NGA-LTER

Northern Gulf of Alaska Long-Term Ecological Research

Cruise Report July 2019

Cruise ID: SKQ2019-15s

Funding Sources: NSF, NPRB, AOOS, EVOS/GWA

Purpose:

The NGA is a highly productive subarctic Pacific marine biome where intense environmental variability has profound impacts on lower trophic level organisms and community dynamics that, directly or indirectly, support the iconic fish, crabs, seabirds and marine mammals of Alaska. In the NGA, a pronounced spring bloom and regions of sustained summer production support a stable base of energy-rich zooplankton grazers that efficiently transfers primary production up the food chain and a substantial sinking flux of organic matter that exports carbon to the sea bottom communities. The LTER research cruises examine features, mechanisms and processes that drive this productivity and system-wide resilience to understand how short- and long-term climate variability propagates through the environment to influence organisms.

This cruise represents a continuation of sampling begun in fall 1997 under the NSF/NOAA NE Pacific GLOBEC program, and subsequently a consortium of the North Pacific Research Board (NPRB), the Alaska Ocean Observing System (AOOS), and the Exxon Valdez Oil Spill Trustee Council's (EVOSTC) Gulf Watch. This is the second year with expanded domain, measurements and investigators under the NSF's Northern Gulf of Alaska Long-term Ecological Program (NGA-LTER). This cruise marks the 2nd consecutive summer cruise for the Seward Line in the NGA and falls in the 49th year of observations at GAK1.

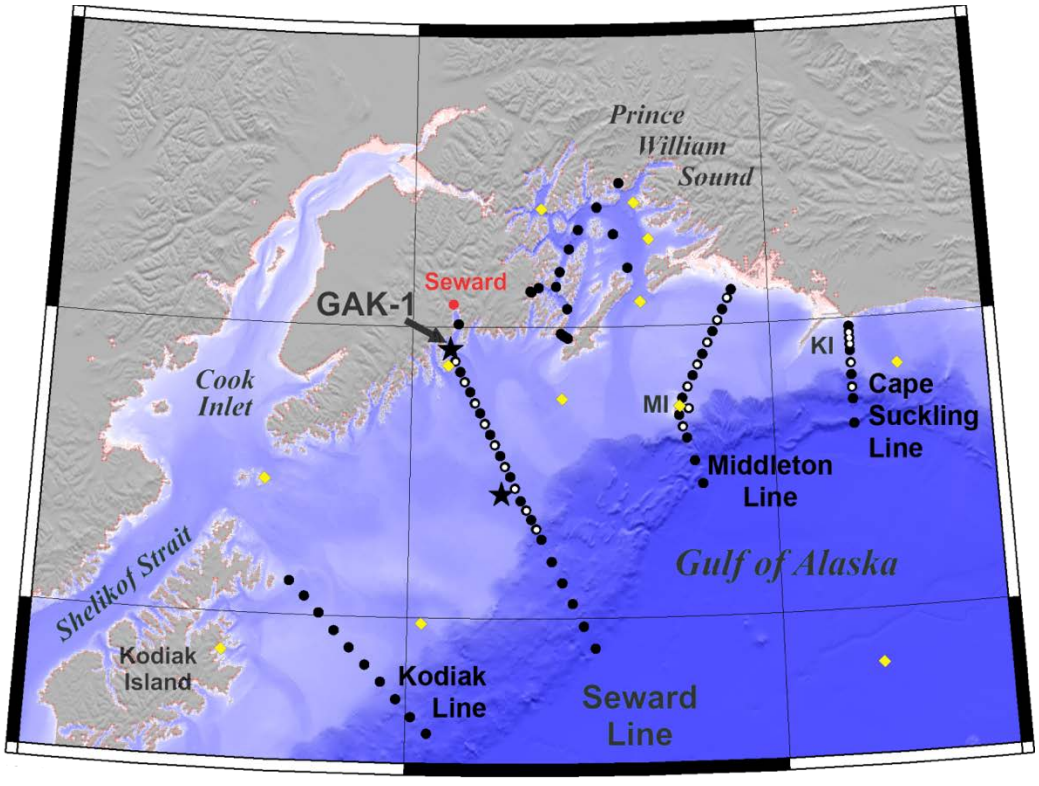

Figure 1. *LTER sampling stations. CTDs cast without water sampling shown as open symbols. Yellow diamonds represent locations of meteorological data from NOAA buoys or ground stations*.

Science Party Cruise Participants

Name (Lead role)	**Component, Institute**
Ana Aguilar-Islas (LTER PI)	Chemistry (Nutrients, Iron), UAF
Ayanda Brydie	Physics (Moorings/CTD/Acrobat), UAF, REU
Carrie Brown	Chemistry (Nutrients, Iron), UAF
Hana Busse	Phytoplankton/Microzoop, WWU
Delaney Coleman	Zooplankton (nights), UAF
Ken Coyle	Zooplankton, Night shift lead scientist
Daniel Cushing	Seabirds/Mammals, US Fish & Wildlife Service
Seth Danielson (LTER PI, Chief Scientist)	Physics, UAF
Kerri Fredrickson	Phytoplankton/Microzoop, WWU
Catherine Fuller	Teacher at sea (Particle Flux team member)
Gwenn Hennon	Microbes & genetics, UAF
Adrianna Hernandez	Zooplankton (nights), UAF, REU
Russ Hopcroft (LTER Lead PI)	Zooplankton (days), UAF
Annie Kandel	Chemistry (Nutrients, Iron), UAF
Kelsie Maslen	Chemistry (Nutrients, Iron), UAF, REU
Kate Mayer	Zooplankton (days), UAF, REU
Bern McKiernan	SKQ Marine technician
Heidi Mendoza-Islas	Zooplankton (nights), UAF
Clay Mazur	Phytoplankton/Microzoop, WWU
Kira Monell	Zooplankton (days), UHawaii
Stephanie O'Daly	Particle Flux (Particle Fluxes), UAF
Ethan Roth (Lead Martech)	SKQ Marine technician
Pete Shipton	Physics (Moorings/CTD/Acrobat), UAF
Caitlin Smoot	Zooplankton (nights), UAF
Suzanne Strom (LTER PI)	Phytoplankton/Microzoop, WWU
Delphina Walker-Phelan	Phytoplankton/Microzoop, WWU, REU

Sampling Overview

Cruise SKQ201915S had two multi-day components (Plume Study and Monitoring Transects) and two shorter components that required something less than one day each to accomplish (Mooring Operations and a High-Nutrient Low-Chlorophyll (HNLC) experiment).

1. Plume Study

Approximately 5 days of the cruise was dedicated to high-resolution sampling of the Copper River discharge plume. Activities included mapping of the plume extent and depth using an undulating towed Acrobat CTD system and towing a surface sampler (Iron Fish) that collects clean water for iron analyses. We paused mapping activities daily to collect water and plankton samples using the CTD and nets. We deployed a few satellite-tracked drifters. An important facet of the plume study involved the simultaneous towing of the **Iron Fish** (abeam starboard) and the **Acrobat** undulating vehicles (astern). The Iron Fish package is towed just below the surface away from the vessel by the starboard crane, and does not have enough line paid out to ever foul with Sikuliaq's propulsion system. The Acrobat is towed 170 to 230 meters astern from the A-frame. Acrobat/Iron Fish tows will involve zig-zags across the river plume frontal region.

2. Station Transects

Approximately 15 days of the cruise was dedicated to transect station work. The overall approach of the transect component of the cruise is to occupy 3 transect lines across the shelf and additional stations within PWS. While occupying transect lines, operations are generally divided into distinct day and night tasks, thus requiring each station to be occupied twice. This structure avoids each discipline needing to supply 2 shifts of scientists and ensures all organisms – especially larger diel-migrating zooplankton – are captured with minimal time-of-day bias. During each morning we will typically occupied a selected "intensive" station for experimental work. Intensive stations involve a greater number and range of collections than other stations occupied that day. Stations profiles are supplemented by underway measurements.

3. HNLC Experiment

Following the Plume Study, we will transited to offshore HNLC waters to collect carboys of filtered and unfiltered surface water for an incubation growth experiment that combined river plume waters with offshore waters.

4. Moorings

This cruise involved the initial commissioning of the moored Gulf of Alaska Ecosystem Observatory (GEO) mooring set, located in the vicinity station GAK6. It is comprised of one subsurface mooring, one instrumented mooring with a surface expression and one guard mooring with a surface expression. The two surface buoys have radar reflectors, flashing lights and real-time telemetry.

Disciplinary Reports

Physics

PI: Seth Danielson

Participants: Seth Danielson, Pete Shipton, Ayanda Brydie (UAF LTER REU)

Physics sampling

On this cruise we conducted 72 casts for water column hydrography (Figure 1) using a 24 x 10 liter bottle rosette. Bottle trips were made at standard levels: 0, 10, 20, 30, 40, 50, 75, 100, 125, 150, 200, 250, 500, 750, 1000, 1250 and 1500 m depths and within 5 m of the bottom when the bottom depth was less than 1500 m. The SBE9-11 CTD was outfitted with pressure, dual temperature, dual conductivity, and dual oxygen sensors. Ancillary sensors included a WetLabs fluorometer, a WetLabs C-Star transmissometer, a Biospherical PAR sensor, and a Tritech altimeter. One channel was assigned to a self-logging Sequoia LISST particle size spectra instrument; one channel provided power and communication to a self-logging SUNA nitrate sensor. A self-logging Underwater Vision Profiler (UVP) was also attached to the CTD rosette frame. The UVP instrument required a soak at 30 m, so for profiles needing UVP data recording the CTD had an unusually deep soak that may have impacted the profiles' depiction of the near-surface stratification. Only one profile at each station required a UVP profile so stations with multiple casts had a combination of deep and shallow soak depths.

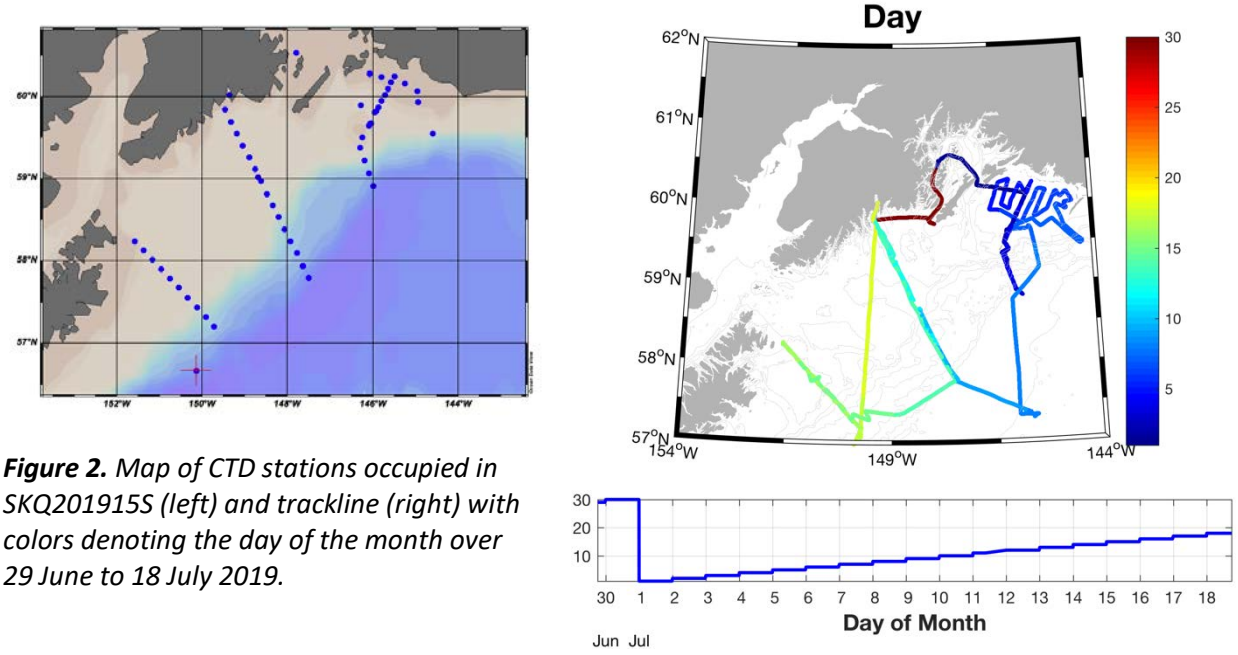

Figure 2. *Map of CTD stations occupied in SKQ201915S (left) and trackline (right) with colors denoting the day of the month over 29 June to 18 July 2019.*

The CTD stations were occupied on three primary shelf transects (Kodiak, Middleton and Seward Line; Figure 2) plus one station in Prince William Sound and stations in the vicinity of the Copper River and two slope region eddies.

Ocean velocity data was collected using a hull-mounted Teledyne RDI 75 kHz Ocean Surveyor instrument and a centerboard-mounted Teledyne RDI 300 KHz Workhorse instrument. The 75 kHz instrument

collected data using 16 m bin thickness and the 300 kHz instrument collected data in 2 meter bins. Due to hull depth and bubble sweep along the hull, the first good bin of the 75 kHz ADCP was typically at 18 m below the surface or deeper. The 300 KHz instrument measured good data starting at 11 m depth.

We ran the ADCPs triggered from the K-sync system so as to provide an interference-free time interval for the EK-60 fisheries acoustics pings. Over shallow waters (< 1000 m depth) all acoustic instruments could be run simultaneously. In deep water (>1000 m depth) the time for the return acoustic pings become exceedingly long so we ran in one of two modes in deeper water. In "night operations mode" we would secure the EM302 mulitbeam during night station work and operate only the ADCP and EK-60 so as to have concurrent acoustics data alongside the nighttime trawl operations. In the "day operations mode" we would secure the EK-60 and run the EM-302 so as to map the seafloor along our trackline.

Regions previously unmapped by multibeam acoustics were preferentially selected for ship routes in order to map uncharted areas of the seafloor. Many portions of the cruise occurred in previously unmapped regions, including especially portions of Prince William Sound, between Middleton Island and the Copper River, and east of Kayak Island. Future cruises will continue to fill in mapping coverage gaps.

Other underway data collected include the ship's operational data, meteorological data and ocean surface data. Operational data of ships equipment (e.g., navigation and winch payout and tensions) were also logged. Navigation data parameters include GMT date time, latitude, longitude and water depth. Atmospheric data parameters measured by the ship's underway system included atmospheric pressure, wind speed/direction, air temperature, humidity, CO_2, shortwave downwelling irradiance, longwave downwelling irradiance, and PAR. Surface seawater underway data samples included temperature, salinity, chlorophyll a fluorescence, phycoerytherin, partial pressure of CO_2, and nitrate.

Two nitrate dataloggers were used on the cruise. An ISUS instrument was plumbed into the underway uncontaminated seawater throughflow system that feeds the thermosalinograph sensors. This instrument was set to take three samples every five minutes. The second nitrate sensor was a SUNA instrument strapped to the CTD frame. The SUNA was powered by a stand-alone battery pack that was energized when the CTD sent power to the bulkhead connectors. This dataset was stored internally to the SUNA and its full data will require a matching of dataset time stamps to align the nitrate profile with the rest of the CTD profile, however an simple analog signal provides preliminary estimates.

High resolution (~ 300m horizontal spacing) CTD profiles over the upper water column (50 to 60 m depth) were collected using a towed Sea Sciences Acrobat system, which undulates at a rate of about 0.5 to 1.0 m s^{-1} while being towed at a ship speed of 3-4 m s^{-1}. The Acrobat was equipped with a SBE49 FastCat CTD and a WetLabs ECO-Triplett optical sensor with channels for chlorophyll a fluorescence, CDOM and optical backscatter (OBS) at 700 nm. We towed the Acrobat for the "plume study", along the length of the Seward Line, and into a shelf slope eddy. For ship speeds of about 7 knots and 220 m of Acrobat cable paid out from the winch, we were able to consistently profile to about 50 m depth (Figure 3).

We struggled with sensor noise on the Acrobat pressure channel, which rendered the autopilot function inoperable at times, along with data dropouts. A re-termination of the tow cable showed an electrical short near the end of the cable in the vicinity of the “yale grip” strength member, but this was not the only issue. Following a number of additional data issues, we spent special attention to routing the cable termination so as to avoid bending stresses. This new routing resulted in excellent data quality for the reminder of the cruise. Future deployments of the Acrobat should incorporate the same cable routing scheme.

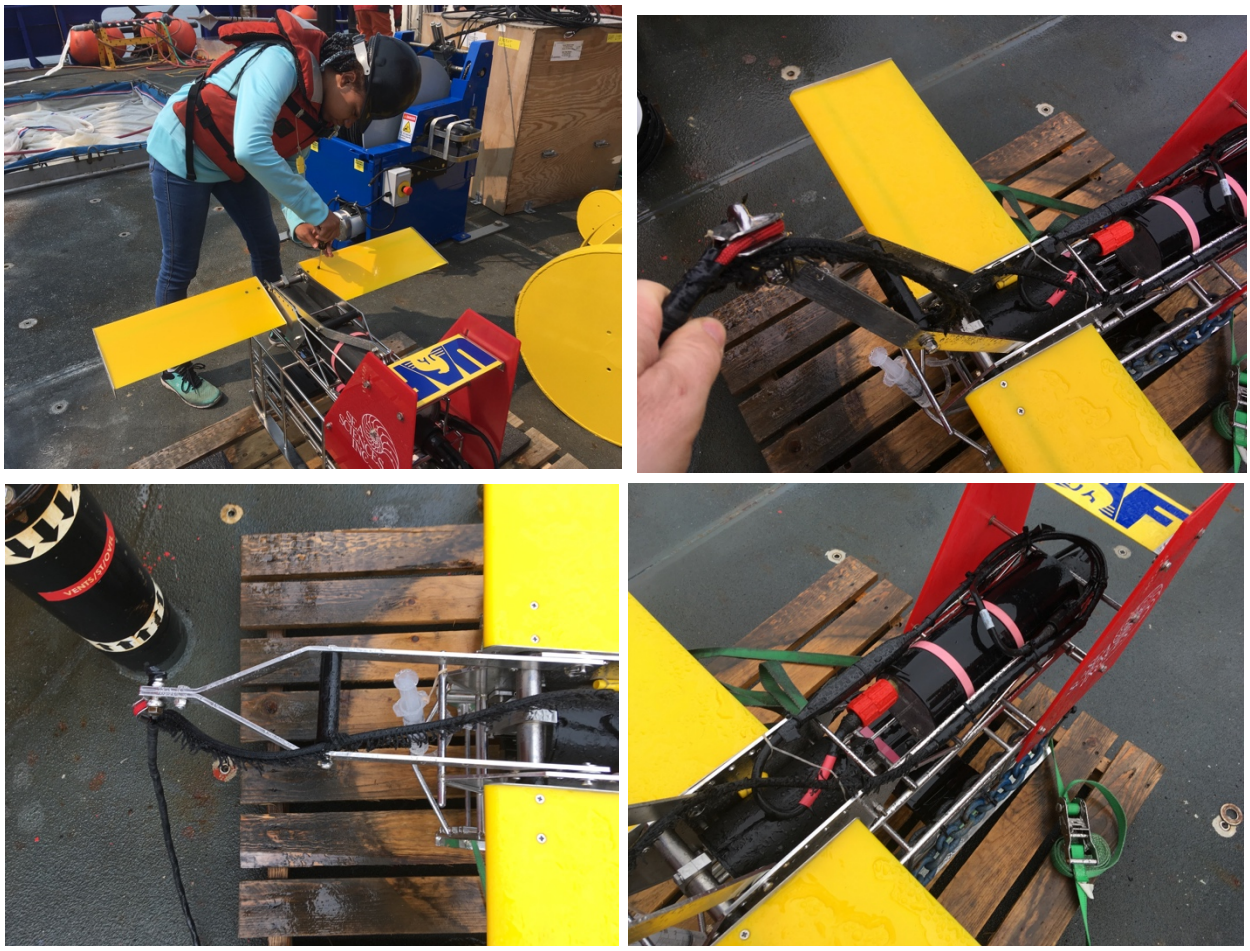

Figure 3. *Acrobat tow cable routing that eliminated data dropouts.*

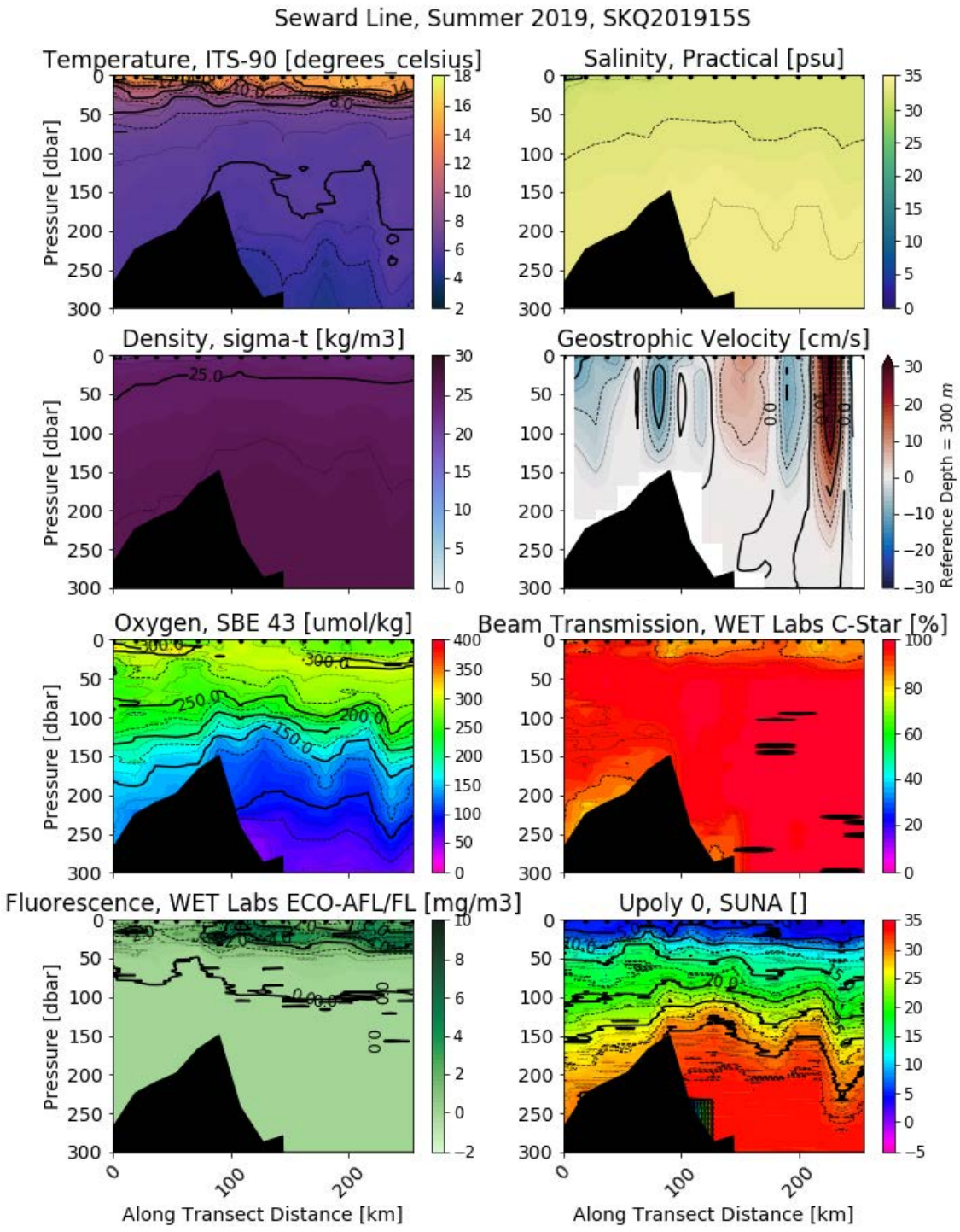

Figure 4. *Seward Line Hydrography. Clockwise from upper left: temperature, salinity, geostrophic velocity, beam transmission, SUNA nitrate, chlorophyll a fluorescence, dissolved oxygen, density.*

