:20	73.822228	-162.05791	290	Cast Depth 280
33	HC	VPR	recover	10/17/22 19:40	73.825132	-162.04988	290	
33	HC	Bongo Net	deploy	10/17/22 19:50	73.826808	-162.04871	288	Cast Depth 297
33	HC	Bongo Net	deploy	10/17/22 20:05	73.827768	-162.048	288	
33	HC	multinet	deploy	10/17/22 20:22	73.828788	-162.04721	296.3	Cast Depth 260.9 m
33	HC	multinet	recover	10/17/22 20:31	73.828947	-162.04771	296.3	
33		Optics	deploy	10/17/22 20:44	73.829093	-162.04739		
33		Optics	recover	10/17/22 20:51	73.829115	-162.04698		
33		Multicorer	deploy	10/17/22 21:36	73.832525	-162.05389	289.7	HC1
		Underway Seawater System	pointSample	10/17/22 23:47	73.835597	-162.05021		EDNA/ POM
33	HC	CTD911	recover	10/18/22 0:39	73.835213	-162.06638	283	
33	HC	CTD911	deploy	10/18/22 0:50	73.83669	-162.07833	289	
34		Optics	deploy	10/18/22 2:31	73.761761	-162.23177		
34		Optics	recover	10/18/22 2:40	73.763325	-162.23417		
34	HC	CTD911	deploy	10/18/22 3:24	73.75693	-162.2469	242	HC2 dry ctd
34	HC	CTD911	recover	10/18/22 3:46	73.76486	-162.26942	248	
35	HC	CTD911	deploy	10/18/22 4:44	73.688565	-162.38239	224	HC3
		Underway Seawater System	pointSample	10/18/22 5:02	73.693287	-162.38943		EDNA/ POM
35	HC	CTD911	recover	10/18/22 5:20	73.698983	-162.40065	220	
35	HC	multinet	deploy	10/18/22 5:37	73.694735	-162.39159	221.6	Cast Depth 190.0
35	HC	multinet	recover	10/18/22 5:54	73.693999	-162.38993	221.6	
35	HC	VPR	deploy	10/18/22 6:10	73.687047	-162.38531	215.6	200 m w/o
35	HC	VPR	recover	10/18/22 6:29	73.686706	-162.38532	215.6	
35	HC	Bongo Net	deploy	10/18/22 6:36	73.686417	-162.38715	217.3	Tow Depth 174 m
35	HC	Bongo Net	recover	10/18/22 6:51	73.686524	-162.3858	217.3	
35		Van Veen Grab	deploy	10/18/22 7:05	73.686829	-162.38822	216.5	HC3

35		Van Veen Grab	deploy	10/18/22 7:19	73.687946	-162.38611	225.9	HC3
35		Van Veen Grab	deploy	10/18/22 7:33	73.6889	-162.38604	213	HC3
35		Van Veen Grab	deploy	10/18/22 7:48	73.690958	-162.39031	223.2	HC3
35		Multicorer	deploy	10/18/22 8:27	73.687968	-162.396	222.8	HC3
36	HC	CTD911	recover	10/18/22 10:04	73.650583	-162.47408	190	
36	HC	CTD911	deploy	10/18/22 10:53	73.621791	-162.55486	190	
		Underway Seawater System	pointSample	10/18/22 10:58	73.62182	-162.55825		7188 (Stn 36)
37	HC	CTD911	deploy	10/18/22 12:11	73.545075	-162.69189	173	
37	HC	CTD911	recover	10/18/22 12:30	73.546589	-162.69674	173	
37	HC	Bongo Net	deploy	10/18/22 12:59	73.546104	-162.69924	161.9	Tow Depth 141 m
37	HC	Bongo Net	recover	10/18/22 13:10	73.545018	-162.70002	161.9	
37	HC	VPR	deploy	10/18/22 13:18	73.544763	-162.70058	162.7	150 m w/o
37	HC	VPR	recover	10/18/22 13:30	73.543326	-162.69975	162.7	
37		Van Veen Grab	deploy	10/18/22 13:30	73.543293	-162.69976	221	HC5
37		Van Veen Grab	deploy	10/18/22 13:40	73.542381	-162.69985	221	HC5
37		Van Veen Grab	deploy	10/18/22 13:50	73.54205	-162.69679	221	HC5
37		Van Veen Grab	deploy	10/18/22 14:00	73.540863	-162.6959	221	HC5
37		Multicorer	deploy	10/18/22 14:30	73.536433	-162.70279	221	HC5
38	HC	CTD911	deploy	10/18/22 16:34	73.483745	-162.82973	159	
38	HC	CTD911	recover	10/18/22 16:34	73.483745	-162.82973	159	
		Underway Seawater System	pointSample	10/18/22 16:36	73.484009	-162.82974		7189 (stn 38)
39	HC	CTD911	deploy	10/18/22 17:58	73.399311	-163.03492	105	
39	HC	CTD911	recover	10/18/22 18:15	73.401359	-163.03672	105	
39	HC	Bongo Net	deploy	10/18/22 18:26	73.401263	-163.03436	102.8	Tow depth 95 m
39	HC	Bongo Net	recover	10/18/22 18:34	73.401521	-163.03304	102.8	
39	HC	VPR	deploy	10/18/22 18:44	73.402102	-163.03405	103	92 m w/0

39	HC	VPR	recover	10/18/22 18:50	73.402086	-163.03517	103	
39		LargeVolumePump	deploy	10/18/22 19:00	73.401783	-163.03644		
39		LargeVolumePump	startSample	10/18/22 19:15	73.402749	-163.03543	106.6	1 pump for 90 min
39		LargeVolumePump	stopSample	10/18/22 20:45	73.401774	-163.04811		
39		Optics	deploy	10/18/22 20:48	73.401251	-163.04876		
39		Optics	recover	10/18/22 20:55	73.399967	-163.04743		
39		LargeVolumePump	recover	10/18/22 20:59	73.399603	-163.04774		
39		Van Veen Grab	deploy	10/18/22 21:03	73.399385	-163.04855	107	HC7
39		Van Veen Grab	deploy	10/18/22 21:15	73.39862	-163.04883	107	HC7
39		Van Veen Grab	deploy	10/18/22 21:27	73.398213	-163.05128	100.8	HC7
39		Van Veen Grab	deploy	10/18/22 21:38	73.397763	-163.05249	102.8	HC7
39		Multicorer	deploy	10/18/22 22:05	73.395893	-163.0547	106.7	HC7
		Underway Seawater System	pointSample	10/18/22 23:01	73.39393	-162.96591		EDNA/ POM
40	HC	CTD911	deploy	10/19/22 0:15	73.343363	-162.6159	104	Station Name is HC8
		Underway Seawater System	pointSample	10/19/22 0:16	73.343453	-162.61666		7190 (stn 40)
40	HC	CTD911	recover	10/19/22 0:25	73.344606	-162.62007	104	
40		Optics	deploy	10/19/22 0:26	73.34465	-162.6202		
40		Optics	recover	10/19/22 0:35	73.347695	-162.62576		
41	HC	CTD911	deploy	10/19/22 1:36	73.306231	-162.32532	126	Station Name HC9
41	HC	CTD911	recover	10/19/22 2:02	73.313229	-162.32989	126	
41		LargeVolumePump	startSample	10/19/22 2:14	73.313471	-162.32879		
41		LargeVolumePump	startSample	10/19/22 2:30	73.313532	-162.32677	122.7	1 pump for 90 mins
41		LargeVolumePump	stopSample	10/19/22 4:00	73.321528	-162.30078		
41		LargeVolumePump	recover	10/19/22 4:15	73.307522	-162.33119		
41	HC	Bongo Net	deploy	10/19/22 4:22	73.301356	-162.3278	123.9	110.4 m w/o, Tow Depth 104 m
41	HC	VPR	deploy	10/19/22 4:27	73.302072	-162.32415	124.5	110 m w/o

41	HC	VPR	recover	10/19/22 4:34	73.302008	-162.3243	124.5	
41	HC	Bongo Net	recover	10/19/22 4:55	73.301137	-162.32084	123.9	
41		Van Veen Grab	deploy	10/19/22 5:07	73.300713	-162.32108	125.4	HC9
41		Van Veen Grab	deploy	10/19/22 5:23	73.300506	-162.3196	126.8	HC9
		Underway Seawater System	pointSample	10/19/22 5:31	73.29956	-162.31978		EDNA/ POM
41		Van Veen Grab	deploy	10/19/22 5:39	73.29922	-162.31831	134.2	HC9
41		Van Veen Grab	deploy	10/19/22 5:51	73.299448	-162.31301	131	HC9
41		Multicorer	deploy	10/19/22 6:25	73.302724	-162.30676	126.4	HC9
42	HC	CTD911	deploy	10/19/22 8:49	73.274867	-162.04847	158	Station name HC10
42	HC	CTD911	recover	10/19/22 9:03	73.281939	-162.05846	158	
		Underway Seawater System	pointSample	10/19/22 9:28	73.250706	-161.90529		7191 (stn 42)
43	HC	CTD911	deploy	10/19/22 10:05	73.225271	-161.73157	220	
43	HC	CTD911	recover	10/19/22 10:19	73.230657	-161.73833	220	
		Underway Seawater System	pointSample	10/19/22 10:25	73.233154	-161.74039		7192