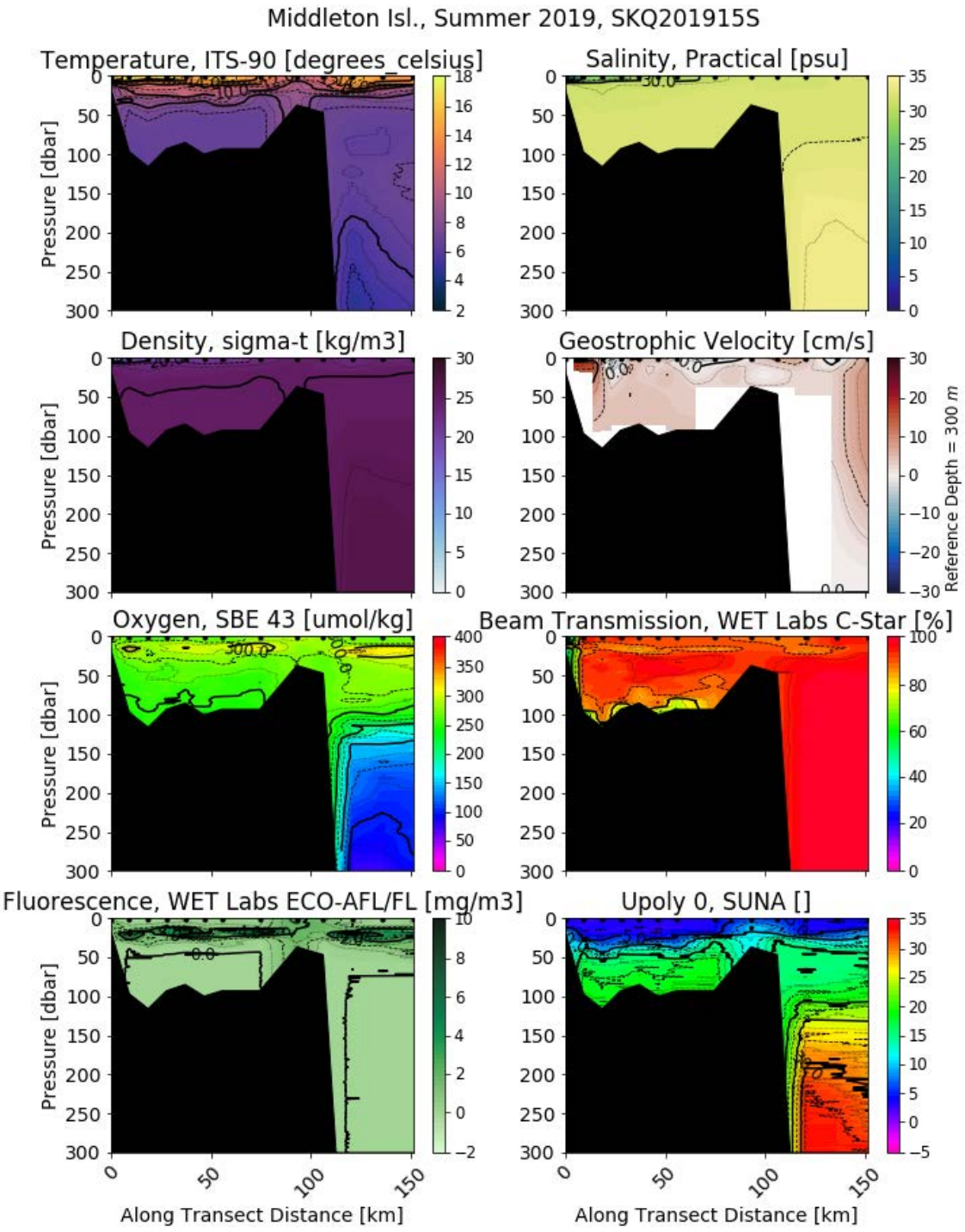

Figure 5. *Middleton Island Line Hydrography. Clockwise from upper left: temperature, salinity, geostrophic velocity, beam transmission, SUNA nitrate, chlorophyll a fluorescence, dissolved oxygen, density.*

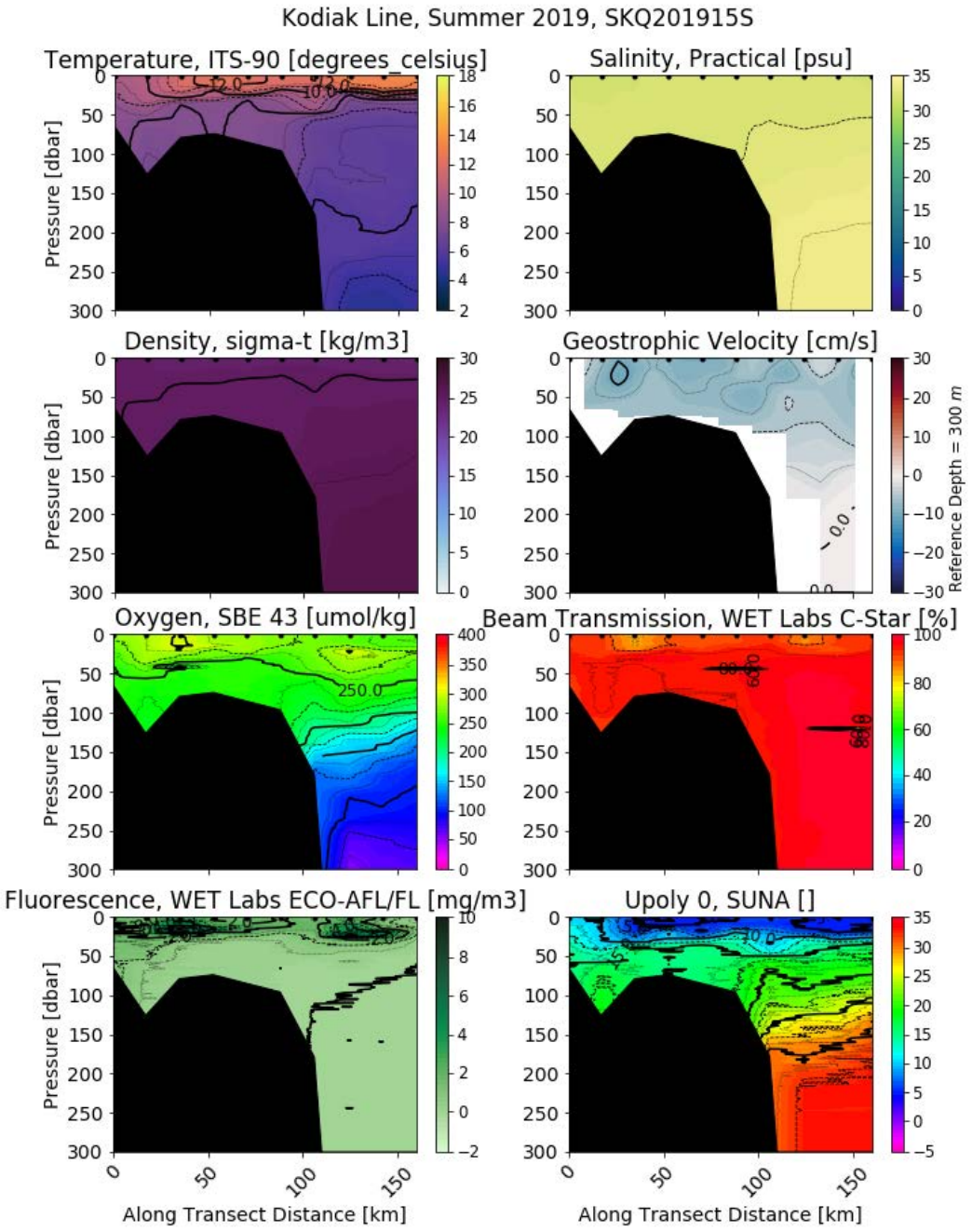

Figure 6. *Kodiak Island Line Hydrography. Clockwise from upper left: temperature, salinity, geostrophic velocity, beam transmission, SUNA nitrate, chlorophyll a fluorescence, dissolved oxygen, density.*

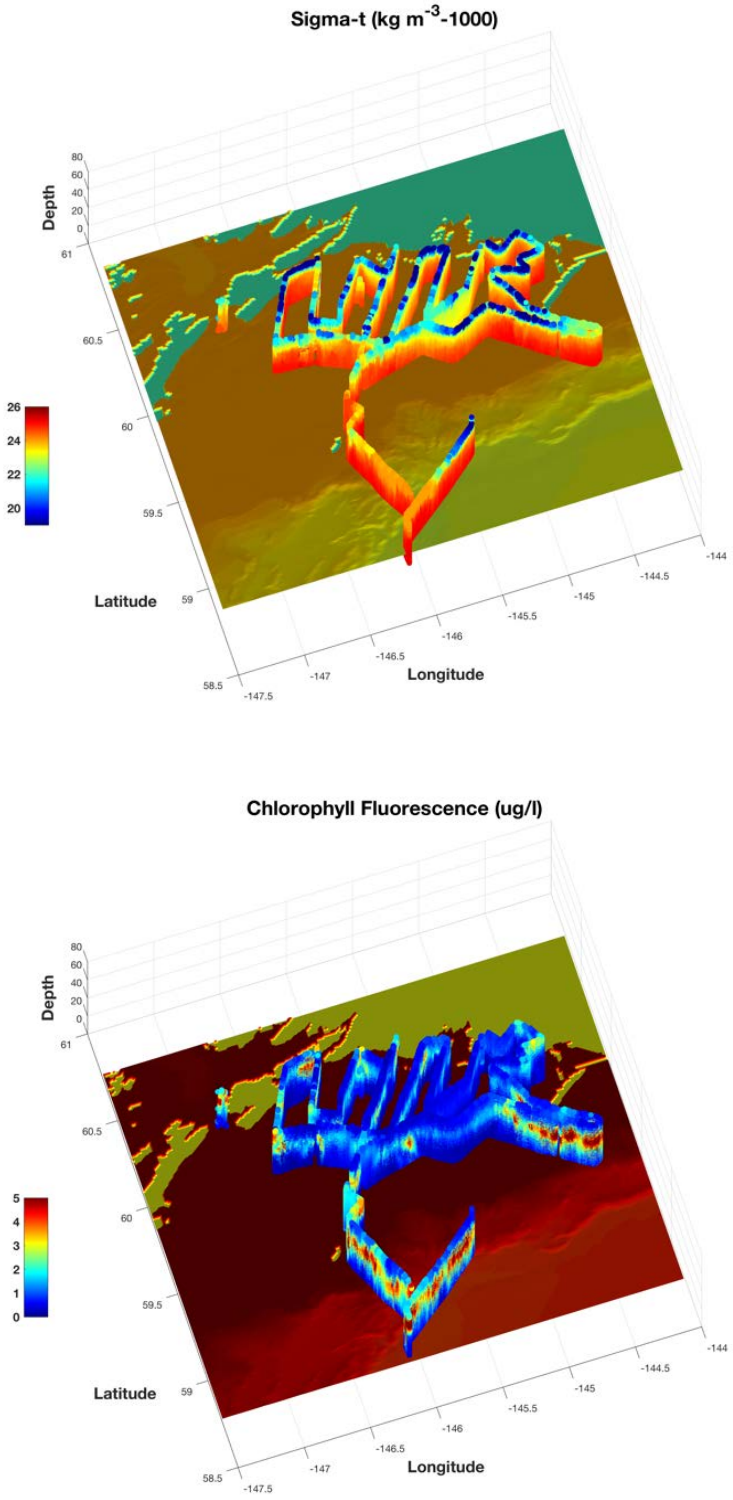

Figure 7. *Density (top) and Chlorophyll fluorescence (bottom) from Acrobat traces in the Copper River Plume region.*