43	HC	Bongo Net	deploy	10/19/22 10:54	73.219423	-161.72467	221	Tow depth 200 m
43	HC	Bongo Net	recover	10/19/22 11:06	73.219084	-161.72504	221	
44	HC	CTD911	deploy	10/19/22 12:02	73.141554	-161.72706	276	
44	HC	CTD911	recover	10/19/22 12:35	73.145449	-161.72911	276	
44	HC	multinet	deploy	10/19/22 12:52	73.145768	-161.72821	280.7	Tow depth 257.3 m
44	HC	multinet	recover	10/19/22 13:09	73.14557	-161.72543	280.7	
44	HC	Bongo Net	deploy	10/19/22 13:23	73.145268	-161.72179	282	198.8 m w/o
44	HC	Bongo Net	recover	10/19/22 13:38	73.145245	-161.7213	282	
44	HC	VPR	deploy	10/19/22 13:50	73.146164	-161.72153	281.8	270 m w/o
44	HC	VPR	recover	10/19/22 14:18	73.145722	-161.72463	281.8	
44		LargeVolumePump	deploy	10/19/22 14:20	73.145643	-161.72456		

44		LargeVolumePump	startSample	10/19/22 14:50	73.144565	-161.72671	282.7	3 pumps for 2 hours
44		LargeVolumePump	startSample	10/19/22 16:50	73.14479	-161.7116		
44		LargeVolumePump	recover	10/19/22 17:15	73.148239	-161.70426		
		Underway Seawater System	pointSample	10/19/22 17:29	73.149547	-161.70016		EDNA/ POM
44		Multicorer	deploy	10/19/22 17:37	73.150099	-161.69863	284.4	HC12; misfire, no cores collected
44		Multicorer	deploy	10/19/22 18:13	73.15129	-161.68834	286.6	HC12
45	HC	CTD911	deploy	10/19/22 20:19	73.065386	-161.73719	158	HC13
45	HC	CTD911	recover	10/19/22 20:33	73.067983	-161.7417	158	HC13 lots of jelly slime noted on ctd and bottles on recovery
45		Optics	deploy	10/19/22 20:37	73.068652	-161.74283		
45		Optics	recover	10/19/22 20:46	73.070305	-161.74427		
46	HC	CTD911	deploy	10/19/22 21:49	72.984296	-161.73243	112	Station name HC14
46		Optics	deploy	10/19/22 22:09	72.988381	-161.73468		
46	HC	CTD911	recover	10/19/22 22:15	72.989255	-161.73371	112	Station name HC14, lots of jelly slime on CTD, plumbing, and frame on recovery
46		Optics	recover	10/19/22 22:17	72.989405	-161.7339		
46	HC	Bongo Net	deploy	10/19/22 22:27	72.989333	-161.73871	114.1	Tow Depth 87 m
46	HC	Bongo Net	deploy	10/19/22 22:36	72.988142	-161.74403	114.1	
46	HC	VPR	deploy	10/19/22 22:44	72.988576	-161.74521	115.2	105 m w/o
46	HC	VPR	recover	10/19/22 22:55	72.988793	-161.7413	115.2	
46		Van Veen Grab	deploy	10/19/22 22:55	72.988793	-161.7413	110	HC14
		Underway Seawater System	pointSample	10/19/22 23:01	72.988534	-161.74102		EDNA/ POM
46		Van Veen Grab	deploy	10/19/22 23:07	72.987918	-161.74079	110	HC14
46		Van Veen Grab	deploy	10/19/22 23:25	72.986775	-161.73731	110.4	HC14
46		Van Veen Grab	deploy	10/19/22 23:34	72.986752	-161.73799	110.9	HC14

46		Multicorer	deploy	10/20/22 0:03	72.986778	-161.7375	111.2	HC14
47	HC	CTD911	deploy	10/20/22 2:08	72.886725	-161.74419	64	HC15
47		Optics	deploy	10/20/22 2:16	72.888196	-161.74786		
47	HC	CTD911	recover	10/20/22 2:16	72.888318	-161.74838	65	
		Underway Seawater System	pointSample	10/20/22 2:20	72.888871	-161.75136		7194_DIC
47		Optics	recover	10/20/22 2:22	72.889113	-161.75291		
		Underway Seawater System	pointSample	10/20/22 2:28	72.890417	-161.7592		7193
48	HC	CTD911	deploy	10/20/22 3:49	72.690517	-161.72923	51	HC 16
48	HC	CTD911	recover	10/20/22 4:00	72.691905	-161.73098	51	
		Ship	other	10/20/22 4:14	72.694428	-161.72966		Loss of ship power total downtime 5 mins no UPS faults
48	HC	Bongo Net	deploy	10/20/22 4:15	72.694444	-161.72918	47.1	Tow depth 35.9
48	HC	Bongo Net	recover	10/20/22 4:19	72.694353	-161.72861	47.1	
48	HC	VPR	deploy	10/20/22 4:29	72.692634	-161.73173	47	40 m w/o
48	HC	VPR	recover	10/20/22 4:34	72.692099	-161.73344	47	
48		Van Veen Grab	deploy	10/20/22 4:40	72.69159	-161.73249	49.3	HC16
48		Van Veen Grab	deploy	10/20/22 4:49	72.690694	-161.73219	49	HC16
48		Van Veen Grab	deploy	10/20/22 4:57	72.690405	-161.73197	51.9	HC16
48		Van Veen Grab	deploy	10/20/22 5:06	72.692057	-161.73003	49.3	HC16
		Underway Seawater System	pointSample	10/20/22 5:21	72.69738	-161.72632		EDNA/ POM
48		Multicorer	deploy	10/20/22 5:34	72.700409	-161.72113	46.4	HC16
49	EHS	CTD911	deploy	10/20/22 11:46	72.821136	-158.30675	396	EHS6 (second time)
		Underway Seawater System	other	10/20/22 12:19	72.827454	-158.31532		low flow below 2.0 LPM on PSSW 1220-1504
49	EHS	CTD911	recover	10/20/22 12:36	72.833381	-158.33069	395	EHS6 (second time)
49	EH	Bongo Net	deploy	10/20/22 13:20	72.817748	-158.30976	384	

49	EH	Bongo Net	recover	10/20/22 13:36	72.820447	-158.31289	384	
49		Multicorer	deploy	10/20/22 14:11	72.819695	-158.31364	386.6	14:11:24; EHS6 Station
49		LargeVolumePump	deploy	10/20/22 16:05	72.812582	-158.23242		
49		LargeVolumePump	startSample	10/20/22 16:35	72.813914	-158.23119	425.8	3 pumps for 2 hours
49		LargeVolumePump	stopSample	10/20/22 18:34	72.819593	-158.22086		
49	EHS	multinet	deploy	10/20/22 18:58	72.820928	-158.2213	439	Tow depth 400 m
49		LargeVolumePump	recover	10/20/22 19:00	72.820897	-158.22168		
49	EHS	multinet	recover	10/20/22 19:24	72.818517	-158.22205	439	
49	EHS	VPR	deploy	10/20/22 19:34	72.817945	-158.22336	426.9	300 m w/o
49	EHS	VPR	recover	10/20/22 19:54	72.816826	-158.22502	426.9	
49		Optics	deploy	10/20/22 19:56	72.816764	-158.22544		
49		Optics	recover	10/20/22 20:07	72.818005	-158.23467		
		Underway Seawater System	stop	10/20/22 20:37	72.805281	-158.54842		SSW secured to work on PSSW sink
		Underway Seawater System	start	10/20/22 21:03	72.787447	-158.87418		SSW pump on and sensors powered back on after PSSW sink fix
		Underway Seawater System	pointSample	10/20/22 22:00	72.751147	-159.60917		7195_DIC
		Underway Seawater System	pointSample	10/20/22 23:04	72.719118	-160.29417		7196_DIC
		Underway Seawater System	pointSample	10/20/22 23:19	72.71036	-160.48156		EDNA/ POM
		Underway Seawater System	pointSample	10/20/22 23:59	72.687879	-160.96003		7197_DIC
		Underway Seawater System	pointSample	10/21/22 0:59	72.648083	-161.80734		7198_DIC
		Underway Seawater System	pointSample	10/21/22 2:02	72.606517	-162.68911		7199_DIC
		XBT	release	10/21/22 2:10	72.602545	-162.77553	40	XBT Deep Blue 1178992
		Underway Seawater System	pointSample	10/21/22 3:06	72.567914	-163.50837		7200_DIC

XBT	release	10/21/22 3:42	72.555713	-163.7672	53	XBT Deep Blue 1178988
Underway Seawater System	pointSample	10/21/22 4:08	72.546438	-163.96406		7201_DIC
Underway Seawater System	pointSample	10/21/22 5:16	72.522947	-164.46		EDNA/ POM