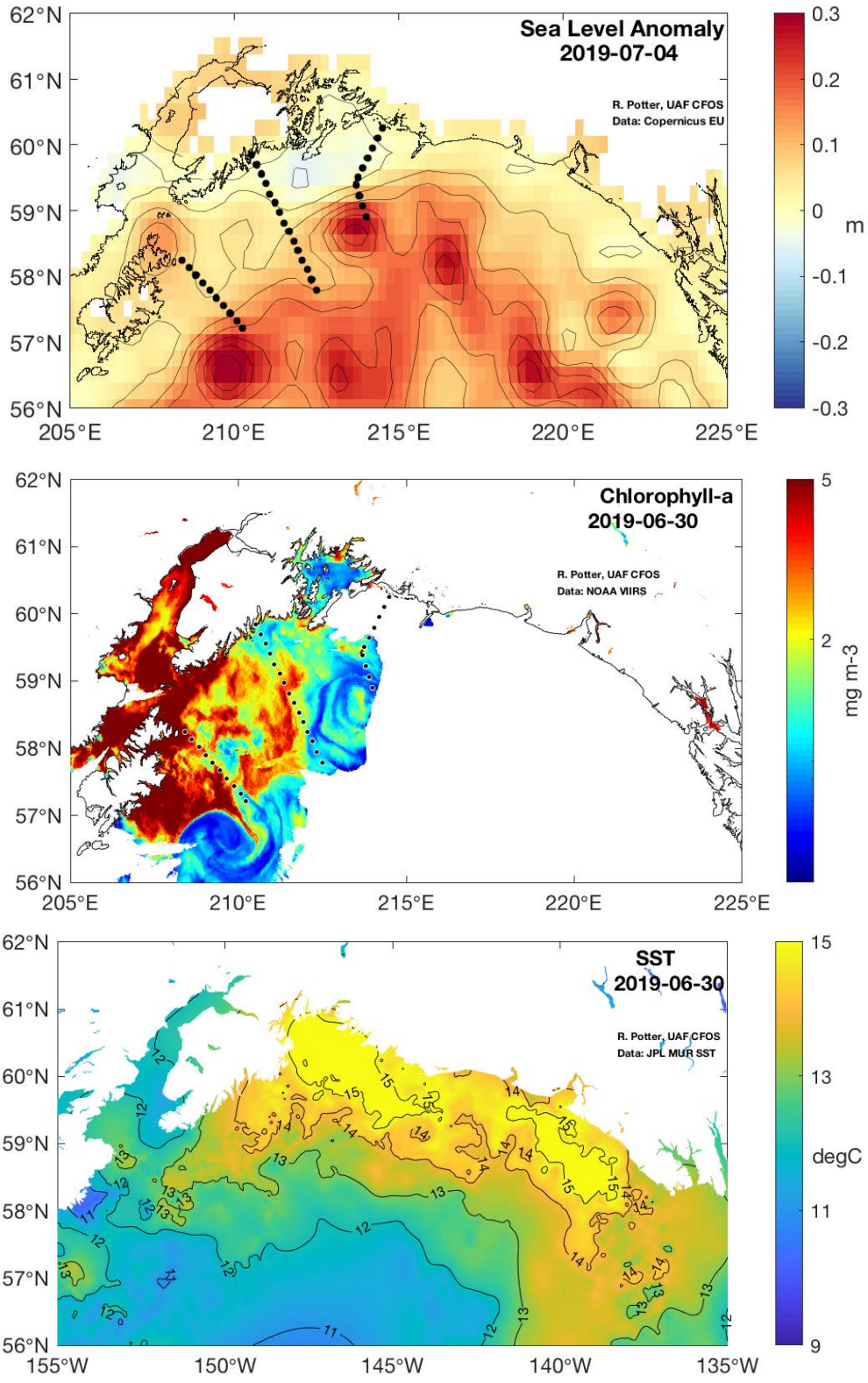

Figure 8. *Remote sensing imagery from the cruise period.*

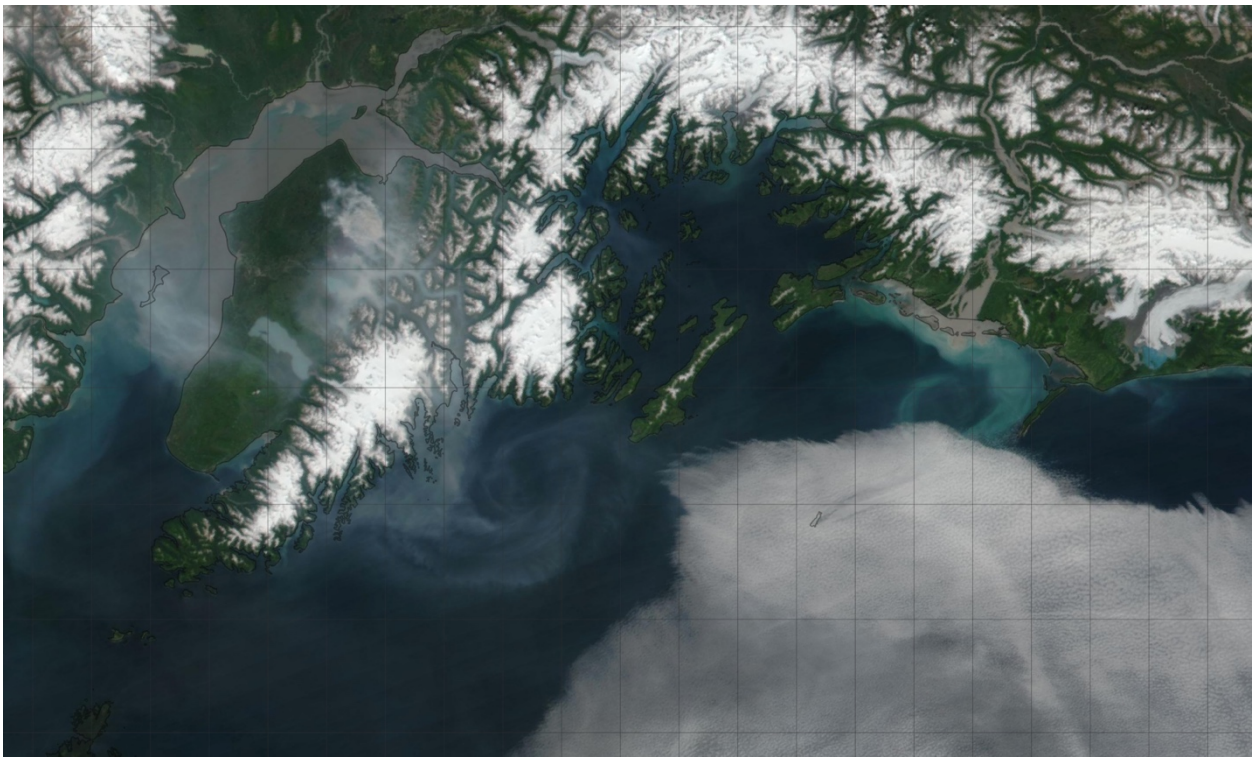

Figure 9. *MODIS 29 June 2019.*

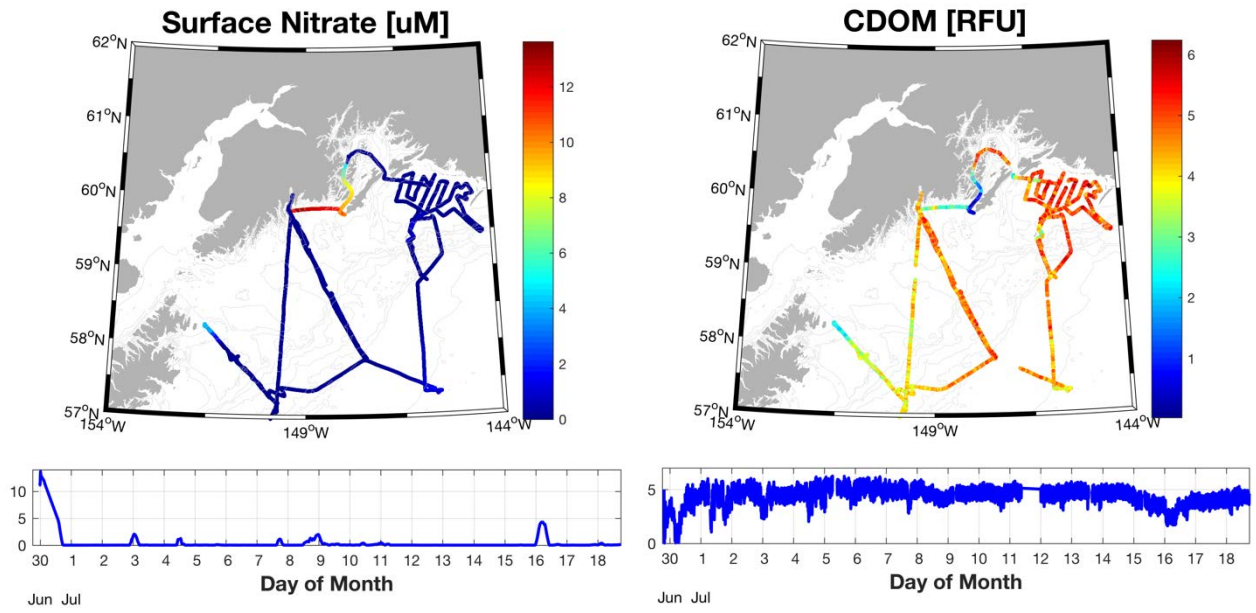

Figure 10. *Surface underway nitrate & Colored Dissolved Organic Matter (CDOM).*

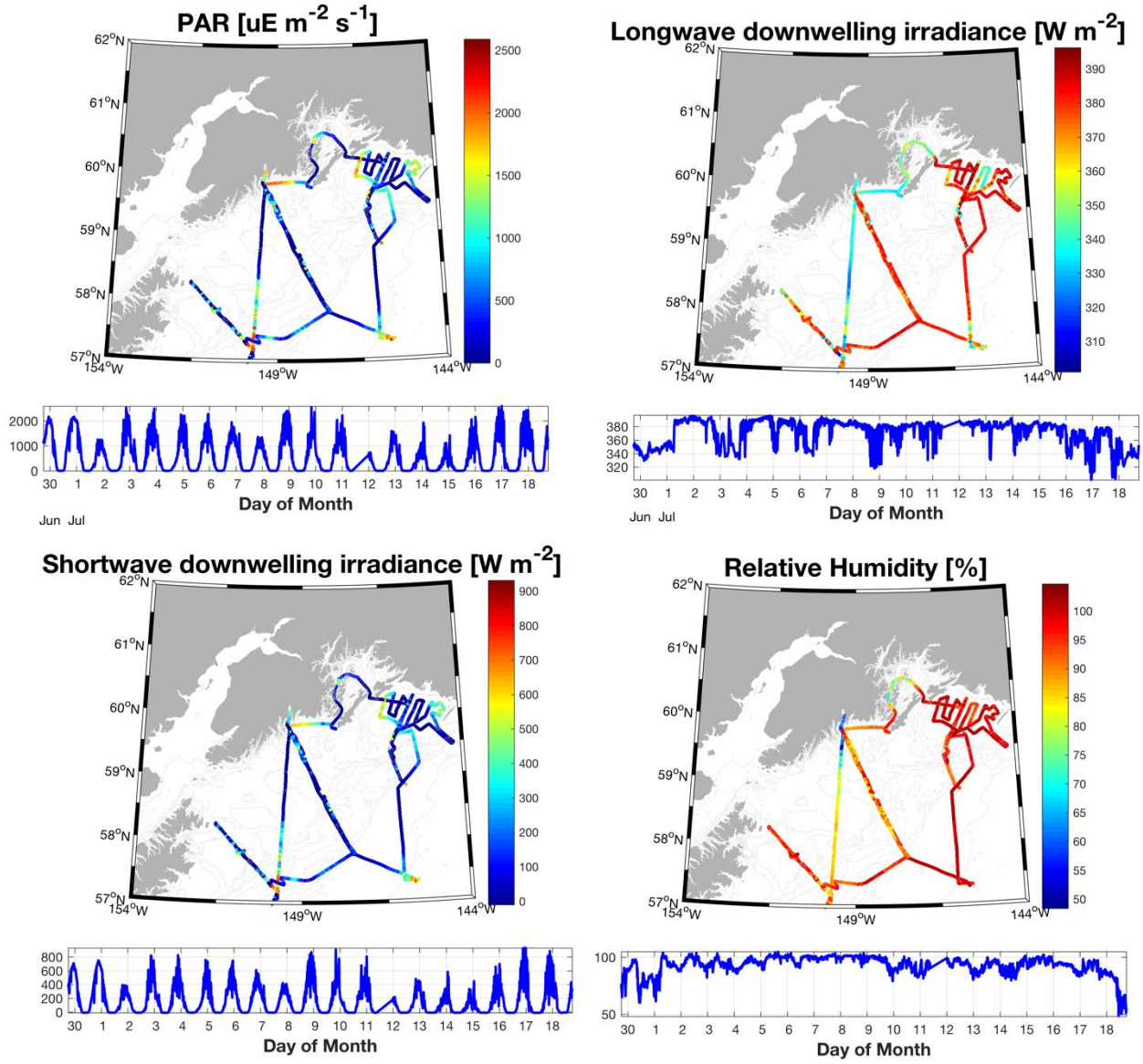

Figure 11. *Surface underway Photosynthetically Available Radiation (PAR), downward shortwave and longwave radiation, and relative humidity.*

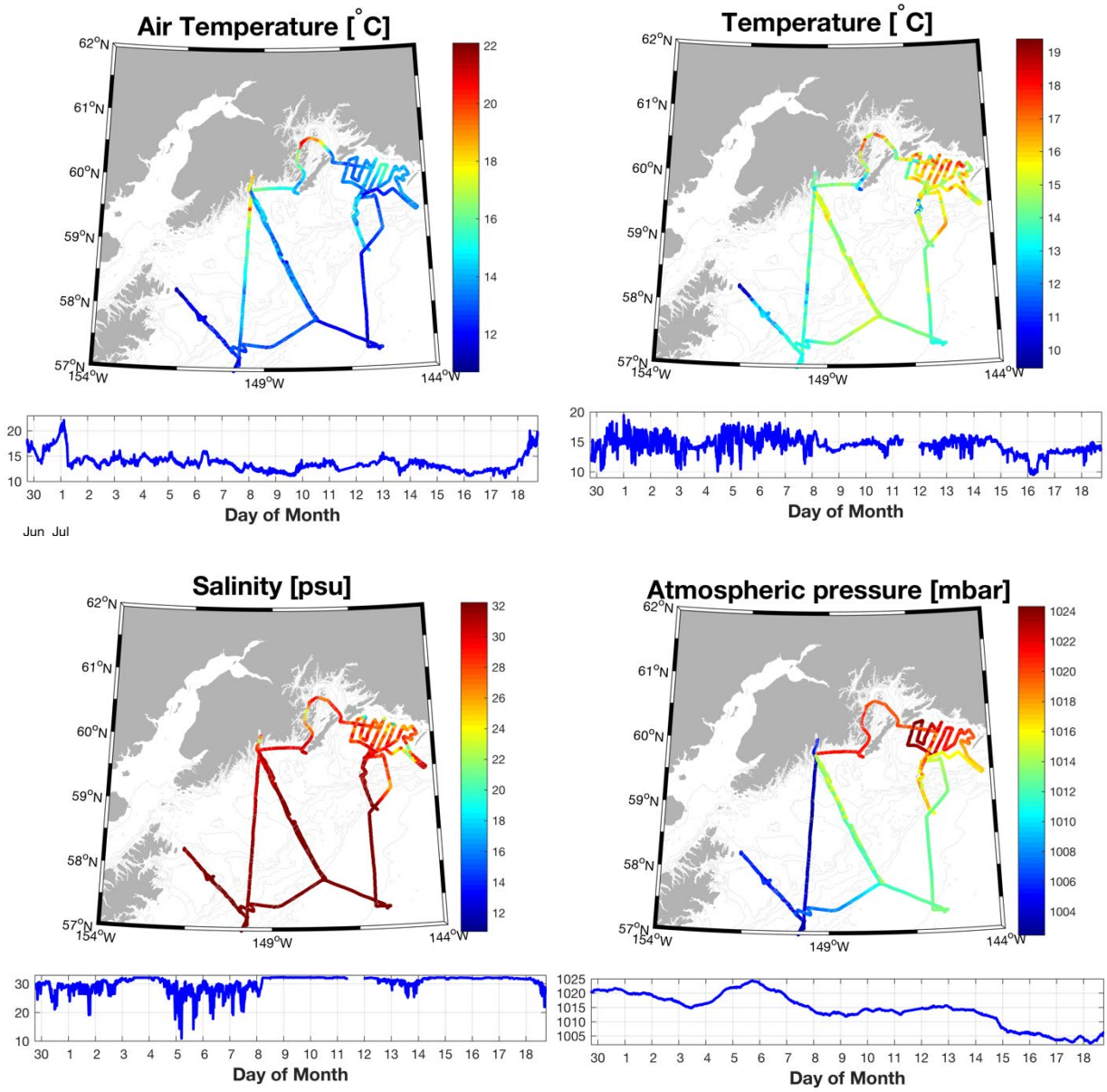

Figure 12. *Surface underway air and water temperature, salinity, and atmospheric pressure.*

GEO Moorings

We deployed a cluster of three moorings as the Gulf of Alaska Ecosystem Observatory near the middle of the Seward Line (close to station GAK6). The GEO moorings were deployed at:

- GEO1 = 59.0142 °N, 148.6902 °W
- GEO2 = 59.0153 °N, 148.6934 °W
- GEO3 = 59.0165 °N, 148.6966 °W

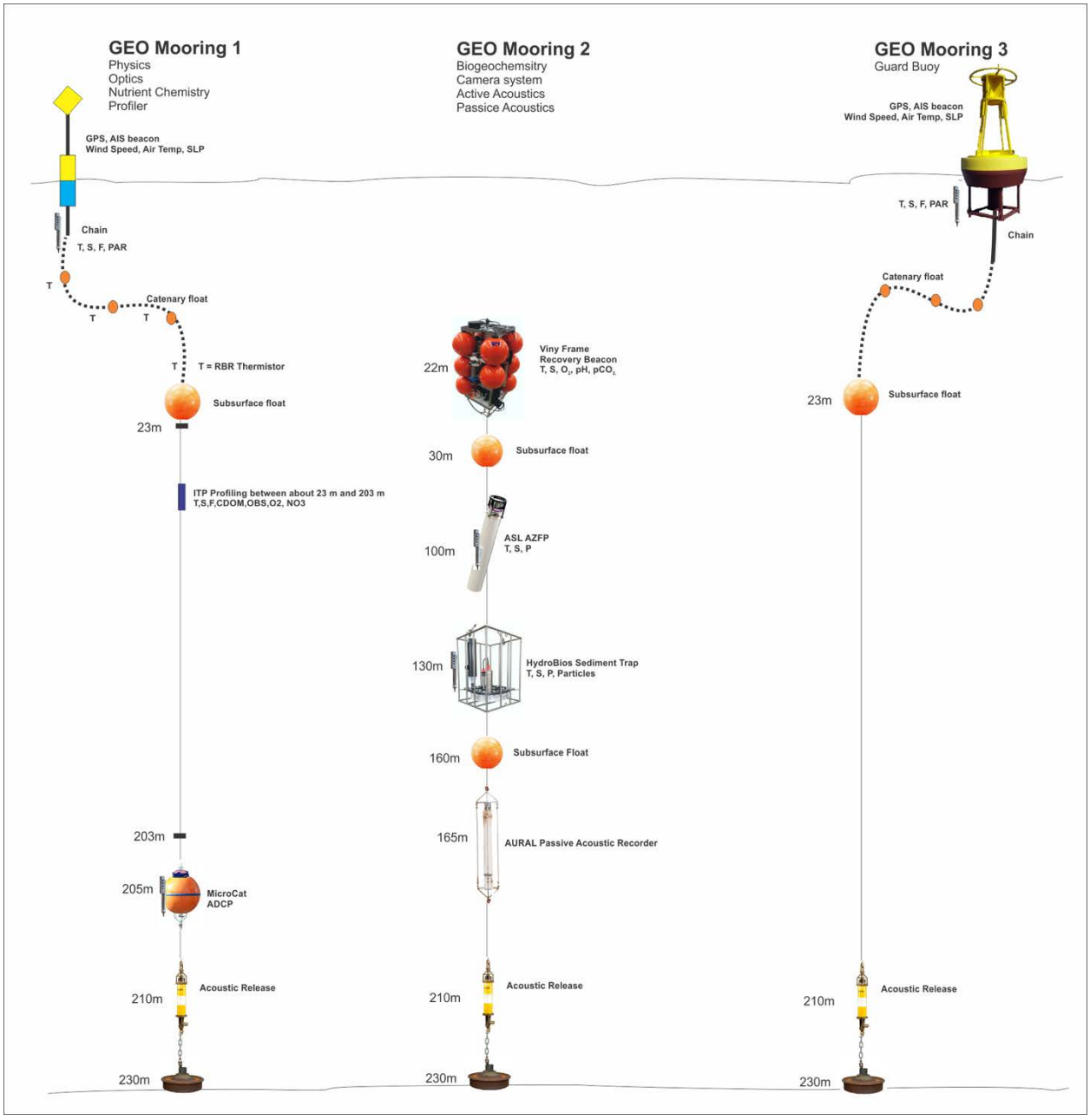

Figure 13. *GEO mooring configuration*.

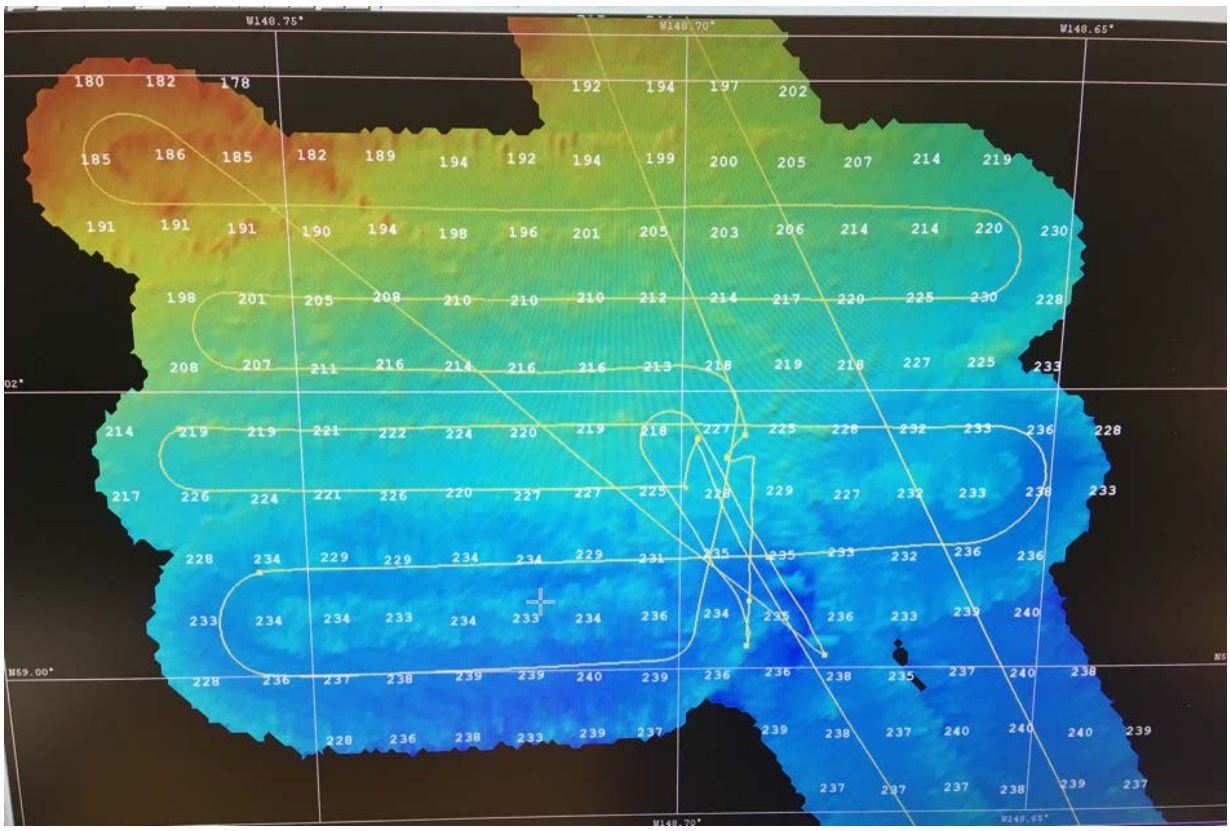

Figure 14. *Bathymetric survey of the vicinity of the mooring using Sikuliaq's multibeam seafloor swath mapping acoustics.*

Figure 15. *Moorings GEO1 (left) and GEO3 (right) following deployment.*

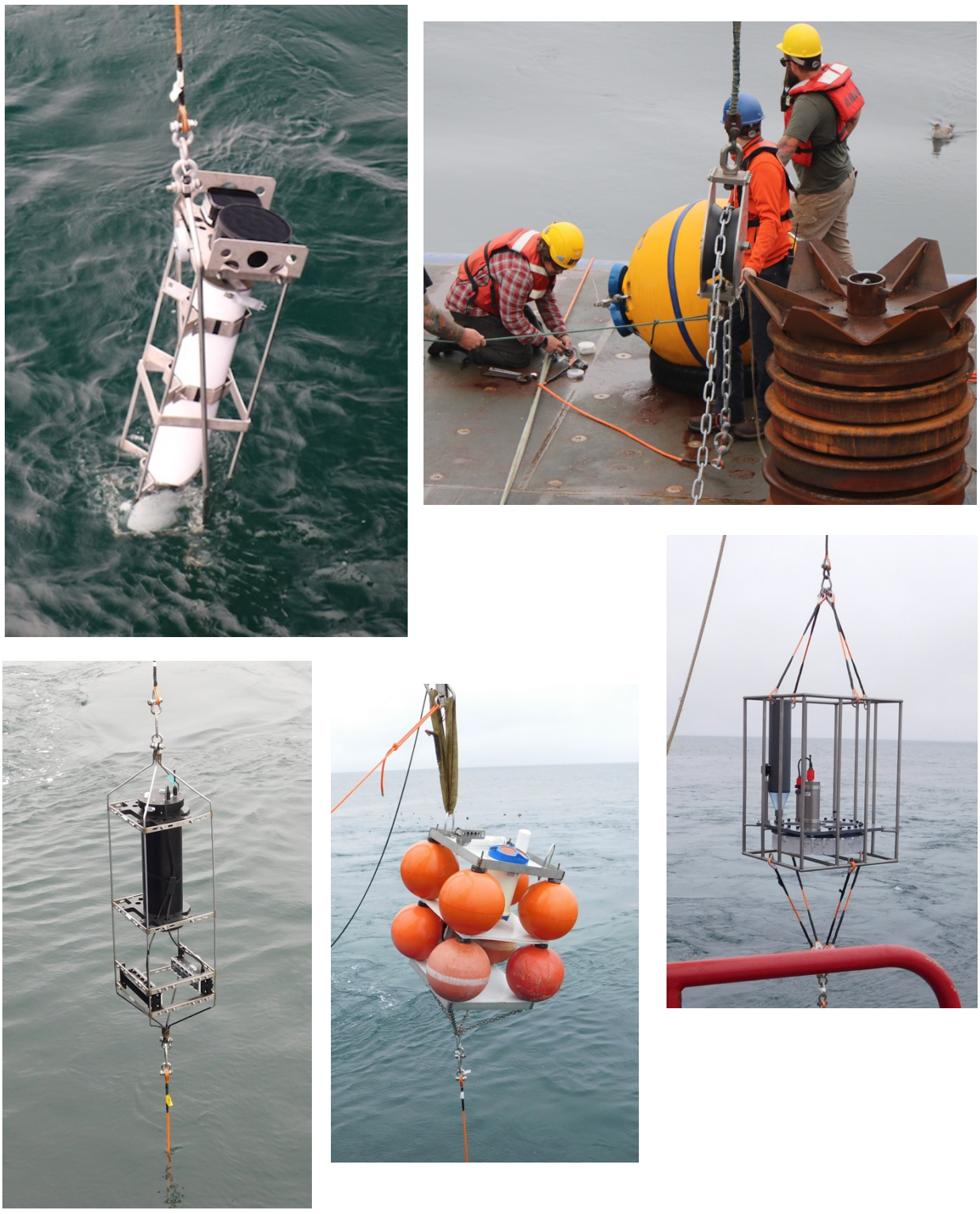

Figure 16. *Clockwise from upper left: AZFP, ADCP, Sediment Trap, ADCP/T/S/pCO2 Frame, Optics packages.*

Macro- and Micronutrient sample collection and processing

PI: Ana M. Aguilar-Islas

Participants: Annie Kandel (UAF graduate student), Carrie Brown (UAF graduate student), Kelsie Maslen (UAF undergraduate student)

During this field effort our goal was to determine ambient distribution of dissolved inorganic macronutrients (nitrate, nitrite ammonium, phosphate and silicic acid) and the micronutrient iron. The influence of the Copper River plume on nutrient dynamics was the major focus of the cruise. Nutrient distributions in conjunction with hydrography are used to determine resource variability to the phytoplankton community in space and time and to identify the relative importance of various processes in supplying nutrients to surface waters. A secondary aim was to train students in field-related work.

Table 1. Samples for Nutrient Analysis. *Intensive stations are in bold. Additional samples collected from primary production (PP) casts, the iron addition experiment (FeAX), and surface transects are under "OTHER".*

STATION	# samples	STATION	# samples	STATION	# samples
RES 2.5-a	13	GAK8	13	PL-1	16
GAK1-a	13	**GAK9**	13	PL-2	5
PWS2	14	GAK10	16	PL-3	8
MID1	4	GAK11	16	PL-4	13
MID2	9	GAK12	16	PL-5	7
MID3	8	GAK13		PL-6	6
MID4	8	GAK14	16	PL-7	15
MID5	8	**GAK15**	16	PL-8	11
MID6	5	KOD1	7	PL-9	8
MID7	5	KOD2	9	PL-10	16
MID8	14	KOD3	7	GEO	12
MID9	16	KOD4	7	KOD Eddy	13
MID10	16	**KOD5**	8	OTHER	# samples
GAK1-b	13	KOD6	8	Transects 1-4	97
GAK2	12	KOD7	11	Transect 5	19
GAK3	12	KOD8	14	Transect 6	0
GAK4	11	KOD9	16	FeAX	32
GAK5	11	**KOD10**	16	PP casts	106
GAK6	10	GAK1-c	13		
GAK7	12	RES2.5-b	13	**GRAND TOTAL**	**812**

Sample collection and processing for macronutrient analysis:

Filtered seawater samples were collected from 52 vertical profiles (see Table 1) from surface to 1500 m using the ship's CTD rosette bottles. Samples were filtered through 0.45 um cellulose acetate filter disks using a syringe, and were frozen (-80 ^{o}C) following collection. Samples were also obtained from primary production casts, surface water during the Copper River Plume (Transects 1-4), and the GAK line (Transect 5) transects, but not during the KOD Eddy transect (Transect 6). Additional samples for

nutrient analysis were collected from all replicates of an iron addition experiment (FeAX). Annie Kandel and Kelsie Maslen were responsible for CTD macronutrient sampling with some help from members of the Strom team. Nutrient samples during transects and the FeAX were collected by Carrie Brown and Annie Kandel. In total > 800 samples were collected for nutrient analysis.

Sample collection for dissolved oxygen analysis:

Unfiltered seawater samples for the analysis of dissolved oxygen were collected in an alternating fashion from the surface and the bottom depths from CTD casts. Triplicate samples were collected from the surface and bottom depths at station GAK1a. These samples will be analyzed at the Ocean Acidification Research Center (OARC) in Fairbanks, and will be used to check calibration of the CTD oxygen sensor and sensors on moorings. A total of 51 samples were taken during the cruise. Annie Kandel was responsible for sampling, processing and storing these samples during the cruise. Stephanie O'Daly was responsible for delivering the samples to OARC.

Sample collection for iron analysis:

a) Seawater samples were collected from 11 vertical profiles (see Table 2) from 15 -1000 m using a trace metal clean (TMC) rosette made of powder coated aluminum and loaded with Teflon-coated Niskin bottles with external springs. A dedicated winch (MASH2K) with 5/16" Amsteel line and a TMC block mounted on the starboard crane were used to deploy/recover the TMC rosette. The winch and block were borrowed from the UNOLS East Coast winch pool. All participants were involved in deck operations, with assistance from crew and marine technician. Annie Kandel and Carrie Brown learned to program the Auto Fire module, download cast data and to operate the winch.

b) Surface seawater samples were collected underway while arriving (or departing) the stations where TMC casts took place. These samples were used to complete vertical profiles. Surface seawater samples were also collected during the Copper River Plume Transects and the GAK line and KOD Eddy transect. These samples were obtained from a custom-made surface sampler (FeFish) deployed from the starboard crane, and kept at a distance of ~ 5 m from the hull (see Photo 1). Water was pumped with the use of an air actuated diaphragm pump that delivered the sample into the clean lab "bubble" through Teflon-lined polyethylene tubing (see Photo 1). Water from the FeFish was also provided to Gwenn Hennon for the analysis of biological parameters. All team members were involved in deck operations, with assistance from the crew and marine technician.

Sample processing for iron analysis:

A positive-pressure, plastic enclosure supplied with HEPA filtered air (the "bubble") was constructed in the analytical lab to house the Nisking bottles, IronFish sampling spigots and filtration rigs. Immediately after collection Niskin bottles were transferred to the the bubble for subsampling. Filtered subsamples for dissolved Fe analysis were processed from all casts at all depths, and from all IronFish samples.

Filtered subsamples for the analysis of iron-binding organic ligands, soluble iron, unfiltered samples for total dissolvable iron analysis, and filters for particulate iron analysis were obtained from a subset of samples (see Table 2). Samples were filtered through 0.2 um polycarbonate filter discs (Nuclepore) using trace metal clean techniques. Ana Aguilar-Islas, Annie Kandel, and Carrie Brown were responsible for subsampling and filtration. Samples for soluble iron were further filtered through 0.02 um Anotop syringe filters, and Ana Aguilar-Islas and Annie Kandel were responsible for the ultrafiltration.

Table 2. Samples for iron parameters

DFe = dissolved iron (< 0.2 um), TDFe = total dissolvable iron (unfiltered), SFe = soluble Fe (< 0.02 um), PFe = particulate iron (> 0.2 um)

STATION	DFe	SFe	TDFe	Ligands	PFe
PWS2	13	3	4	2	4
MID2	7	4	4	3	4
MID5	7	4	4	3	4
MID10	13	5	7	4	7
GAK15	13	4	6	7	6
GAK 9	10	4	6	3	6
GAK 5	9	4	6	4	6
GAK1	9	3	6	4	6
KOD5	7	3	6	3	6
KOD10	13	1	6	1	6
KOD Eddy	9	0	0	0	4
TOTAL	**110**	**35**	**54**	**34**	**58**
TRANSECT	**DFe**	**SFe**	**TDFe**	**Ligands**	**PFe**
1 (Plume)	22	1	6	1	22
2 (Plume)	23	2	8	2	23
3 (Plume)	37	2	9	2	35
4 (Plume)	17	0	2	2	17
5 (GAK)	20	0	0	0	19
6 (KOD Eddy)	14	0	0	0	0
TOTAL	**133**	**5**	**25**	**7**	**116**
FeAX	**DFe**	**SFe**	**TDFe**	**Ligands**	**PFe**
All treatments	**33**	**8**	**1**	**10**	**12**
GRAND TOTAL	**276**	**48**	**80**	**51**	**186**

Seawater collection and processing for the Fe addition, and particulate Fe dissolution experiments:
a) The FeAX was conducted in collaboration with the Strom Lab using unfiltered surface seawater from a patch of HNLC water obtained with the FeFish offshore, between the MID and GAK lines in a region not affected by eddy activity. This water was amended with addition of iron as either $FeCl_3$ (+ 3 nM), or as dissolved Fe from filtered surface water collected in the Copper River Plume. Filtered surface water was collected with the FeFish and filtered inline through 0.2 um Acropak filter cartridges. Filtered seawater from the Copper River Plume was kept in the dark inside the walking freezer until the initiation of the experiment. The treatments were as follows: Control (~2:5 mixture of filtered and unfiltered surface offshore water); + $FeCl_3$ (~2:5 mixture of filtered and unfiltered offshore water + an $FeCl_3$ spike); + River water (~2:5 mixture of filtered river and unfiltered offshore water). Subsamples were obtained from 5 time points (0hr, 48hr, 72hr, 96hr, and 120hr) for the analysis of nutrients, iron and biological

parameters. There were 30 bottles in total, 10 for each treatment. Subsamples were also provided to Gwenn Hennon for additional analysis of biological parameters.

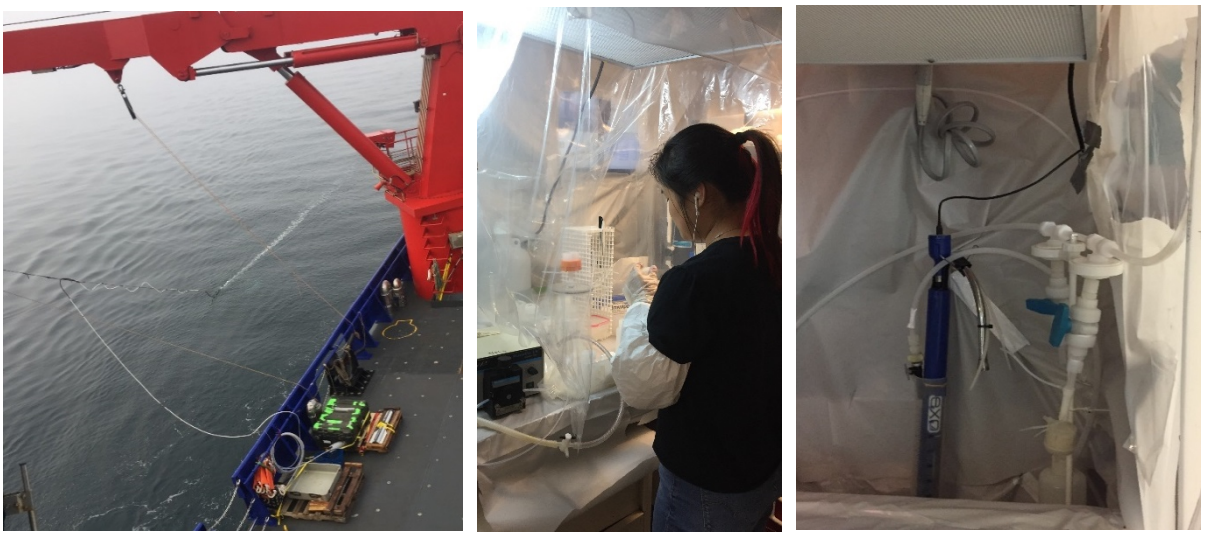

Figure 17. Left: *FeFish being towed at 7 knots during one of the many calm days of the cruise.* ***Center:*** *Annie Kandle processing samples in the "bubble"* ***Right:*** *Fish sampling station inside the "bubble".*

b) Two particulate iron dissolution experiments (FeDX) were conducted; one with suspended plume particles (FeDX1) and the second with subsurface suspended particles from the bottom layer at KOD5 (FeDX2). A 1:2 mixture of unfiltered and filtered seawater was transferred into two quartz cells and place within a deck incubator at ambient water temperature for 12 hours. One of the quartz cells was wrapped in aluminum foil while the other was exposed to sunlight. Subsamples were obtained from 4 time points (0hr, 1.5hr, 7.5hr and 12hr) for the analysis of dissolved and soluble iron.

General Notes

We had a successful cruise with an NGA-LTER record of samples taken for macro-nutrients and iron parameters. The deck crew provided excellent support and their help ensured the success of our operations. The marine technicians also provided excellent support throughout the cruise. The crew was always helpful responding promptly to requests in a happy and professional manner. We experienced no issues with ship's facilities needed for macro- and micronutrient work. Laboratory spaces were adequate, the ship's deck gear, -80 ^{o}C freezer and walk-in refrigerator were in good working condition. Although not essential for this cruise, the Baltic Room is nice to have.

DIC Sampling

PI: Claudine Hauri

Participant: Stephanie O'Daly

DIC samples were filtered with a 0.45 micron membrane filter using a peristaltic pump to remove PIC. During productivity casts if the light level depths were within 2 meters of a DIC depth we adjusted the DIC depth so these overlapped. This occurred 20 times over the course of the cruise. A total of 66 DIC samples were taken with 9 samples taken in triplicate. Triplicate DIC measurements were taken from two Niskin bottles at the depth of the pCO2 sensor on the GEO2 mooring. Additionally, two studies occurred (one in Prince William Sound and a second in the Copper River Plume) where triplicate filtered and unfiltered DIC samples were taken. This will help determine how important filtering DIC samples are for the Gulf of Alaska study region. Finally, a full DIC profile for each of the primary productivity depths was taken at KOD5.

Table 3: *Filtered DIC sample log*

Station ID	Cast Description	Cast #	# Samples Taken	# Samples taken in Triplicate
PWS2	Intensive	3	6	
PWS2	Prod	4	7	2
PL4	Prod	25	2	2
GAK15	Prod	35	7	
GAK15	Intensive	36	6	1
GAK9	Prod	41	7	1
GAK9	Intensive	42	4	
GEO		47	2	2
GAK5	Prod	52	8	
GAK1	Prod	57	10	1
KOD5	Prod	59	7	

OARC DIC sampling

Unfiltered DIC samples were taken in triplicate at GAK1 at the surface and bottom from CTD cast 002 along with a full water column profile. Additionally, a full profile was taken at GAK3 on CTD cast 055.

Phytoplankton sample collection and processing

PI: Suzanne Strom

Participants: Suzanne Strom, Kerri Fredrickson, Clayton Mazur, Hana Busse (all WWU), Delphina Walker-Phelan (LTER REU program)

State Measurements

In addition to the normal NGA LTER station lines (MID, GAK, KOD) and their component intensive stations, this cruise involved a study of the Copper River plume. During the 4-D plume study, CTD casts were done at ~0800, 1600, and 0000 each day. The 0800 casts were treated as intensive stations, as was the CTD cast in the (non-plume) region of the eddy SW of KOD10.

Phytoplankton biomass and performance: Phytoplankton biomass was characterized by size-fractionated chlorophyll at all non-intermediate shelf stations, all plume CTD stations, and PW2 (total = 50 vertical profiles). Samples were analyzed fluorimetrically on board (7 depths per station). Primary production estimates were made at all intensive and morning plume study stations (total = 14) using the 13-C method and 24-h deck incubations. DIC samples to be analyzed by C. Hauri were matched to primary productivity depths in the upper water column where possible. Six 'light depths' were sampled per station based on the attenuation coefficient as estimated from the CTD PAR profile. Chlorophyll (GFF only) and nutrient samples were also taken from each of these productivity depths during experiment set-up.

As part of his thesis work, WWU M.S. student Clay Mazur collected samples for determination of size-fractionated and total community photosynthetic efficiency (Fv/Fm, Walz WaterPAM) at 0 and 10m at most stations and on several iron fish transects. He also collected samples for flow cytometry (*Synechococcus* and picoeukaryote abundance and condition) and for additional chlorophyll size fractionation (<5 µm, 5 to 20 µm, >20 µm) at these depths. Use of the CellROX Green fluorescent probe for phytoplankton intracellular reactive oxygen species (a marker of oxidative stress) was also explored.

Community characterization: Photosynthetic organisms and other protists were sampled at approximately every other shelf station as well as at selected stations in the plume, in the eddy SW of the KOD line, and at PWS2. Samples were fixed in acid Lugol's for standard microzooplankton biomass and composition estimates; these were taken from 10 m only at most stations, from 0 and 10 m at most plume stations, and from 4 depths at intensive stations. At a similar sampling frequency, samples from 10 m were fixed in borate-buffered formalin for diatom characterization. Additional samples collected in conjunction with our NPRB-funded mixotrophy project were i) fixed in glutaraldehyde, DAPI-stained, and made into slides for biomass and composition of nano- and picoplankton, and ii) fixed in HMTA-buffered formalin for inverted-epifluorescence microscopy to assess mixotrophy in ciliates and larger dinoflagellates. At intensive stations only, additional samples were taken from 10 m and one additional euphotic zone depth for HPLC analysis of phytoplankton pigments (chemotaxonomy) and from 10 m only (in duplicate) for molecular (18S rRNA) characterization of the protist community.

Organic carbon characterization: Samples were filtered and frozen at approximately every other shelf station as well as at PWS2 for DOC profiles (total profiles = 19); depths sampled were mainly 150 m and above except in the deep intensive casts, and corresponded to nutrient sampling depths. At intensive stations only (total = 15), a 4-depth vertical profile (0, 10, 20, 40 m) was sampled for POC and PIC.

Process Studies

Seawater dilution experiments: These experiments (7 total) were conducted to understand how river plume-related salinity gradients in the near surface influenced microplankton community composition and rate processes. The dilution experiments were combined with copepod (*Pseudocalanus* sp. adult female) additions in all cases excluding the two experiments conducted at lowest salinities. Rate data obtained from these experiments include: phytoplankton community intrinsic growth rates, degree of phytoplankton growth rate limitation by N+P, and microzooplankton community grazing rates on phytoplankton. All rates were obtained for both <20 µm and >20 µm chlorophyll size fractions. Samples were also taken for flow cytometry which should yield growth and grazing rates specific to the cyanobacteria *Synechococcus* and to the eukaryote picophytoplankton, and allow rate correction for photoacclimation. Rates of grazing on the two phytoplankton size fractions by adult female *Pseudocalanus* have been obtained; later analysis of Lugol's samples should allow us to compute rates of copepod grazing on various microzooplankton taxa and size classes under the different environmental regimes.

Table 4. *Summary of seawater dilution experiments conducted on SKQ2019-15S:*

Exp #	Date	Station	CTD#	Water collection depth	Salinity (approx)	Pseudocalanus treatment?
DE-1	7/4/19	PL-1	22	4	26	Y
DE-2	7/5/19	PL-4	26	4	19.3	--
DE-3	7/6/19	PL-7	30	4	3.3	--
DE-4	7/7/19	PL-10	34	4	29.9	Y
DE-5	7/12/19	GAK-5	52	4	30.9	Y
DE-6	7/13/19	GAK-1	57	4	25	Y
DE-7	7/15/19	KOD-5	59	4	32.2	Y

Iron source experiment: A 5-d incubation experiment was conducted to investigate the effect of iron-rich Copper River plume water, in comparison with added $FeCl_3$, on the offshore HNLC community. After an extensive search for HNLC water (characterized by high salinity, high nitrate and low chlorophyll as indicated on the underway system), we managed to sample a small patch using repeated transits with the iron fish. We speculate that the rich mesoscale eddy field of 2019 combined with the unusually high freshwater runoff led to much less HNLC water in our study area than is typical. The patch we eventually sampled on 7/8/19 was in the vicinity of 57° 23' N and 145° 47' W. The HNLC community so collected was combined with various sources of filtered seawater to create three treatments: i) Control (HNLC community with filtered HNLC water); Iron-enriched (HNLC community combined with filtered HNLC water and spiked with ~3 nM iron chloride); River plume (HNLC community combined with filtered water from an intermediate salinity region of the Copper River plume). Bottles were incubated on deck for up to 5 days with replicate bottles sacrificed at 24-h intervals for sampling of iron in various fractions, chlorophyll, photosynthetic efficiency, and several measures of community composition including molecular analysis of 18s rRNA by Gwenn Hennon. Preliminary observations combined with on-board chlorophyll analysis show that chlorophyll and micro-organisms in the control treatment increased slowly and only modestly overall during the 5-d period (Fig. 18). The $FeCl_3$ treatment sustained an impressive bloom of long, thin diatoms of several species; large chloroplast-retaining ciliates from the

genus *Tontonia* were also abundant. The river plume treatment had intermediate chlorophyll concentrations and a substantially different phytoplankton community than the $FeCl_3$ treatment, with more typical coastal diatom species present after 5 d. Note that all treatments had exactly the same initial plankton community composition, that of the HNLC source water.

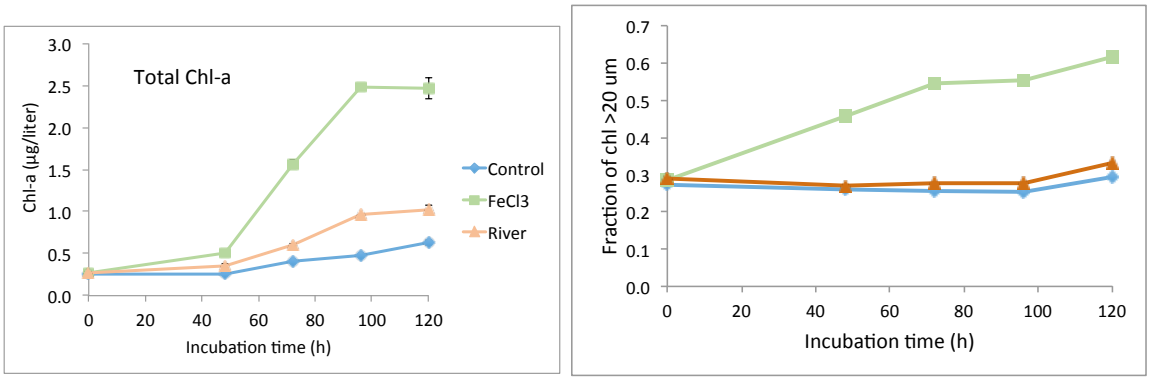

Figure 18. *Preliminary results from the iron source experiment. Left panel shows time course of chlorophyll increase (sum of both size fractions) in the three treatments (averages ±1 SD, error bars smaller than data points in most cases). Right panel shows increased proportion of large cells (mostly diatoms) in the $FeCl_3$ treatment.*

Mixotrophy: WWU M.S. student Hana Busse conducted multiple prey addition experiments to assess the potential for prey uptake by photosynthetic flagellates, including dinoflagellates. Water collected from near the surface was amended with cultured *Synechococcus* sp. and incubated on deck in gradients of light, added N+P concentrations, and added *Synechococcus* prey concentrations. After 4 h, samples were fixed and slides prepared for epifluorescence microscopy determination of prey uptake by different flagellate groups. The goal is to develop functional response curves describing the relationship between grazing rate and environmental gradients (light, nutrients, prey concentration) thought to influence grazing by mixotrophs. Ultimately these curves will be used to inform 'NPZ' model development to include mixotrophy.

Preliminary observations:

Middleton (MID) line: Low chlorophyll (<1.0 at most depths and stations); pronounced SCM except at stns 6 and 7 (tidal mixing due to shallow depth near island). Community composition nearly all small cells except at MID-10 where upper 20 m was ~50% large cells, possibly due to influence of eddy.

Plume (PL) stations: clear evidence of a distinctive surface layer community, with elevated chlorophyll and a higher percentage of large phytoplankton cells, was seen at PL-4, -5, -7, and -9. Large cell contributions were present elsewhere in the water column at PL-3 and PL-10, while chlorophyll profiles at stations PL-1, -2, -6, and -8 were reminiscent of MID line stations. In general, the introduction of fresh water from the Copper River seemed stimulatory to diatoms although the detailed dynamics might be hard to piece together given the coarse vertical resolution of the near-surface sampling with the *Sikuliaq* CTD package.

Seward (GAK) line: Stations offshore of the shelf break (GAK-10 through -15) had generally low chlorophyll (<0.8 µg/liter) but a consistent 15-25% contribution by large cells in the upper 20 m. In contrast, the mid shelf (GAK-4 through GAK-9) looked like most of the MID line, with low chlorophyll

concentrations, a pronounced SCM, and nearly all chlorophyll biomass in small cells. A higher proportion of large cells was seen on the inner shelf, with GAK-2 the biomass winner at 1.6 µg/liter.

Kodiak (KOD) line and offshore eddy: The inner KOD line (KOD-1 through -5) showed spring-like conditions with total chlorophyll ranging from 1.4 to 4.2 in the upper 20 m, and large cells comprising 40% or more of that total. Seaward of KOD-5, stations 6 and 7 had lower chlorophyll and more small cells. By KOD-8 a pronounced SCM of large cells was evident, possibly related to the presence of a mesoscale eddy centered SW of KOD-10. KOD-10 was very oceanic (extremely low chlorophyll, small cells). A station nearer the center of the eddy ('Eddy and the Jets') showed a modest surface layer enrichment of chlorophyll in larger cells, but not to the extent of the inner KOD line.

Phaeopigments were plentiful at many stations, sometimes equaling chlorophyll in their concentration, and reflected the history of grazing and other degradation processes.