Underway Seawater System	pointSample	10/21/22 5:33	72.516912	-164.58702		7202_DIC
XBT	release	10/21/22 5:52	72.510573	-164.72136	53	XBT Deep Blue 1178997
Underway Seawater System	pointSample	10/21/22 6:40	72.494031	-165.06944		7203_DIC
Underway Seawater System	pointSample	10/21/22 8:13	72.461827	-165.7477		7204_DIC
XBT	release	10/21/22 8:16	72.460882	-165.76749	50	XBT Deep Blue 1178993 Good to 40m
Underway Seawater System	pointSample	10/21/22 9:43	72.430836	-166.39955		7205_DIC
XBT	release	10/21/22 10:33	72.413617	-166.76027	50	XBT Deep Blue SN 1178989
Underway Seawater System	pointSample	10/21/22 11:51	72.386219	-167.335		7206_DIC
XBT	release	10/21/22 12:58	72.346711	-167.75101	53	XBT Fast Deep SN 036605
Underway Seawater System	pointSample	10/21/22 13:03	72.334936	-167.75593		7207_DIC
Underway Seawater System	pointSample	10/21/22 14:37	72.120026	-167.81827		7208_DIC
XBT	release	10/21/22 15:29	72.004627	-167.85063	51	XBT Fast Deep SN 036609
Underway Seawater System	pointSample	10/21/22 16:22	71.898937	-167.88084		7209_DIC
Underway Seawater System	pointSample	10/21/22 17:44	71.728223	-167.9293		7210_DIC
Underway Seawater System	pointSample	10/21/22 18:54	71.586512	-167.96851		7211
Underway Seawater System	pointSample	10/21/22 20:17	71.317841	-168.04291		7212
Underway Seawater System	pointSample	10/21/22 21:49	71.017236	-168.12484		7213

XBT	release	10/21/22 23:11	70.773613	-168.1897	44	XBT Fast Deep 036600 was for 71 deg/ delayed from broken gun
Underway Seawater System	pointSample	10/22/22 0:08	70.596769	-168.23698		7214
Underway Seawater System	pointSample	10/22/22 0:08	70.595973	-168.23716		EDNA/ POM
Underway Seawater System	pointSample	10/22/22 1:35	70.320948	-168.30963		7215
Underway Seawater System	pointSample	10/22/22 2:40	70.113247	-168.3632		7216
XBT	release	10/22/22 3:20	69.989634	-168.39519	43	XBT Fast Deep 036360
Underway Seawater System	pointSample	10/22/22 3:52	69.903137	-168.41761		7217
Underway Seawater System	pointSample	10/22/22 5:05	69.700161	-168.46914		7218
Underway Seawater System	pointSample	10/22/22 6:02	69.550906	-168.50662		EDNA/ POM
Underway Seawater System	pointSample	10/22/22 6:05	69.542267	-168.50881		7219
Underway Seawater System	pointSample	10/22/22 7:24	69.330796	-168.56167		7220_DIC
Underway Seawater System	pointSample	10/22/22 8:54	69.08847	-168.62161		7221
XBT	release	10/22/22 9:23	69.009103	-168.64139	52	XBT Fast Deep 036608
Underway Seawater System	pointSample	10/22/22 10:12	68.865029	-168.67633		7222_DIC
Underway Seawater System	pointSample	10/22/22 11:57	68.559155	-168.75059		7223_DIC
Underway Seawater System	pointSample	10/22/22 13:18	68.327517	-168.80604		7224_DIC
XBT	release	10/22/22 14:26	68.129453	-168.85272	58	XBT Fast Deep SN 036604
Underway Seawater System	pointSample	10/22/22 15:09	68.014402	-168.87986		7225_DIC
Underway Seawater System	pointSample	10/22/22 16:47	67.752402	-168.94087		7226_DIC

50	DBO3	CTD911	deploy	10/22/22 18:19	67.675431	-168.95323	52	DBO3.8
50	DBO3	CTD911	recover	10/22/22 18:31	67.676854	-168.9528	52	
50	DBO3	Bongo Net	deploy	10/22/22 18:42	67.677396	-168.95103	50.3	DBO3.8, Tow depth 38.3 m
50	DBO3	Bongo Net	recover	10/22/22 18:46	67.67758	-168.94971	50.3	