Comparing these observations with those from summer 2018, we see a similar pattern of chlorophyll size structure, with large cells primarily associated with fresher surface layers (i.e. the inner ends of the sampling lines) and portions of the Kodiak line.

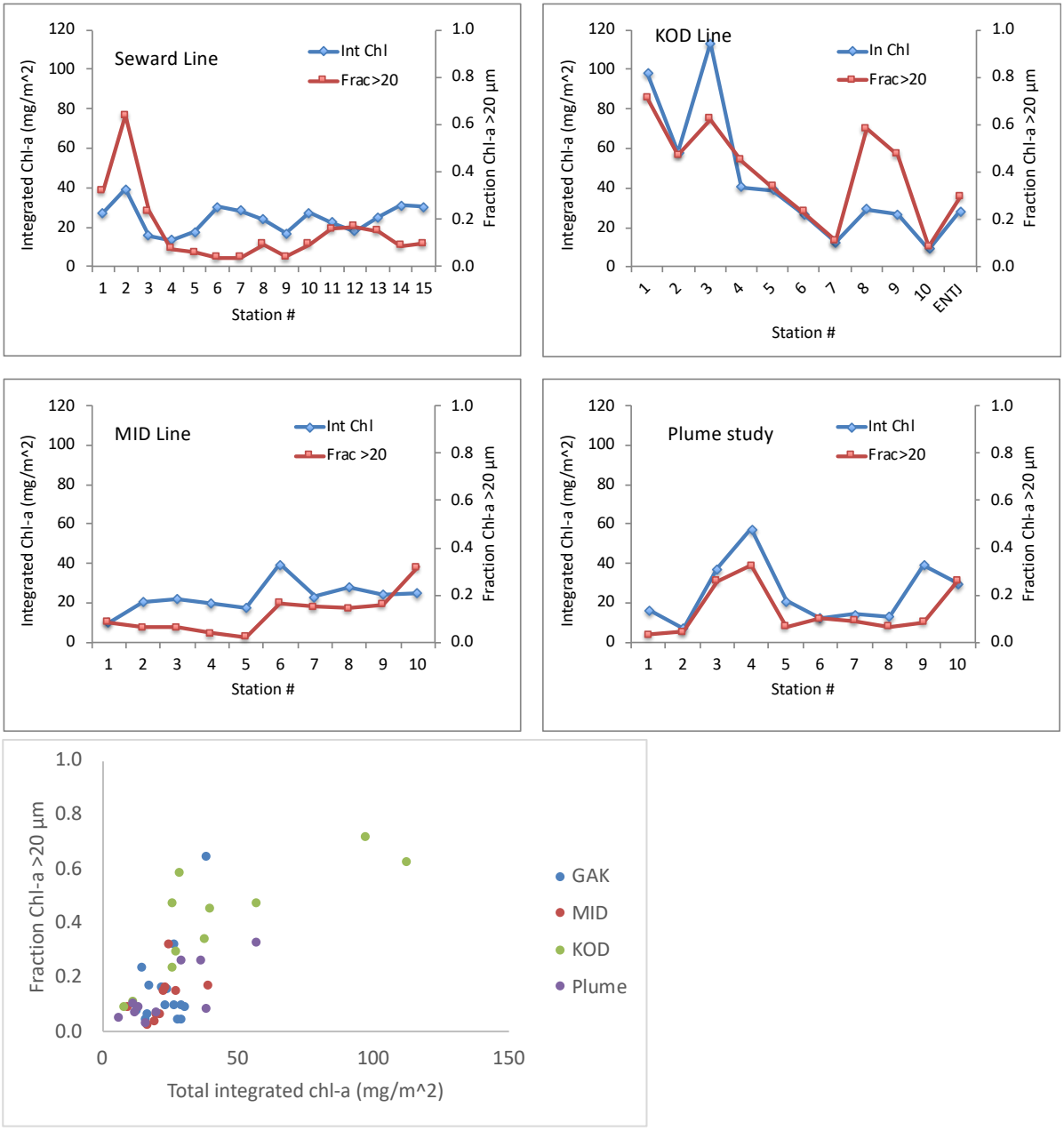

Figure 19. *Summer 2019 chlorophyll-a quantities and size composition. Upper panels: total integrated (surface to 75 m or bottom if shallower) chlorophyll-a, and fraction of total integrated chl-a in cells >20 µm, as a function of station across sampling lines or within plume study. Bottom panel: relationship between total integrated chl-a and size composition of the chlorophyll-containing particles for the 4 study lines/regions.*

Table 5. *Sampling effort for Strom component, by station. Intensive stations shown in* ***red****.*

Station	SF Chl	Lugols µzoo	Diatom	Mixo	Nano/ pico	HPLC	Euk Mol	DOC	POC/ PIC	13C prod
RES2.5	x									
GAK1	x									
PWS2	x	x	x	x	x	x	x	x	x	x
MID1	x	x	x					x		
MID2	x	x	x	x	x	x	x	x	x	x
MID3	x	x	x							
MID4	x	x	x							
MID5	x	x	x	x	x	x	x	x	x	x
MID6	x	x	x							
MID7	x									
MID10	x	x	x	x	x	x	x	x	x	x
MID9	x	x	x							
MID8	x									
PL1	x	x	x	x	x	x	x	x	x	x
PL2	x	x						x		
PL3	x									
PL4	x	x	x	x	x	x	x	x	x	x
PL5	x	x						x		
PL6	x									
PL7	x	x	x	x	x	x	x	x	x	x
PL8	x	x					x			
PL9	x									
PL10	x	x	x	x	x	x	x	x	x	x
GAK15	x	x	x	x	x	x	x	x	x	x
GAK14	x									
GAK13	x	x	x							
GAK9	x	x	x	x	x	x	x	x	x	x
GAK10	x									
GAK11	x	x	x	x	x					
GAK12	x									
GEO	x									
GAK6	x									
GAK7	x	x	x	x	x					
GAK8	x									
GAK5	x	x	x	x	x	x	x	x	x	x
GAK4	x									
GAK3	x	x	x	x	x					
GAK2	x									
GAK1	x	x	x	x	x	x	x	x	x	x
KOD5	x	x	x	x	x	x	x	x	x	x
KOD4	x									
KOD3	x	x	x	x	x					
KOD2	x									
KOD1	x	x	x					x		
KOD6	x									
KOD7	x	x	x							
KOD8	x									
KOD9	x									
EATJ	x	x	x	x	x	x	x	x	x	
KOD10	x	x	x	x	x	x	x	x	x	x
TOTAL	50	30	27	19	19	15	16	19	15	14

Sample Effort Key:

SF Chl: size-fractionated chlorophyll-a; water sample filtered in series through a 20 µm pre-size filter followed by a glass fiber filter (effective pore size 0.7 µm)

Lugol's µzoo: water sample preserved in acid Lugol's iodine solution (final concentration 5%) for microscopy analysis of size and composition of ciliate and dinoflagellate microzooplankton (cells ≥15 µm).

Diatom: water sample preserved in borate-buffered formalin (final concentration xx%) for microscopy analysis of diatom community.

Mixo: water sample preserved in HMTA-buffered formalin (final concentration xx%) and stored in refrigerator for microscopy analysis of mixotrophic ciliates and dinoflagellates.

Nano/pico: water sample pre-screened through 100 µm Nitex mesh, preserved in glutaraldehyde (final concentration 0.5%), and stained with DAPI for on-board filtration and slide preparation. Slides stored frozen for epifluorescence microscopy analysis of cyanobacteria and protists <20 µm in size.

HPLC: water sample filtered (glass fiber, 0.7 µm) and frozen in liquid N_2 for HPLC analysis of phytoplankton pigments (chemotaxonomy).

Euk Mol: water sample filtered (0.2 µm) and frozen in liquid N_2 for molecular analysis of eukaryotic microbial community composition.

DOC: water sample filtered directly from Niskin through pre-combusted glass fiber filter and filtrate stored frozen for analysis of dissolved organic carbon concentration.

POC/PIC: Paired samples from a single Niskin filtered through pre-combusted glass fiber filters and filters stored frozen for analysis of particulate organic and particulate inorganic carbon.

13C prod: Water column primary productivity measured via 24-h incubation of samples from different depths with 13C-labeled sodium bicarbonate.

Particles

PI: Andrew McDonnell

Participant: Stephanie O'Daly

We successfully deployed the drifting sediment trap 9 times during the cruise with a total of 38 individual measurements of flux at different depths (Table 6). These traps drift with the currents and are deployed for short time durations (Figure 20). Up to 5 in-line traps were deployed when water depth allowed. The trap tubes were either filled with a removable cup containing viscous polyacrylamide gel and topped with filtered sea water (0.4 um) or a salty brine spiked with 1% formalin topped with filtered sea water (0.4 um). After recovering the sediment trap, the tubes were allowed to settle for 1 hour before overlying filtered seawater was siphoned. The gels were imaged with light field and dark field backgrounds and will be analyzed to determine sinking flux particle type and size structure. When compared with particle abundance size structure, size specific average sinking velocity can be determined. The fluid in tubes collecting bulk particles was split and filtered for 3 different analyses. A pre-weighed, pre-combusted GFF will be used to determine total mass POC, PON, delta 13-C and delta 15 N of sinking particles. A second pre-combusted GFF will be used to determine PIC and PIN. Thirdly, a 0.45 um PVDF membrane filter will be used to determine silica flux.

Table 6. *Drifting Sediment Trap Deployment Log*

Cast	Station	Seafloor Depth (m)	# Traps	Depth of Traps (m)	Deploy Time	Recover Time	Deployment Length (hours)	Notes on Particle Type
01	PWS2	731	4	80, 105, 130, 155	6/30/2019 17:31	7/1/2019 3:39	10.13	Lithogenic/Fluffy aggregates
02	MID5	93	3	25, 50, 75	7/2/2019 7:31	7/2/2019 22:11	14.67	Long fecal pellets
03	MID10	4464	5	25, 50, 75, 100, 125	7/3/2019 13:26	7/3/2019 21:17	7.85	Rizosilica diatom
04	GAK15	4400	5	25, 50, 75, 100, 125	7/9/2019 6:32	7/10/2019 0:55	18.383	Aggregates and fecal pellets, rizosilica diatom
05	GAK9	270	5	25, 50, 75, 100, 125	7/10/2019 14:07	7/11/2019 7:05	16.967	Fecal pellets and aggregates
06	GAK5	173	4	25, 50, 75, 100	7/12/2019 12:47	7/12/2019 20:18	8.5167	Fecal pellets and pteropods
07	GAK1	269	5	25, 50, 75, 100, 125	7/13/2019 13:00	7/13/2019 20:50	7.833	Fecal pellets and pteropods
08	KOD5	86	2	25, 50	7/15/2019 14:58	7/15/2019 21:19	6.345	pteropods
09	KOD10	2501	5	25, 50, 75, 100, 125	7/17/2019 0:21	7/17/2019 15:54	15.55	pteropods

Particle Dynamics (UVP and LISST)

The LISST collected particle size and abundance data for all CTD casts. A backscatter was performed at the start and end of the cruise to determine if any drift occurred in the instrument.

A total of 50 profiles were collected with the UVP. MID1 was not sampled because the water depth was too shallow. At intensive stations, only the full water column profile from the intensive cast was collected using the UVP and not the partial water column from the productivity cast.

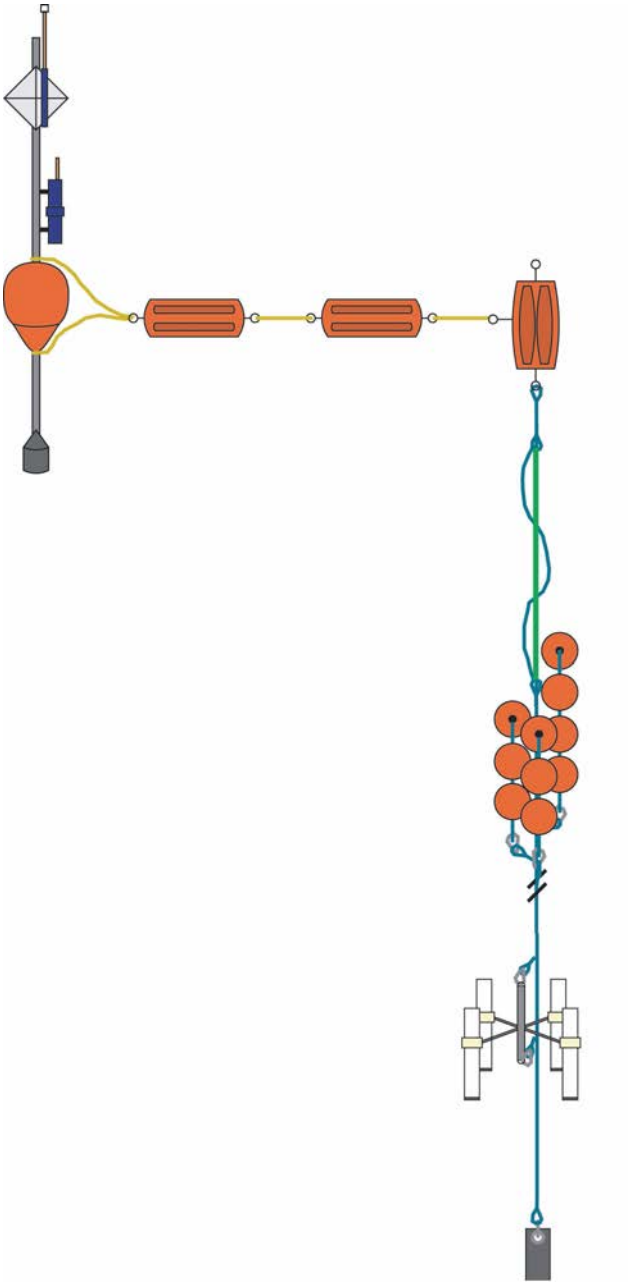

Figure 20. *Drifting Sediment Trap design.*

Microbes and Genetics

PI: Gwenn Hennon

Sample collection at NGA-LTER stations:

At each station four depths including the surface, deep chlorophyll max, pycnocline and bottom depths were filtered for DNA on a 0.2 μm sterivex filter and stored at -80°C (Table 7). These samples will be used to assess the diversity of prokaryotic and eukaryotic microbial communities using 16S/18S rRNA gene amplicon sequencing in collaboration with Eric Collins. In addition, at intensive stations, duplicate water samples from 10 m depth were size fractionated for RNA (20 μm, 3 μm, 0.2 μm pore size) and flash frozen in liquid nitrogen for metatranscriptome analysis (Table 1). Metatranscriptome samples will be used to assess the gene expression activity of prokaryotic and eukaryotic microbes in different size classes (>20 μm, 20-3 μm, 3-0.2 μm) with a particular interest in expression of genes regulating the acquisition of iron along natural gradients of iron availability.

Flow cytometry samples (1 mL in 0.5% glutaraldehyde) were collected from the same depths as each DNA/RNA sample at all stations, fixed for 10-20 min and flash frozen in liquid nitrogen (Table 1). These samples will be analyzed to determine abundances of chlorophyll and phycoerythrin containing cyanobacteria such as *Synechococcus*, eukaryotic picoplankton and nanoplankton and stained to determine abundances of heterotrophic bacteria. At several stations including GAK5, MID2 and the Copper River plume, we noted a distinct pinkish color on the filters which is likely the pigment phycoerythrin- these flow cytometry samples in concert with amplicon sequencing (Collins lab), and pigment analysis (Strom lab) will be able to identify the likely source of those pigments in the phytoplankton community which we suspect to be *Synechococcus* which is an important and under-studied member of the phytoplankton community in the Northern Gulf of Alaska (NGA).

Copper River Plume Study:

The process study of this cruise was a detailed study of the Copper River Plume region. High resolution underway measurements were collected by the Danielson lab via the acrobat and underway collection of water was performed by the Aguilar-Islas lab via a trace metal clean towfish system. During the transits between stations we utilized the trace metal clean water source to collect DNA from surface water over several transects through salinity gradients (Fig. 21). These samples will be analyzed for 16S/18S amplicon sequencing to determine how microbial community structure varies along gradients of salinity around the Copper River Plume. These DNA samples were taken in conjunction with photosynthetic efficiency (Fv/Fm) samples collected by Clay Mazur from the Strom Lab and metals measurements collected by Annie Kandel from the Aguilar-Islas lab. These data will be used to tease apart the impacts of microbial community succession and mixing in plume waters from physiological changes of phytoplankton due to gradients in metal availability. The ultimate result will be to better understand the role of fresh water inputs in shaping microbial community dynamics in the NGA.

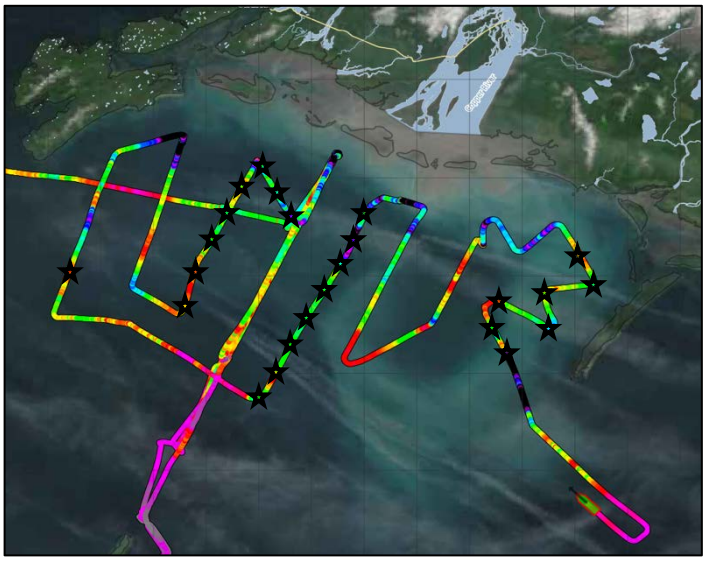

Figure 21. *Approximate locations of the underway DNA samples collected along gradients of salinity in the Copper River Plume (stars).*

HNLC Incubation

Size-fractionated RNA filters were collected from the high nitrate low chlorophyll (HNLC) surface water using the trace metal clean towfish. These metatranscriptome samples can serve as a t_0 for the incubation experiment conducted by the Strom and Aguilar-Islas groups and as a useful comparison to other metatranscriptomes collected from iron replete regions (e.g.: the Copper River Plume). DNA samples were also collected from the incubation experiment at four time points (48, 72, 96, 120 hrs). These samples were collected on a 0.2 micron filter and stored at -80 for amplicon sequencing. Microscopy observations suggest that the phytoplankton communities differed between the control, +$FeCl_3$, and the filtered Copper River Plume water treatments which can be quantified in the analysis of the 18S/16S amplicon sequence data.

Other Synergistic sampling efforts

Other stations of note include Middleton Line 10 (MID10) which sampled the edge of an anticyclonic coastal eddy during an intensive station. We observed large chains of elongated bipolar centric diatoms tentatively identified as *Rhizosolenia*. These diatoms were also collected in the sediment traps and UVP data collected by Stephanie O'Daly from the McDonnell Lab. We collected size fractionated RNA for metatranscriptomics which could be used to analyze the gene expression of large phytoplankton such as *Rhizosolenia* and closely associated heterotrophic bacteria to understand genetic mechanisms of productivity in these summer offshore waters and serve as a contrasting sample to the HNLC initial RNA samples which also contained *Rhizosolenia* cells. I also collected filters for amplicon sequencing from the underway trace metal clean line as we crossed into the middle of the eddy and came out the other side. These samples can be used to assess how microbial community composition varies across the eddy.

Green ciliates were isolated by Suzanne Strom from Station PL4. Ten specimens were preserved in RNA Later for 16S/18S sequencing to determine the phylogeny of the ciliates and the origin of the plastids that are contained within the ciliates. These data are intended to be used to identify sequences of uncultured marine ciliates and their plastid donating prey so these sequences can be located in the sequencing data collected at stations across the NGA and from incubation experiments. This project is a

proof-of-concept towards the goal of determining the ecological role and distribution of kleptoplastic mixotrophs in the NGA.

Table 7: *Summary of microbial and genetic samples collected on SKQ2019-15S.*

Sample Type	No. collected	Volume	Filter size
DNA	269	1-4 L	0.2 μm
RNA	101	2-6 L	0.2, 3, 20μm
Flow cytometry	298	1 mL	unfiltered

Meso/Macro Zooplankton

PI: Russ Hopcroft

Participants: Jennifer Questel, Emily Stidham, Heidi Mendoza-Islas, Kira Monell, Cara Nelson

Standard zooplankton sampling

Zooplankton sampling operations were divided into distinct day and night activities. During daytime, Quadnets (Quad frame has 4 nets, 2 of 150μm mesh and 2 of 53μm mesh) casts were conducted at all stations (except "i" stations) to 100m depth, or within 5m of the bottom at shallower stations. At intensive stations, and additional Quadnet cast was taken, with the 150um net preserved in ethanol for molecular studies and the 53μm nets used for live sorting. Additionally, at intensive stations along the Seward Line and at PWS2, a multinet equipped with 150μm-mesh nets was deployed vertically to 200 m (shelf) with a second cast deployed to 750m (PWS2) dividing strata at 600, 400, 300, 200,100, 60, 40, and 20 m (a vertical multinet could not be completed on the outer Seward Line due to weather). During night-operations a Bongo net of 505μm mesh was towed obliquely to 200m depth (or 5 m above the bottom) at all shelf stations except for the Seward Line where Bongos were often taken during daylight. Bongo depths were monitored using a Fastcat (SBE49) CTD mounted immediately above the nets. Along the Seward Line and within PWS, a multinet equipped with 505μm-mesh nets was towed obliquely to 200m depth (or 5 m above the bottom) dividing strata at 100, 60, 40, and 20 m. Methot nets were collected at night concurrent with most Multinets or Bongos (see Table 4).