50	DBO3	VPR	deploy	10/22/22 18:54	67.677723	-168.94731	51.9	42 m w/0
50	DBO3	VPR	recover	10/22/22 18:58	67.677665	-168.94636	51.9	
50		Optics	deploy	10/22/22 19:00	67.67762	-168.94594		
50		Optics	recover	10/22/22 19:08	67.678135	-168.94379		
50		Van Veen Grab	deploy	10/22/22 19:18	67.678352	-168.94337	51.4	DBO 3.8
50		Van Veen Grab	deploy	10/22/22 19:24	67.67841	-168.94483	53.6	DBO 3.8
50		Van Veen Grab	deploy	10/22/22 19:30	67.678638	-168.94609	51.8	DBO 3.8
50		Van Veen Grab	deploy	10/22/22 19:36	67.678846	-168.94692	51.2	DBO 3.8
50		Van Veen Grab	deploy	10/22/22 19:46	67.679124	-168.9466	50.7	DBO 3.8
		Underway Seawater System	pointSample	10/23/22 0:03	67.113946	-168.74152		EDNA/ POM
		XBT	release	10/23/22 0:31	67.035897	-168.72028	45	XBT Fast Deep 036189
		Underway Seawater System	pointSample	10/23/22 3:02	66.464734	-168.49264		EDNA/ POM
		XBT	release	10/23/22 4:45	65.995287	-168.4884	53	XBT Fast Deep 036603
		Underway Seawater System	pointSample	10/23/22 4:55	65.957731	-168.48864		7227
		Echosounder12	stop	10/23/22 5:35	65.79099	-168.55799		secured for em122 multibeam survey of A2 mooring
		Echosounder12	start	10/23/22 5:50	65.776067	-168.56349		pinging again after A2 mooring survey
		Underway Seawater System	pointSample	10/23/22 6:33	65.600695	-168.48486		7228
		Underway Seawater System	pointSample	10/23/22 8:22	65.09429	-168.47127		7229_DIC
		XBT	release	10/23/22 8:39	65.016137	-168.4691	46	XBT Fast Deep 036607

Underway Seawater System	pointSample	10/23/22 9:35	64.767392	-168.34409		7230_DIC
Underway Seawater System	pointSample	10/23/22 12:09	64.060502	-167.98064		7231_DIC
XBT	release	10/23/22 12:18	64.01891	-167.95954	37	XBT Fast Deep SN 036601
Underway Seawater System	pointSample	10/23/22 14:40	63.404998	-167.65172		7232_DIC
XBT	release	10/23/22 16:10	62.998156	-167.45141	33	XBT Fast Deep SN 036356
Underway Seawater System	pointSample	10/23/22 17:21	62.666558	-167.29035		7233_DIC
XBT	release	10/23/22 19:55	61.998092	-167.42316	32	XBT Fast Deep SN 036350
XBT	release	10/23/22 23:27	61.031136	-167.96662	28	XBT Fast Deep 036352
XBT	release	10/24/22 2:57	60.057505	-168.33872	35	XBT Fast Deep 036359
XBT	release	10/24/22 6:35	59.03386	-167.68942	40	XBT Fast Deep 036355
XBT	release	10/24/22 10:02	58.018655	-167.34834	42	XBT Fast Deep 036351
XBT	release	10/24/22 13:32	57.023881	-167.12618	42	XBT Fast Deep SN 036554
XBT	release	10/24/22 17:07	56.01104	-166.90624	132	XBT Fast Deep SN 036358
XCTD	deploy	10/24/22 23:10	54.25844	-166.53835	1365	XCTD 1N21117961
Underway Seawater System	stop	10/25/22 0:20	53.987205	-166.48481		secured for entering Dutch Harbor
PCO2	stop	10/25/22 0:22	53.98616	-166.48425		secured for entering Dutch Harbor
Multibeam	stop	10/25/22 0:40	53.946083	-166.48255		secured for entering Dutch Harbor
Echosounder12	stop	10/25/22 0:40	53.944389	-166.48267		secured for entering Dutch Harbor
ADCP OS150	stop	10/25/22 0:43	53.934473	-166.48379		secured for entering Dutch Harbor
ADCP OS75	stop	10/25/22 0:43	53.932623	-166.48412		secured for entering Dutch Harbor
Ship	endCruise	10/25/22 0:44	53.931699	-166.48429		ending HLY2202 at dock in Dutch Harbor