During the mesoscale mapping of the Copper River plume, experimental studies were undertaken with *Pseudocalanus* adult females in conjunction with microzooplankton grazing experiments undertaken by Strom. A these sites 100-120 randomly selected *Pseudocalanus* females where incubated in Tissue-culture flasks and checked for the presence of eggs after 24 and 48 hrs in the walk-in incubator set at 13-14°C. Egg-producing females were preserved individually with their clutches, while remaining females were aggregated and preserved. Additional experiments were setup at selected process station on the Seward and Kodiak Lines. Egg production experiments were also setup along the Seward Line (GAK1,5,9) for *Calanus marshallae* using females collected in the drogue net. To our surprise egg

production rates in the Copper River Plume, where surface ambient temperatures exceeded 15°C were close to zero and remained nearly so on the Seward shelf stations. Only at KOD5 where ambient surface temperatures were below 15°C was EPR relatively "normal" (i.e. more than 10 eggs/female/day). *Calanus* egg production was zero at all stations. See Strom's section for grazing experimental setup and results.

At all intensive stations, Calvet samples were sorted for *Neocalanus* species and life-stages to image for body size and lipid sac volume (~50 for each species/stage combination). In general, an entire net was sorted, allowing a preliminary estimate of their species abundances. On the Inner Seward Line, we realized that although Calvets nets were nearly devoid of *Neocalanus*, the Multinets were collecting large numbers of lipid-rich animals below 100m. At GAK1 to GAK3, up to 50 *N. plumchrus* CV and *N. flemingeri* females from the multinet's drogue were imaged for size and lipid volume.

***Neocalanus* physiology**

PI: Petra H. Lenz & Russ Hopcroft

Participant: Kira Monell

Project Goals: *Neocalanus* emergence from diapause (NSF project - UHM & UAF; PIs: Lenz, Hopcroft, Christie and Hartline) – transcriptional profiling of individuals in the genus *Neocalanus* in the adult stage. 2019 marks the 5th year of fall collection of Neocalanus flemingeri from our PWS2 station.

Research Activities:

- Deep collections were taken with MultiNet (150 µm mesh nets) towed vertically from depth (PWS2: 750 m) for samples to enumerate diapausing individuals (no aggregations of Neocalanus found above 300 m).
- Participated in obtaining images of *N. flemingeri*, *N. plumchrus* and *N. cristatus* from PWS2 400-500m strata for prosome length & width and lipid sac volume (up to 50 per species) prior to preservation. A separate subset of *N. flemingeri* were sorted for cell-division experiments and RNA sequencing
- Collected a total of 176 diapausing female *Neocalanus flemingeri,* individuals were collected at PWS2 with MultiNet (max depth 725 m) towed vertically from depth. Individuals were used in three experiments and were either stained in EdU, fixed for *in situ* hybridization, or stored for RT-qPCR across a 4.5 week timeline. Time points for all three experiments were: 0, 24, 36, 72 hr, and 1, 2, 3, 4, 4.5 wks.
- Cell division: termination of diapause and early oogenesis cell division was tracked using EdU in females. Experiments lasted over a 4.5 week period (last 2 weeks were on the OE cruise) with females either being given EdU and fixed immediately or given EdU and returned to flask to track movement of cells.
- *In situ* hybridization: females were fixed and preserved at seven time points post collection, starting at 0 hours and ending at 3 weeks.
- RT-qPCR: 6-8 individuals were placed in RNAlater for RT-qPCR at each of the experimental time points over the 4.5 week period.
- Images of all experimental individuals were taken over the 4.5 week timeline except for the 0 hour time point due to its critical nature. Images were taken to track how lipid sac volume changes as days since collection increases.

Table 8. *Sampling effort for Zooplankton. Intensive stations highlighted. *samples taken for bulk genetics, sorting or imaging.*

Station	Calvet-Quad	Multi Vert.	Multi Tow	Bongo	Methot
RES2.5	x				
GAK1	X*	x	x		x
GAK2	x		x		x
GAK3	x		x		x
GAK4	x		x		x
GAK5	X*	x	x		x
GAK6	x		x		X
GAK7	x		x		x
GAK8	x		x		x
GAK9	X*	x	x		x
GAK10	x		x		x
GAK11	x		x		x
GAK12	x		x		X
GAK13	x		x		X
GAK14	X		x		X
GAK15	X*	x	x		X
KOD1	x			X	x
KOD2	x			X	x
KOD3	x			X	x
KOD4	x			X	x
KOD5	x			X	X
KOD6	x			X	X
KOD7	x			X	x
KOD8	X			X	X
KOD9	X			X	X
KOD10	X			X	X
MID1	x				
MID2	x			X	X
MID3	x			X	X
MID4	x			X	X
MID5	x			X	X
MID6	x			X	X
MID7	x			X	X
MID8	x			X	X
MID9	x			X	X
MID10	x			X	X
KIP2	X*		x		x
PWS1	x		x		x
PWS2	X*	x	x		x
PL1-PL10	10				
TOTAL	**48**	**5**	**18**	**19**	**37**

Marine bird and marine mammal surveys

PI: Kathy Kuletz, U.S. Fish and Wildlife Service

Participant: Dan Cushing, Pole Star Ecological Research LLC

Background

We conducted marine bird and marine mammal surveys in the Northern Gulf of Alaska (NGA), June 29 to July 17, 2019, aboard the 80-m R/V *Sikuliaq*, as a component of the NGA Long-term Ecological Research (NGA-LTER) cruise lead by chief scientist Seth Danielson of the University of Alaska Fairbanks. The two major components of the cruise were 1) station-based sampling of the Seward Line, Middleton Line, and Kodiak Line, and 2) high-resolution sampling using towed instruments such as the Acrobat CTD system. Seabird and marine mammal surveys were conducted when the vessel was underway, including transits between sampling stations, sampling lines, and ports of call, and while conducting high-resolution sampling with towed equipment.

Methods

Observer D. Cushing conducted visual surveys during daylight hours while the vessel was underway. Surveys were conducted from the port side of the bridge (platform height: 9.7m), using a modified line-transect protocol. 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 species identification. Observations were recorded using four perpendicular distance bins: 0-50m, 51-100m, 101-200m, and 201-300m. Observations of rare birds or large flocks, or marine mammals observed outside of the sampling window were recorded as "off-transect". The behavior of each animal was recorded as flying, on water, on ice, or foraging. Birds and mammals on the water or ice, or actively foraging from the air, were recorded continuously. Flying birds were recorded using instantaneous scans (frequency based on ship speed, typically about 1 per minute), to minimize bias due to movement of flying birds. Observations were recorded directly into a laptop computer using software Dlogv3 (R.G. Ford Consulting, Portland, OR) which logged the geographic coordinates of each sighting, as well as the track line and environmental conditions (Beaufort Sea state, weather, glare, ice coverage) at 20 sec intervals. Following completion of the cruise, survey transects were subdivided into 3-km segments, and density values (birds km^{-2}) were calculated for each taxon in each transect segment.

Preliminary results

We conducted 133 hours of surveys totaling 2168 linear km during the June-July 2019 cruise (Figure 22). On-transect, we observed a total of 5075 individuals of 32 species of birds, with an additional 16 species observed off-transect during surveys or while at stations (Table 1). Averaged across all 3-km transect segments, the mean density (all bird species combined) was 8.5 birds km^{-2}. This is the same mean density value observed during the April-May 2019 cruise, and lower than the 10.3 birds km^{-2} observed during July 2018.

The majority (54%; Table 9) of the birds observed during the cruise were fork-tailed storm-petrels. Storm-petrels were frequently observed everywhere except for inshore regions such as Prince William Sound, the Alaska Coastal Current, and the Copper River plume (Figure 23). Dense aggregations of storm-petrels occurred at the shelf-break. Near the shelf-break south of Portlock Bank, over 1500 storm-

petrels were observed within a 15-minute period. Large flocks of storm-petrels also occurred at the shelf-break on the Seward Line.

The second most abundant species of seabird during the summer 2019 cruise was the northern fulmar, which made up 18% of bird observations. As with storm-petrels, fulmars were widely distributed, with the exception of inshore waters (Figure 24). The highest concentrations of fulmars were observed near the shelf-break, over shallow banks, and in some offshore locations.

Tufted puffins comprised 7% of total birds. The highest concentrations of tufted puffins occurred near breeding sites such as Middleton Island and Resurrection Bay (Figure 25). The next most abundant species were black-legged kittiwake and glaucous-winged gull, each of which individually made up 3% of bird observations. In contrast to storm-petrels and fulmars, black-legged kittiwakes and glaucous-winged gulls were both most abundant in inshore waters, as well as near Middleton Island, where both species breed (Figure 26; Figure 27).

Shearwater species made up 3% of total birds, with about two-thirds of shearwaters that were identified to the species level being short-tailed shearwater, and the remainder sooty shearwater (Figure 28). This contrasts with July 2018, when shearwaters made up 24% of all bird observations, and were the third most abundant taxon, after northern fulmar and fork-tailed storm-petrel.

An exciting event during the cruise was four sightings of dark-bellied gadfly petrels, observed over the continental slope approximately 170 km ESE of Kodiak (Figure 29). Photos of these sightings will be reviewed by species experts. The most likely of several possibilities is that these sightings were of Murphy's petrel, *Pterodroma ultima*. If confirmed, these observations would be the first confirmed record of this species in Alaska, and about 3.5° latitude higher than the previous northernmost record of this species.

We observed nine species of marine mammal (Table 10), with 61 individuals on transect and 116 off transect. The most abundant toothed whale (odontocete) species observed was the Dall's porpoise. Dall's porpoises were widely distributed, including inner shelf, middle shelf, and offshore sightings (Figure 30). Groups of killer whales were encountered along all three sampling lines. Sperm whales were observed on the continental slope east of Kodiak.

The most abundant baleen whale (mysticete) species was the fin whale. Most fin whale observations occurred either at or offshore of the shelf-break. An estimated 10 fin whales occurred in a small patch of high-nutrient, low chlorophyll (HNLC) water located and sampled for experiments conducted as part of the plume study. Humpback whales were observed near Montague and Middleton Islands (Figure 31).

Harbor seals occurred in the Copper River plume (Figure 32). A total of four northern fur seals were observed during the cruise, all off the shelf. A Steller Sea lion was observed over the inner shelf on the Middleton Line, and sea otters were observed in Resurrection Bay.

Table 9. *Marine birds observed during the June-July 2019 NGA-LTER cruise. Numbers include on-transect observations only. Species only observed off-transect are indicated by an asterisk.*

Common name	Scientific name	Number	% of total
Harlequin duck	*Histrionicus histrionicus*	*	-
Surf scoter	*Melanitta perspicillata*	*	-
White-winged scoter	*Melanitta fusca*	*	-
Rufous hummingbird	*Selasphorus rufus*	*	-
Black oystercatcher	*Haematopus bachmani*	*	-
Surfbird	*Calidris virgata*	*	-
Rock sandpiper	*Calidris ptilocnemis*	*	-
Red-necked phalarope	*Phalaropus lobatus*	66	1.3
Red phalarope	*Phalaropus fulicaria*	23	0.5
Phalarope spp.	*Phalaropus* spp.	27	0.5
Shorebird spp.	*Charadriidae* or *Scolopacidae* spp.	7	0.1
Pomarine jaeger	*Stercorarius pomarinus*	4	0.1
Parasitic jaeger	*Stercorarius parasiticus*	*	-
Long-tailed jaeger	*Stercorarius longicaudus*	1	< 0.1
Common murre	*Uria aalge*	75	1.5
Thick-billed murre	*Uria lomvia*	1	< 0.1
Pigeon guillemot	*Cepphus columba*	1	< 0.1
Marbled murrelet	*Brachyramphus marmoratus*	21	0.4
Marbled or Kittlitz's	*Brachyramphus* spp.	6	0.1
Ancient murrelet	*Synthliboramphus antiquus*	48	0.9
Cassin's auklet	*Ptychoramphus aleuticus*	1	< 0.1
Parakeet auklet	*Aethia psittacula*	29	0.6
Auklet spp.	*Aethia* or *Ptychoramphus* spp.	2	< 0.1
Rhinoceros auklet	*Cerorhinca monocerata*	63	1.2
Horned puffin	*Fratercula corniculata*	8	0.2
Tufted puffin	*Fratercula cirrhata*	357	7.0
Black-legged kittiwake	*Rissa tridactyla*	133	2.6
Mew gull	*Larus canus*	1	< 0.1
Herring gull	*Larus argentatus*	5	0.1
Glaucous-winged gull	*Larus glaucescens*	134	2.6
Aleutian tern	*Onychoprion aleuticus*	1	< 0.1
Arctic tern	*Sterna paradisaea*	22	0.4
Tern spp.	*Sterna* or *Onychoprion* spp.	1	< 0.1
Pacific loon	*Gavia pacifica*	*	-
Common loon	*Gavia immer*	1	< 0.1
Laysan albatross	*Phoebastria immutabilis*	7	0.1
Black-footed albatross	*Phoebastria nigripes*	119	2.3
Northern fulmar	*Fulmarus glacialis*	920	18.1
Dark gadfly petrel spp.	*Pterodroma ultima* or *solandri*	2	< 0.1
Short-tailed shearwater	*Ardenna tenuirostris*	93	1.8
Sooty shearwater	*Ardenna grisea*	50	1.0
Dark shearwater spp.	*Ardenna spp.*	26	0.5
Fork-tailed storm-petrel	*Oceanodroma furcata*	2773	54.6
Leach's storm-petrel	*Oceanodroma leucorhoa*	37	0.7
Double-crested cormorant	*Phalacrocorax auritus*	*	-
Red-faced cormorant	*Phalacrocorax urile*	*	-
Pelagic cormorant	*Phalacrocorax pelagicus*	5	0.1
Olive-sided flycatcher	*Contopus cooperi*	*	-

Tree swallow	*Tachycineta bicolor*	*	-
White-winged crossbill	*Loxia leucoptera*	*	-
Savannah sparrow	*Passerculus sandwichensis*	*	-
Common yellowthroat	*Geothlypsis trichas*	*	-
Total		**5075**	**100.0**

Table 2. *Marine mammal species observed during the June-July 2019 NGA-LTER cruise.*

Common name	***Scientific name***	**Number on-transect**	**Number off-transect**
Fin whale	*Balaenoptera physalus*	7	27
Humpback whale	*Megaptera novaeangliae*	1	4
Sperm whale	*Physeter macrocephalus*	0	3
Killer whale	*Orcinus orca*	9	11
Whale spp.	*Cetacea* spp.	0	8
Dall's porpoise	*Phocoenoides dalli*	38	53
Northern fur seal	*Callorhinus ursinus*	1	0
Steller sea lion	*Eumetopias jubatus*	2	2
Harbor seal	*Phoca vitulina*	3	5
Sea otter	*Enhydra lutris*	0	3
Total		**61**	**116**

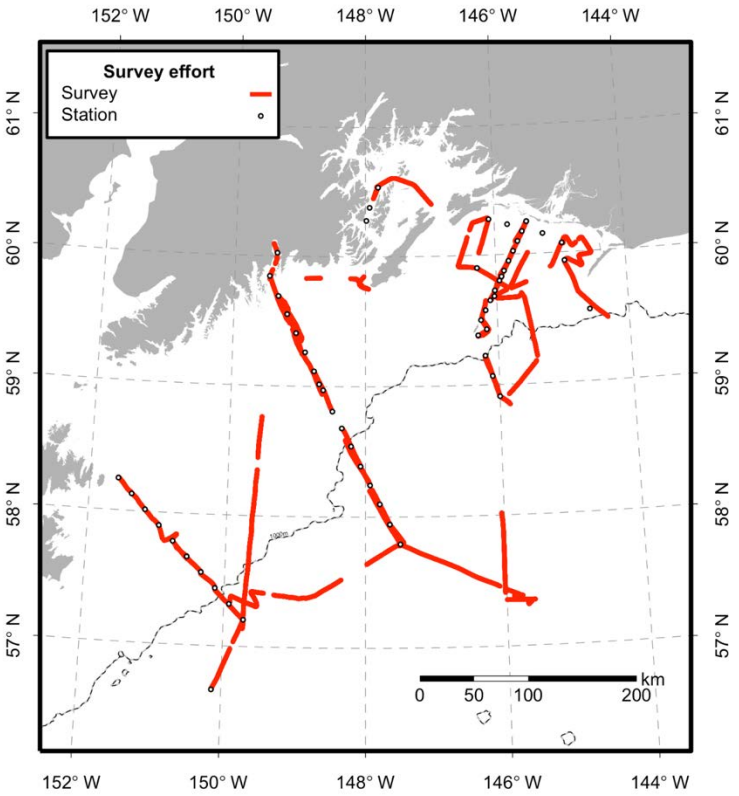

Figure 22. *Location of seabird and marine mammal surveys (red) during the June-July 2019 NGA-LTER cruise.*

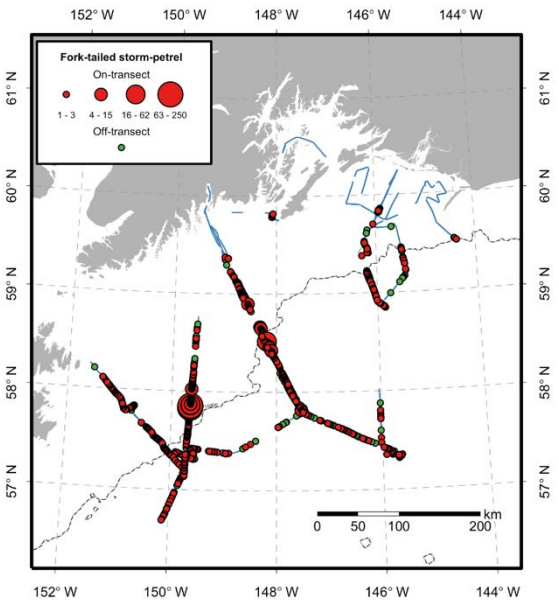

Figure 23. *Fork-tailed storm-petrel.*

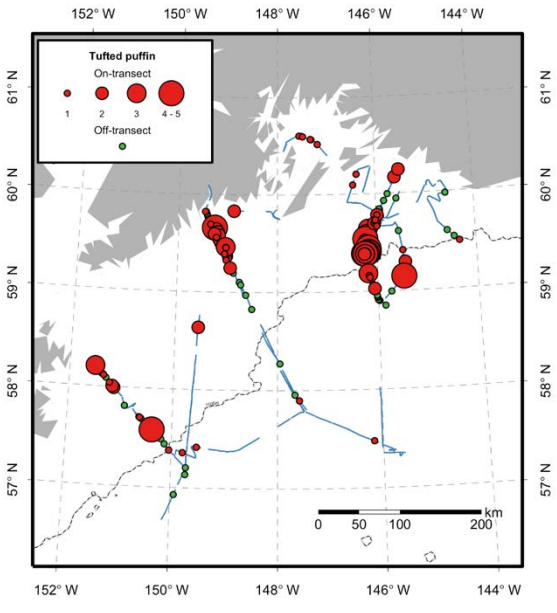

Figure 25. *Tufted puffin.*

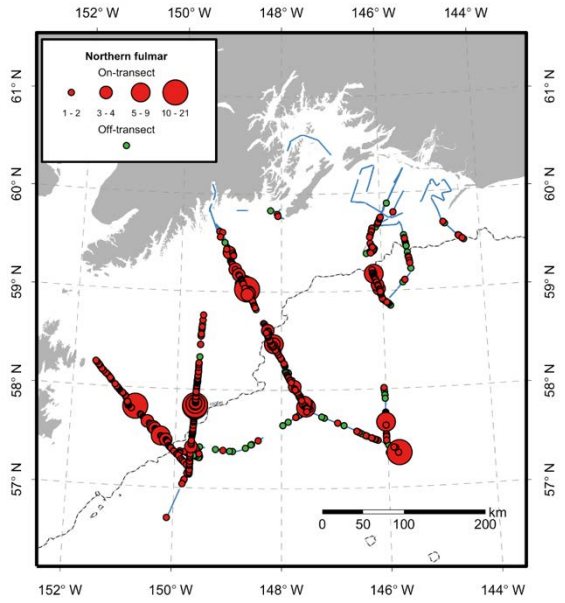

Figure 24. *Northern fulmar.*

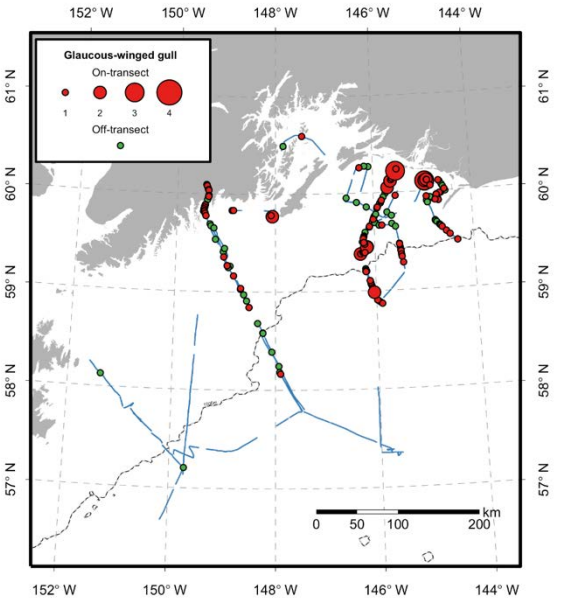

Figure 27. *Glaucous-winged gull.*

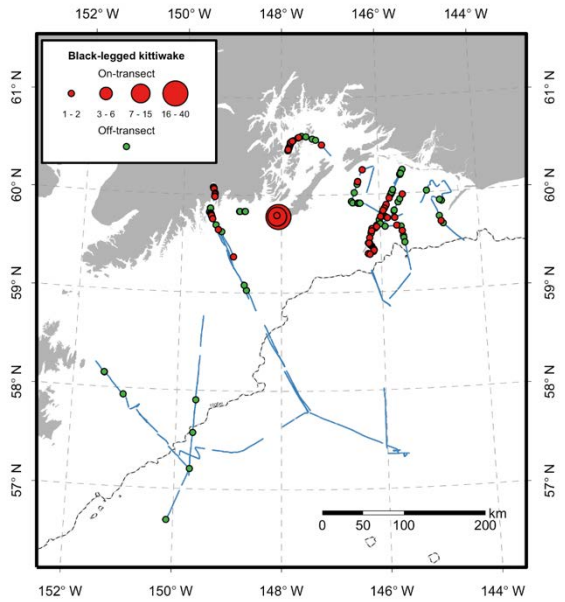

Figure 26. *Black-legged kittiwake.*

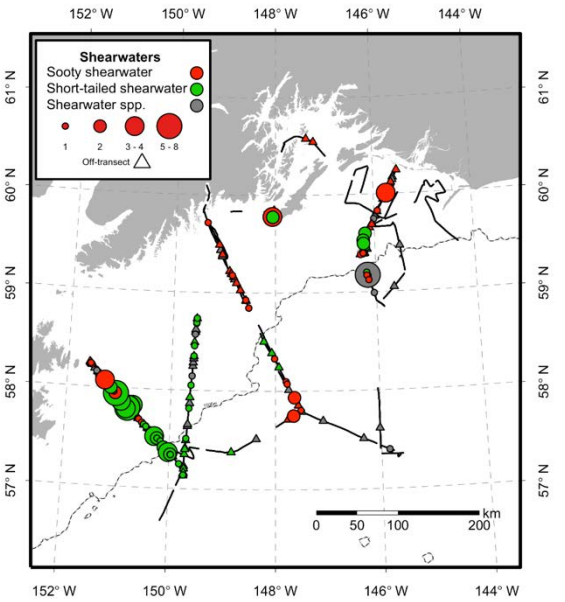

Figure 28. *Shearwater species.*

Figure 29. *Pterodroma petrels observed on July 14, 2019. The upper and lower panels depict separate observations about an hour apart.*

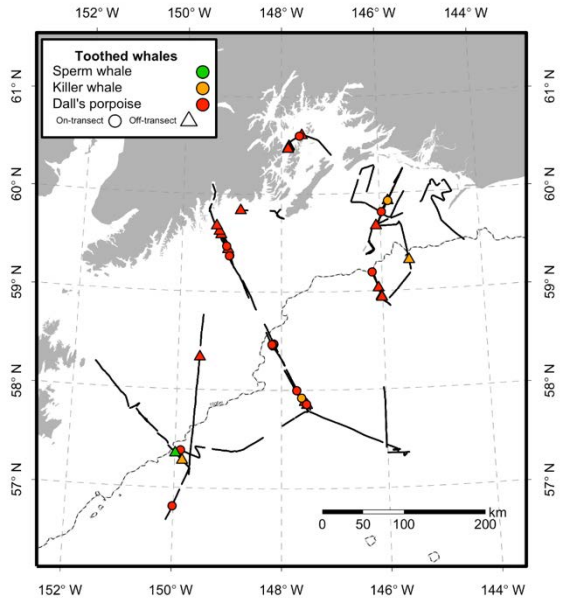

Figure 30. *Toothed whales.*

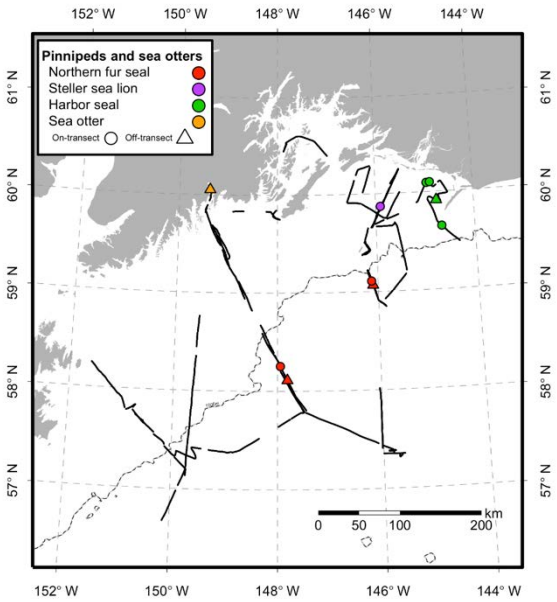

Figure 32. *Pinnipeds and sea otters.*

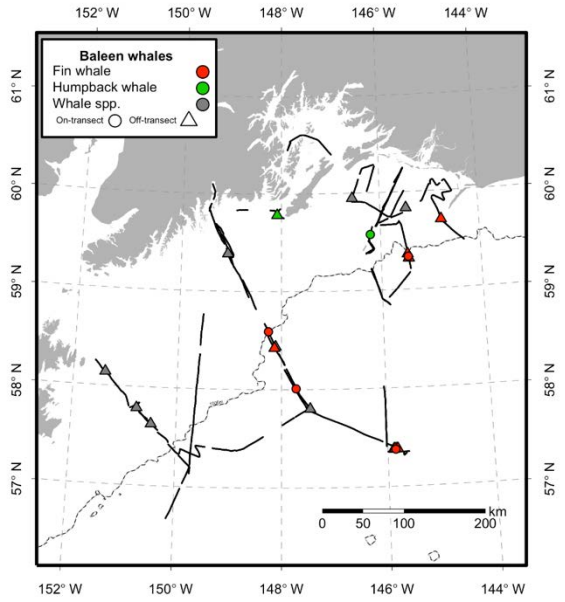

Figure 31. *Baleen whales.*

Appendix A. *Table A1. Standard stations (intensive stations highlighted)*

Latitude N (degrees, minutes)		Longitude W (degrees, minutes)		Station Name	Depth
Resurrection Bay Station					
60	1.5	149	21.5	RES2.5	298
Seward Line					
59	50.7	149	28	GAK1	269
59	46	149	23.8	GAK1I	
59	41.5	149	19.6	GAK2	228
59	37.6	149	15.5	GAK2I	
59	33.2	149	11.3	GAK3	213
59	28.9	149	7.1	GAK3I	
59	24.5	149	2.9	GAK4	201
59	20.1	148	58.7	GAK4I	
59	15.7	148	54.5	GAK5	167
59	11.4	148	50.3	GAK5I	
59	7	148	46.2	GAK6	151
59	2.7	148	42	GAK6I	
58	58.3	148	37.8	GAK7	243
58	52.9	148	33.6	GAK7I	
58	48.5	148	29.4	GAK8	288
58	44.6	148	25.2	GAK8I	
58	40.8	148	21	GAK9	276
58	36.7	148	16.7	GAK9I	
58	32.5	148	12.7	GAK10	1459
58	23.3	148	4.3	GAK11	1410
58	14.6	147	56	GAK12	2134
58	5.9	147	47.6	GAK13	2058
57	*56.6*	*147*	*39*	*GAK14*	*3518*
57	*47.5*	*147*	*30*	*GAK15*	*4543*
Prince William Sound Stations					
60	7.5	147	50	KIP0	
60	16.7	147	59.2	KIP2	588
60	22.78	147	56.17	PWS1	248
60	32.1	147	48.2	PWS2	798
60	40	147	40	PWS3	742
60	49..25	147	24	PWSA	472
60	45	147	14	PWSB	
60	38.1	147	10	PWSC	245
60	31.5	147	7.6	PWSD	
60	24.3	147	58.3	PWSE	291
60	24	146	45	PWSF	
Columbia Glacier					
61	7.4	147	3.8	CG0	
60	59.5	147	4.2	CG1	192
60	57.6	147	5.9	CG2	
Icy Bay					
60	16.3	148	21.7	IB0	
60	15.5	148	20.1	IB1	172
60	16.3	148	14	IB2	157
Montague Strait Line					
59	57.257	147	55.602	MS1	
59	56.6	147	53.7	MS2	194
59	55.9	147	51.4	MS3	169
59	55.2	147	49.7	MS4	119

Latitude N (degrees, minutes)		Longitude W (degrees, minutes)		Station Name	Depth
Kodiak Line					
58	14.7	151	35.4	KOD1	71
58	7.8	151	23.07	KOD2	127
58	0.9	151	10.74	KOD3	84
57	54	150	58.17	KOD4	78
57	47.1	150	45.6	KOD5	87
57	40.26	150	32.97	KOD6	102
57	33.42	150	20.34	KOD7	178
57	26.37	150	7.95	KOD8	708
57	19.32	149	55.56	KOD9	1310
57	12.27	149	43.17	KOD10	2503
Cape Suckling Line					
59	56.35	143	53.5	CS1	63
59	53.85	143	53.5	CS1.25	85
59	51.35	143	53.5	CS1i	104
59	48.85	143	53.5	CS1.75	116
59	46.35	143	53.5	CS2	124
59	41.35	143	53.5	CS2i	134
59	36.35	143	53.5	CS3	193
59	31.35	143	53.5	CS3i	1316
59	26.35	143	53.5	CS4	2010
59	16.35	143	53.5	CS5	2810
Middleton Island Line					
60	15	145	30	MID1	35
60	10.5	145	34.5	MID1i	100
60	6	145	39	MID2	116
60	1.5	145	43.5	MID2i	98
59	57	145	48	MID3	87
59	52.5	145	52.5	MID3i	100
59	48	145	57	MID4	90
59	43.5	146	1.5	MID4i	72
59	39	146	6	MID5	97
59	34.5	146	10.5	MID5i	114
59	30	146	15	MID6	41
59	25.7	146	10	MID6i	65
59	23	146	18	MID7	65
59	18.267	146	15	MID7i	420
59	13.534	146	12	MID8	611
59	4.067	146	6	MID9	2900

Table A2. Event Log

Event #	Description	Station	Date	GMT	Latitude	Longitude	Depth	Scientist	Comments
1	CTD 01 Start	RES2.5	06/29/19	18:00:55	60.0248	149.3576	293	Danielson	CTD cast number added later from R2R log
2	CTD 01 End	RES2.5	06/29/19	18:51:44	60.0248	149.3576	293	Danielson	CTD cast number added later from R2R log
3	CALvet Start	RES2.5	06/29/19	19:11:13	60.0248	149.3576	293	Hopcroft	
4	CALvet End	RES2.5	06/29/19	19:17:00	60.0248	149.3576	293	Hopcroft	
5	CTD 02 Start	GAK1	06/29/19	20:56:47	59.8451	149.4658	270	Danielson	CTD cast number added later from R2R log
6	CTD 02 End	GAK1	06/29/19	21:33:41	59.8451	149.4658	270	Danielson	CTD cast number added later from R2R log
7	Multinet Start	GAK1	06/29/19	21:42:34	59.8451	149.4658	270	Hopcroft	
8	Multinet End	GAK1	06/29/19	21:49:42	59.8451	149.4658	270	Hopcroft	
9	Methot Start	KIP2	06/30/19	9:54:42	60.2576	147.9921	589	Hopcroft	
10	Methot End	KIP2	06/30/19	10:16:48	60.2653	147.9914	589	Hopcroft	
11	Multinet Start	KIP2	06/30/19	10:45:53	60.2724	147.9893	589	Hopcroft	
12	Multinet End	KIP2	06/30/19	11:22:57	60.2885	147.9820		Hopcroft	
13	Methot Start	PWS1	06/30/19	12:13:36	60.3621	147.9463		Hopcroft	
14	Methot End	PWS1	06/30/19	12:33:51	60.3713	147.9405	266	Hopcroft	
15	Multinet End	PWS1	06/30/19	12:49:48	60.3748	147.9380	343	Hopcroft	
16	Multinet End	PWS1	06/30/19	13:36:22	60.3989	147.9204	313	Hopcroft	
17	Methot Start	PWS2	06/30/19	14:34:56	60.5203	147.8161	614	Hopcroft	
18	Methot End	PWS2	06/30/19	14:54:17	60.5295	147.8078	614	Hopcroft	
19	Multinet Start	PWS2	06/30/19	15:17:39	60.5365	147.8025	731	Hopcroft	
20	ISUS service	NaN	06/30/19	15:40:48	60.5469	147.7936		eRoth	s/n 248 - UV light stopped responding; replaced with s/n 077
21	Multinet Start	PWS2	06/30/19	15:49:36	60.5510	147.7901	731	Hopcroft	
22	Sediment Trap Start	PWS2	06/30/19	17:31:34	60.5543	147.7929		Danielson	
23	CTD 03 Start	PWS2	06/30/19	18:14:24	60.5349	147.8042	738	Danielson	CTD cast number added later from R2R log
24	CTD 03 End	PWS2	06/30/19	19:17:23	60.5349	147.8042		Danielson	CTD cast number added later from R2R log
25	TMCTD End	PWS2	06/30/19	20:37:08	60.5349	147.8042	735	Aguilar	
26	CTD 04 Start	PWS2	06/30/19	20:41:14	60.5349	147.8042	735	Danielson	Depth from CTD data file
27	TMCTD Start	PWS2	06/30/19	20:53:02	60.5349	147.8042		Aguilar	
28	CTD 04 End	PWS2	06/30/19	21:28:05	60.5348	147.8042		Danielson	
29	Multinet Start	PWS2	06/30/19	21:40:14	60.5348	147.8042		Hopcroft	vertical deep

30	Multinet End	PWS2	06/30/19	22:23:26	60.5349	147.8042		Hopcroft	
31	Multinet Start	PWS2	06/30/19	22:51:27	60.5349	147.8042	733	Hopcroft	shallow
32	Multinet End	PWS2	06/30/19	23:05:16	60.5349	147.8042	733	Hopcroft	
33	CALvet Start	PWS2	06/30/19	23:41:01	60.5349	147.8042	733	Hopcroft	
34	CALvet End	PWS2	06/30/19	23:47:11	60.5349	147.8042	733	Hopcroft	
35	CALvet Start	PWS2	06/30/19	0:01:37	60.5349	147.8042	733	Hopcroft	genetics
36	CALvet End	PWS2	06/30/19	0:07:11	60.5349	147.8042	733	Hopcroft	
37	Sediment End	PWS2	06/30/19	3:39:50	60.5576	147.7689		Danielson	
38	centerBoard	MID2	07/01/19	16:53:36	NaN	NaN		Danielson	Centerboard set to flush for heading to MID1
39	CTD 05 Start	MID1	07/01/19	18:31:43	60.2490	145.5017	20	Danielson	CTD cast number from R2R log. Position from CTD data file
40	CTD 05 End	MID1	07/01/19	18:54:30			20	Danielson	CTD cast number added later from R2R log
41	CALvet Start	PWS2	07/01/19	19:07:18			15	Danielson	Depth added later
42	CALvet End	PWS2	07/01/19	19:09:23				Danielson	
43	centerBoard	NaN	07/01/19	19:38:29				McKiernan	R2R log stops here. Transition to UAF system
44	CTD 06	MID1i	07/01/19		60.1750	145.5737	100		Position from CTD data file. Start or end is unknown.
45	Iron Fish Start	MID1i	07/01/19	21:00:50	NaN	NaN		Aguilar-Islas	Recorded position was incorrect and removed
46	Iron Fish End	MID2	07/01/19	21:41:59	NaN	NaN		Aguilar-Islas	Recorded position was incorrect and removed
47	CALvet Start	MID2	07/01/19				100		
48	CTD 07	MID2	07/01/19		60.0997	145.6498	122		Position from CTD data file
49	TMCTD Start	MID2	07/01/19	22:00:13	NaN	NaN		Aguilar-Islas	Recorded position was incorrect and removed
50	TMCTD End	MID2	07/01/19	22:30:20	NaN	NaN		Aguilar-Islas	Recorded position was incorrect and removed
51	CTD 08	MID2	07/01/19		60.9933	145.6498	119		Position from CTD data file
52	CTD 09	MID2i	07/01/19		60.0255	145.7238	98		Position from CTD data file
53	CTD 10	MID3	07/01/19		59.9508	145.8012	87		Event log entry created from time and position from CTD data file
54	CALvet Start	MID3	07/01/19				100		
55	CTD 11 Start	MID3i	07/01/19	3:48:45	59.8738	145.8723	103	Danielson	
56	CTD 11 End	MID3i	07/01/19	4:18:44	59.8752	145.8797	103	Danielson	
57	CTD 12 Start	MID4	07/01/19	5:17:45	59.8056	145.9546	94	Danielson	
58	CTD 12 End	MID4	07/01/19	5:39:43	59.8095	145.9524	94	Danielson	
59	CalVet Start	MID4	07/01/19	5:49:57	59.8114	145.9516	97	Hopcroft	
60	CalVet End	MID4	07/01/19	6:01:23	59.8148	145.9540	97	Hopcroft	

61	Sediment Trap Start	MID5	07/01/19	7:31:54	59.6516	146.0951	97	McDonald	
62	Methot Start	MID5	07/01/19	7:54:04	59.6488	146.0933	97	Hopcroft	
63	Methot End	MID5	07/02/19	8:14:13	59.6387	146.0901	97	Hopcroft	
64	Bongo Start	MID5	07/02/19	8:31:37	59.6385	146.0948	100	Hopcroft	
65	Bongo End	MID5	07/02/19	8:48:58	59.6460	146.1083	100	Hopcroft	
66	Methot Start	MID4	07/02/19	10:06:59	59.7847	145.9610	97	Hopcroft	
67	Methot End	MID4	07/02/19	10:26:17	59.7916	145.9513	87	Hopcroft	
68	Bongo Start	MID4	07/02/19	10:38:23	59.7945	145.9503	89	Hopcroft	
69	Bongo End	MID4	07/02/19	10:56:39	59.8001	145.9502	89	Hopcroft	
70	Methot Start	MID3	07/02/19	12:10:47	59.9352	145.8164	86	Hopcroft	
71	Methot End	MID3	07/02/19	12:30:25	59.9429	145.8105	86	Hopcroft	
72	Bongo Start	MID3	07/02/19	12:41:46	59.9473	145.8060	85	Hopcroft	
73	Bongo End	MID3	07/02/19	13:00:35	59.9546	145.7960	85	Hopcroft	
74	Methot Start	MID2	07/02/19	14:06:46	60.0866	145.6643	104	Hopcroft	
75	Methot End	MID2	07/02/19	14:26:48	60.0958	145.6534	104	Hopcroft	
76	Bongo Start	MID2	07/02/19	14:39:00	60.1002	145.6496	117	Hopcroft	
77	Bongo End	MID2	07/02/19	15:05:24	60.1124	145.6351	117	Hopcroft	
78	Iron Fish Start	MID4i	07/02/19	18:45:50	59.6581	146.1595		Aguilar-Islas	
79	Iron Fish End	MID5	07/02/19	18:45:04	59.6580	146.1657		Aguilar-Islas	
80	CTD 13 Start	MID5	07/02/19	19:03:28	59.6492	146.1023	96	Danielson	
81	CTD 13 End	MID5	07/02/19	19:23:24	59.6520	146.1058	96	Danielson	
82	CalVet Start	MID5	07/02/19	19:34:40	59.6519	146.1019	96	Hopcroft	
83	CalVet End	MID5	07/02/19	19:40:33	59.6526	146.1027	96	Hopcroft	
84	CalVet Start	MID5	07/02/19	19:52:28	59.6516	146.1004	96	Hopcroft	genetics
85	CalVet End	MID5	07/02/19	19:58:11	59.6524	146.1003	96	Hopcroft	
86	TMCTD Start	MID5	07/02/19	20:17:16	59.6575	146.1681	96	Aguilar-Islas	Position incorrect? Slightly
87	TMCTD End	MID5	07/02/19	20:30:36	59.6573	146.1687	96	Aguilar-Islas	Position incorrect?
88	CTD 14 Start	MID5	07/02/19	20:53:48	59.6512	146.0979	96	Danielson	
89	CTD 14 End	MID5	07/02/19	21:09:31	59.6524	146.0964	96	Danielson	
90	Sediment Trap Start	MID5i	07/02/19	22:11:55	59.6524	146.1679	93	McDonald	
91	CTD 15 Start	MID6	07/02/19		59.5017	146.2490	43		Position time and depth from CTD data file
92	CTD 15 End	MID6	07/02/19	23:36:05	59.4942	146.2358	43	Danielson	
93	CalVet Start	MID6	07/02/19	23:55:06	59.5002	146.2477	37	Hopcroft	
94	CalVet End	MID6	07/02/19	23:58:09	59.4989	146.2456	37	Hopcroft	

95	CTD 16 Start	MID7	07/02/19	1:12:00	59.3828	146.2998	60		Position time and depth from CTD data file
96	CTD 16 End	MID7	07/02/19	1:34:49	59.3794	146.3024	63	Danielson	
97	CalVet Start	MID7	07/02/19	1:47:20	59.3814	146.3017	63	Hopcroft	
98	CalVet Start	MID7	07/02/19	1:53:00	59.3814	146.3017	64	Hopcroft	
99	Methot Start	MID6	07/02/19	4:36:08	59.5114	146.2365	47	Hopcroft	
100	Methot Start	MID6	07/02/19	4:36:08	59.5114	146.2365	47	Hopcroft	Positions are off for the end because the entry got lost
101	Bongo Start	MID6	07/02/19	4:55:25	59.5143	146.2397	63	Hopcroft	
102	Bongo End	MID6	07/02/19	5:08:52	59.5179	146.2317	63	Hopcroft	
103	Methot Start	MID7	07/02/19	6:49:24	59.3812	146.2812	72	Hopcroft	
104	Methot End	MID7	07/02/19	7:09:31	59.3832	146.2682	88	Hopcroft	
105	Bongo Start	MID7	07/02/19	7:21:33	59.3848	146.2626	88	Hopcroft	
106	Bongo End	MID7	07/02/19	7:40:58	59.3867	146.2476	99	Hopcroft	
107	Methot Start	MID8	07/03/19	9:00:21	59.2382	146.1935	688	Hopcroft	
108	Methot End	MID8	07/03/19	9:20:21	59.2311	146.1944	708	Hopcroft	
109	Bongo Start	MID8	07/03/19	9:32:12	59.2280	146.1962	657	Hopcroft	
110	Bongo End	MID8	07/03/19	9:52:49	59.2201	146.1976	752	Hopcroft	
111	Methot Start	MID9	07/03/19	11:04:27	59.0810	146.1016	2567	Hopcroft	
112	Methot End	MID9	07/03/19	11:24:26	59.0712	146.0945	2567	Hopcroft	
113	Bongo Start	MID9	07/03/19	11:33:49	59.0667	146.0943	2567	Hopcroft	
114	Bongo End	MID9	07/03/19	11:56:39	59.0567	146.0955	2567	Hopcroft	
115	Sediment Trap Start	MID10	07/03/19	13:26:33	58.9089	145.9968	2567	McDonald	
116	Methot Start	MID10	07/03/19	13:33:19	58.9091	146.0017	2567	McDonald	
117	Methot End	MID10	07/03/19	13:53:15	58.9124	146.0136	2567	McDonald	
118	Bongo Start	MID10	07/03/19	14:09:53	58.9127	146.0093	2567	Hopcroft	
119	Bongo Start	MID10	07/03/19	14:36:53	58.9049	145.9713	2567	Hopcroft	
120	TMCTD Start	MID10	07/03/19	15:30:02	58.9054	145.9810	2567	Aguilar-Islas	
121	TMCTD End	MID10	07/03/19	16:15:09	58.9053	145.9810	2567	Aguilar-Islas	
122	CTD 17 Start	MID10	07/03/19	16:40:57	58.9088	145.9941	4443	Danielson	
123	CTD 17 End	MID10	07/03/19	17:04:25	58.9054	145.9842	4443	Danielson	
124	CalVet Start	MID10	07/03/19	17:33:26	58.9129	146.0036	4443	Hopcroft	
125	CalVet End	MID10	07/03/19				4443	Hopcroft	time guess
126	CalVet Start	MID10	07/03/19	17:52:33	58.9107	146.9960	4443	Hopcroft	
127	CalVet End	MID10	07/03/19				4443	Hopcroft	genetics-time guess

128	CTD 18 Start	MID10	07/03/19	20:05:23	58.9107	146.0003	4464	Danielson	start and end have same time but different positions
129	CTD 18 End	MID10	07/03/19	20:05:23	58.9025	145.9845	4464	Danielson	
130	Sediment Trap End	MID10	07/03/19	21:17:01	58.8494	145.8493	4464	McDonald	
131	Iron Fish Start	MID10	07/03/19	21:30:26	58.8697	145.8965	3126	Aguilar-Islas	
132	Iron fish End	MID9	07/03/19	11:30:35	59.0690	146.0959	3126	Aguilar-Islas	
133	CTD 19 Start	MID9	07/03/19	23:37:35	59.0685	146.1003	3126	Danielson	
134	CTD 19 End	MID9	07/03/19	1:06:31	59.0685	146.0887	3126	Danielson	
135	CalVet Start	MID9	07/03/19	1:23:05	59.0681	146.0949	3126	Hopcroft	
136	CalVet End	MID9	07/03/19	1:30:42	59.0681	146.0937	3087	Hopcroft	
137	CTD 20 Start	MID8	07/03/19	2:57:24	59.2251	146.2036	620	Danielson	
138	CTD 20 End	MID8	07/03/19	3:41:51	59.2263	146.2110	539	Danielson	
139	CalVet Start	MID8	07/03/19	3:53:26	59.2258	146.2051	539	Hopcroft	
140	CalVet End	MID8	07/03/19	4:01:04	59.2258	146.2048	539	Hopcroft	
141	Iron Fish Start	MID10	07/03/19	6:18:34	58.9148	145.9967	4440	Aguilar-Islas	
142	Acrobat Start	MID10	07/03/19	6:27:15	58.9172	145.9967	4440	Danielson	
143	Acrobat End	Tow1	07/04/19	16:01:54	59.8314	145.9136	102	Danielson	Between MID4 and MID3i
144	CalVet Start	PL1	07/04/19	16:09:07	59.8309	145.9155	102	Hopcroft	cast to 96m
145	CalVet End	PL1	07/04/19	16:15:32	59.8304	145.9171	102	Hopcroft	for sorting
146	CTD 21 Start	PL1	07/04/19	16:27:41	59.8289	145.9196	102	Strom	
147	CTD 21 End	PL1	07/04/19	16:41:25	59.8277	145.9251	102	Strom	
148	CTD 22 Start	PL1	07/04/19	17:15:13	59.8269	145.9311	102	Strom	
149	CTD 22 End	PL1	07/04/19	17:32:00	59.8272	145.9360	101		
150	Acrobat Start	PL1	07/04/19	18:03:44	59.8439	145.9339	103	Danielson	
151	Drifter deployment	PL1	07/04/19	19:16:45	59.9709	145.7852	84	Danielson	2 sponges 1 microstar
152	USW Strainer Clean Start	transit	07/04/19	20:21:49	60.0887	145.6720	103	Danielson	Clean of uncontaminated seawater throughflow system
153	Acrobat End	transit	07/04/19	20:57:37	60.1472	145.6082	103	Danielson	flight control issues
154	Acrobat Start	transit	07/04/19	21:54:30	60.1514	145.6041	121	Danielson	
155	Drifters Start	transit	07/04/19	21:54:55	60.1517	145.6039	121	Danielson	
156	CalVet Start	PL2	07/04/19	23:30:29	60.2497	145.5013	20	Hopcroft	
157	CalVet End	PL2	07/04/19	23:33:11	60.2497	145.5013	20	Hopcroft	
158	CTD 23 Start	PL2	07/04/19	23:42:50	60.2497	145.5013	20	Hopcroft	adjust times and position
159	CTD 23 End	PL2	07/04/19	23:56:12	60.2497	145.5013	20	Hopcroft	Description originally marked as Start

160	Drifter Deployment 4 Start	Near MID1	07/04/19	2:22:32	60.2488	145.5062	20	Danielson	
161	Acrobat End	PL3	07/04/19	7:46:20	60.2326	145.7998	106	Danielson	
162	CalVet Start	PL3	07/05/19	8:01:29	60.2342	145.8021	102	Hopcroft	
163	CalVet End	PL3	07/05/19	8:11:33	60.2345	145.8032	102	Hopcroft	
164	CTD 24 Start	PL3	07/05/19	8:21:34	60.2348	145.8032	102	Danielson	
165	CTD 24 End	PL3	07/05/19	8:50:00	60.2341	145.8037	102	Danielson	
166	Acrobat Start	PL3	07/05/19	9:16:05	60.2138	145.8238	102	Danielson	Tow # 2 Start. about 15 min late in entry
167	Acrobat Transect Turn	Tow 2	07/05/19	12:08:15	59.9222	146.1030	89	Danielson	
168	Acrobat Transect Turn	Tow 2	07/05/19	12:57:42	59.9691	146.2591	74	Danielson	
169	Acrobat Transect Recovery	Tow 2	07/05/19	15:53:07	60.2755	146.0857	60	Danielson	
170	CalVet Start	PL4	07/05/19	16:06:39	60.2759	146.0863	60	Hopcroft	cv21
171	CalVet End	PL4	07/05/19	16:11:07	60.2760	146.0867	60	Hopcroft	
172	CTD 25 Start	PL4	07/05/19	16:20:09	60.2761	146.0867	60	Danielson	
173	CTD 25 End	PL4	07/05/19	16:48:50	60.2777	146.0837	60	Danielson	
174	CalVet Start	PL4	07/05/19	16:57:00	60.2783	146.0833	60	Hopcroft	repeat for sorting
175	CalVet End	PL4	07/05/19	17:00:58	60.2788	146.0831	60	Hopcroft	
176	CTD 26 Start	PL4	07/05/19	17:30:56	60.2835	146.0827	54	Danielson	full cast
177	CTD 26 End	PL4	07/05/19	18:00:17	60.2850	146.0823	54	Danielson	
178	Acrobat Continue	Tow 2	07/05/19	18:34:11	60.2822	146.1379	54	Danielson	
179	Acrobat Turn near Hinchinbr. Isl.	Tow 2	07/05/19	19:29:06	60.2519	146.3320	54	Danielson	
180	Acrobat End	Tow 2	07/05/19	23:54:44	59.9023	146.2926	78	Danielson	
181	CalVet Start	PL5	07/05/19	0:05:54	59.9022	146.2885	80	Hopcroft	75m
182	CalVet End	PL5	07/05/19	0:09:48	59.9021	146.2883	80	Hopcroft	
183	CTD 27 Start	PL5	07/05/19	0:23:08	59.9014	146.2877	79	Danielson	
184	CTD 27 End	PL5	07/05/19	0:37:50	59.9015	146.2852	79	Danielson	
185	Acrobat Continue	Tow 2	07/05/19	1:00:00	59.9015	146.2852	79	Danielson	
186	Acrobat Start	Acrobat Turn	07/05/19	3:16:14	59.7477	145.8186	90	Danielson	
187	CalVet Start	PL6	07/06/19	8:07:46	60.1529	145.2581	54	Hopcroft	

188	CalVet End	PL6	07/06/19	8:12:01	60.1532	145.2579	52	Hopcroft	
189	CTD 28 Start	PL6	07/06/19	8:25:08	60.1542	145.2593	52	Danielson	
190	CTD 28 End	PL6	07/06/19	8:43:16	60.1543	145.2593	52	Danielson	
191	Acrobat Start	Acrobat Continue	07/06/19	9:00:16	60.1543	145.2593	52	Danielson	
192	Acrobat Turn	Acrobat Turn	07/06/19	9:20:26	60.1409	145.1771	52	Danielson	
193	Acrobat Start	Acrobat Turn	07/06/19	12:23:44	59.8365	145.4698	52	Danielson	
194	Acrobat Start	Acrobat Turn	07/06/19	14:10:37	59.9014	145.1429	156	Danielson	
195	Acrobat End	Acrobat recovery	07/06/19	15:59:57	60.0727	144.9682	106	Danielson	
196	CalVet Start	PL7	07/06/19	16:01:15	60.0727	144.9675	106	Hopcroft	
197	CalVet Start	PL7	07/06/19	16:10:50	60.0727	144.9630	106	Hopcroft	
198	CalVet End	PL7	07/06/19	16:17:26	60.0718	144.9615	106	Hopcroft	
199	CTD 29 Start	PL7	07/06/19	16:28:54	60.0705	144.9585	109	Danielson	prod cast
200	CTD 29 End	PL7	07/06/19	16:42:31	60.0693	144.9559	109	Danielson	prod cast
201	CTD 30 Start	PL7	07/06/19	17:29:42	60.0651	144.9506	110	Danielson	full cast. last event record
202	CTD 30 End	PL7	07/06/19	17:50:27	60.0626	144.9475	110	Danielson	
203	Acrobat Start	PL7	07/06/19	18:28:13	60.0988	144.9443	110	Danielson	turn
204	Acrobat turn	Acrobat Turn	07/06/19	19:28:08	60.0502	144.7995	197	Danielson	Turn
205	Acrobat turn	Acrobat Turn	07/06/19	20:11:49	60.1041	144.6725	112	Danielson	
206	Acrobat turn	Acrobat Turn	07/06/19	21:23:38	59.9903	144.5256	133	Danielson	
207	Acrobat turn	Acrobat Turn	07/06/19	22:13:33	59.9677	144.7103	243	Danielson	
208	Acrobat turn	Acrobat Turn	07/06/19	23:52:55	59.9479	144.8854	212	Danielson	
209	Acrobat End	Acrobat	07/06/19	0:15:40	59.9366	144.9393	212	Danielson	
210	CalVet Start	PL8	07/06/19	0:19:51	59.9366	144.9393	205	Hopcroft	
211	CalVet End	PL8	07/06/19	0:26:45	59.9363	144.9400	205	Hopcroft	

212	CTD 31 Start	PL8	07/06/19	0:37:28	59.9363	144.9402	205	Danielson	full cast
213	CTD 31 End	PL8	07/06/19	1:03:17	59.9363	144.9402	205	Danielson	
214	Acrobat Start	PL8-Acrobat Start	07/06/19	1:18:05	59.9332	144.9391	203	Danielson	
215	Acrobat turn	PL8-Acrobat turn	07/06/19	3:31:14	59.6947	144.7598	100	Danielson	
216	Acrobat turn	Acrobat turn	07/06/19	6:15:30	59.4720	144.3238	1535	Danielson	
217	Acrobat turn	Acrobat turn	07/06/19	6:38:30	59.4558	144.3920	1535	Danielson	
218	Acrobat End	PL9	07/06/19	7:56:02	59.5514	144.5911	1535	Danielson	
219	CalVet Start	PL9	07/07/19	8:12:01	59.5516	144.5928	158	Hopcroft	
220	CalVet End	PL9	07/07/19	8:17:09	59.5514	144.5938	158	Hopcroft	
221	CTD 32 Start	PL9	07/07/19	8:28:29	59.5506	144.5943	158	Hopcroft	
222	CTD 32 End	PL9	07/07/19	8:55:00	59.7712	145.0220	158	Danielson	
223	Acrobat Start	PL9	07/07/19	9:00:00	59.7716	145.0230	158	Danielson	
224	Acrobat Start	acrobat turn	07/07/19	12:08:56	59.7720	145.0239	176	Danielson	
225	Acrobat	acrobat turn	07/08/19	13:31:00	59.6929	145.3159	109		typo fixed in latitude (extra decimal point)
226	Acrobat	acrobat turn	07/08/19	14:45:00	59.7834	145.5227	119		typo fixed in latitude (extra decimal point)
227	Acrobat End	Acrobaqt Recovery	07/07/19	17:02:01	59.6864	146.0287	76	Danielson	
228	CalVet Start	PL10	07/07/19	17:14:36	59.6812	146.0346	78	Hopcroft	
229	CalVet End	PL10	07/07/19	17:19:29	59.6795	146.0369	78	Hopcroft	
230	CTD 33 Start	PL10	07/07/19	17:27:13	59.6771	146.0396	78	Danielson	
231	CTD 33 End	PL10	07/07/19	17:51:51	59.6711	146.0456	78	Danielson	
232	CTD 34 Start	PL10	07/07/19	18:37:17	59.6678	146.0747	78	Danielson	
233	CTD 34 End	PL10	07/07/19	19:02:42	59.6680	146.0854	78	Danielson	
234	MULTIBEAM Start	mb off	07/07/19	1:08:13	59.2984	145.4436	nAn	Danielson	TURN OF MULTIBEAMFOR DEEP WATER AND ADCP PINGS
235	Acrobat Start	ACROBAT TRANS	07/07/19	2:02:58	59.1889	145.4194	nAn	Danielson	

236	Acrobat TURN	ACROBAT TRANS	07/07/19	6:42:40	58.8027	146.0902	4236	Danielson	
237	Acrobat End	ACROBAT TRANS	07/08/19	14:13:05	57.9675	146.0264	4371	Danielson	CHART DEPTH
238	Iron Fish End	fISH TRANS	07/08/19	14:13:54	57.9660	146.0261	4371	Aguilar-Islas	
239	Iron Fish Start	Fe ADD SW COL.	07/08/19	19:32:41	57.3421	145.6405	4371	Aguilar-Islas	
240	IRON FISH END		07/08/19						ESTIMATE END OF OP
241	MAPPING Start	TRANSIT	07/08/19	1:05:40	57.4062	145.8862	3949	Hopcroft	
242	Sediment Trap Start	GAK15	07/08/19	6:32:41	57.7800	147.4762	4854	McDonald	
243	Sediment Trap Start	GAK15	07/08/19	6:58:42	57.7796	147.4875	4854	McDonald	
244	Methot Start	GAK15	07/08/19	7:00:37	57.7804	147.4893	4854	Coyle	
245	Methot End	GAK15	07/08/19	7:20:21	57.7895	147.5036	4854	Coyle	
246	MultiNet Start	GAK15	07/08/19	7:38:24	57.7931	147.5043	4854	Coyle	
247	MultiNet End	GAK15	07/09/19	8:20:06	57.8145	147.5225	4854	Coyle	
248	Methot Start	GAK14	07/09/19	9:20:57	57.9331	147.6423	3337	Hopcroft	
249	Methot End	GAK14	07/09/19	9:35:17	57.9424	147.6490	3337	Hopcroft	
250	MultiNet Start	GAK14	07/09/19	9:47:33	57.9504	147.6535	3315	Hopcroft	
251	MultiNet End	GAK14	07/09/19	10:32:35	57.9807	147.6730	3315	Hopcroft	
252	Methot Start	GAK13	07/09/19	11:25:21	58.0830	147.7775	2049	Hopcroft	
253	Methot End	GAK13	07/09/19	11:46:04	58.0926	147.7882	2049	Hopcroft	
254	MultiNet Start	GAK13	07/09/19	11:56:08	58.0975	147.7932	2065	Hopcroft	
255	MultiNet End	GAK13	07/09/19	12:41:26	58.1179	147.8087	1959	Hopcroft	
256	Methot Start	GAK12	07/09/19	13:40:46	58.2318	147.9277	2128	Hopcroft	
257	Methot End	GAK12	07/09/19	14:00:29	58.2389	147.9358	2128	Hopcroft	
258	MultiNet Start	GAK12	07/09/19	14:16:23	58.2418	147.9379	2128	Hopcroft	
259	MultiNet End	GAK12	07/09/19	15:00:54	58.2167	147.9127	2128	Hopcroft	
260	Iron Fish Start	ARRIVING GAK15	07/09/19	17:25:56	57.8500	147.5595	3945	Aguilar-Islas	
261	Vert Multinet Start	GAK15	07/09/19	18:10:51	57.7913	147.4984	4400	Hopcroft	
262	Iron Fish End	GAK15	07/09/19	18:15:11	57.7909	147.4988	4400	Aguilar-Islas	
263	Vert Multinet End	GAK15	07/09/19	19:23:39	57.7946	147.5021	4400	Hopcroft	
264	CTD 35 Start	GAK15	07/09/19	19:35:33	57.7928	147.5011	4400	Danielson	
265	CTD 35 End	GAK15	07/09/19	20:10:20	57.7931	147.5011	4400	Danielson	

266	Vert Multinet Start	GAK15	07/09/19	20:14:34	57.7920	147.5056	4400	Hopcroft	shallow
267	Vert Multinet End	GAK15	07/09/19	20:27:37	57.7919	147.5055	4400	Hopcroft	
268	TMCTD Start	GAK15	07/09/19	20:44:17	57.7920	147.5000	4400	Aguilar-Islas	
269	TMCTD End	GAK15	07/09/19	21:56:46	57.8003	147.5001	4400	Aguilar-Islas	
270	CalVet Start	GAK15	07/09/19	22:11:02	57.7907	147.5002	4400	Hopcroft	
271	CalVet End	GAK15	07/09/19	22:17:47	57.7909	147.5004	4400	Hopcroft	
272	CalVet Start	GAK15	07/09/19	22:26:56	57.7907	147.5012	4400	Hopcroft	genetics
273	CalVet End	GAK15	07/09/19	22:34:07	57.7911	147.5014	4400	Hopcroft	
274	CTD 36 Start	GAK15	07/09/19	22:45:06	57.7923	147.5036	4400	Danielson	
275	CTD 36 End	GAK15	07/09/19	23:59:06	57.7923	147.5036	4400		
276	Sediment Trap End	GAK15	07/09/19	0:55:37	57.8000	147.4551	4400	Danielson	
277	CalVet Start	GAK14	07/09/19	2:13:46	57.9436	147.6457	3073	Hopcroft	
278	CalVet End	GAK14	07/09/19	2:20:54	57.9436	147.6436	3073	Hopcroft	
279	CTD 37 Start	GAK14	07/09/19	2:39:47	57.9433	147.6407	3187	Danielson	
280	CTD 37 End	GAK14	07/09/19	3:57:19	57.9375	147.6496	3187	Danielson	cast 37 file crashed as CTD returning to the surface
281	CTD 38 Start	GAK14	07/09/19	4:05:14	57.9423	147.6497	3187	Danielson	Redoing 10m to surface of cast 37
282	CTD 38 End	GAK14	07/09/19	4:05:27	57.9423	147.6497	3187	Danielson	
283	CTD 39 Start	GAK14	07/09/19	4:33:44	57.9423	147.6498	3187	Danielson	2nd recast for 10 and 0 m bottles and par over upper 30
284	CTD 39 End	GAK14	07/09/19	4:38:47	57.9415	147.6502	3187	Danielson	2nd recast for 10 and 0 m bottles and par over upper 30
285	CTD 40 Start	GAK13	07/09/19	6:12:57	58.0977	147.7961	2068	Danielson	
286	CTD 40 End	GAK13	07/09/19	7:21:52	58.0996	147.8115	2063	Danielson	
287	CalVet Start	GAK13	07/09/19	7:32:21	58.1004	147.8069	2021	Hopcroft	sample collected in darkness
288	CalVet End	GAK13	07/09/19	7:44:01	58.1014	147.8078	2021	Hopcroft	
289	Methot Start	GAK11	07/10/19	9:36:26	58.3768	148.0551	1426	Hopcroft	
290	Methot End	GAK11	07/10/19	9:56:09	58.3864	148.0628	1426	Hopcroft	
291	MultiNet Start	GAK11	07/10/19	10:07:35	58.3909	148.0682	1426	Hopcroft	
292	MultiNet End	GAK11	07/10/19	10:50:57	58.4105	148.0871	1426	Hopcroft	
293	Methot Start	GAK10	07/10/19	11:48:14	58.5247	148.2022	1565	Hopcroft	
294	Methot End	GAK10	07/10/19	12:08:20	58.5312	148.2067	1534	Hopcroft	
295	MultiNet Start	GAK10	07/10/19	12:19:21	58.5350	148.2090	1516	Hopcroft	
296	MultiNet End	GAK10	07/10/19	13:04:43	58.5519	148.2217	1516	Hopcroft	

297	Sediment Trap Start	GAK9	07/10/19	14:07:04	58.6621	148.3421	269	McDonald	
298	Methot Start	GAK9	07/10/19	14:24:25	58.6665	148.3473	272	Hopcroft	
299	Methot End	GAK9	07/10/19	14:45:09	58.6797	148.3553	272	Hopcroft	
300	Iron Fish Start	GAK9	07/10/19	14:58:55	58.6833	148.3581	272	Hopcroft	
301	MultiNet Start	GAK9	07/10/19	15:02:45	58.6834	148.3552	272	Hopcroft	
302	MultiNet End	GAK9	07/10/19	15:50:04	58.6814	148.3147	272	Hopcroft	
303	Iron Fish End	GAK9	07/10/19	15:50:04	58.6814	148.3147	272		
304	Vert Multinet Start	GAK9	07/10/19	16:20:07	58.6809	148.3494	278	Hopcroft	
305	Vert Multinet End	GAK9	07/10/19	16:34:11	58.6817	148.3522	278	Hopcroft	
306	CTD 41 Start	GAK9	07/10/19	16:45:47	58.6829	148.3553	278	Danielson	Prim Prod
307	CTD 41 End	GAK9	07/10/19	4:12:00	58.6812	148.3549	278	Danielson	Prim Prid
308	TMCTD Start	GAK9							
309	TMCTD End	GAK9	07/10/19	18:00:01	58.6821	148.3486	278	Aguilar-Islas	
310	CalVet Start	GAK9	07/10/19	18:05:14	58.6822	148.3478	278	Hopcroft	
311	CalVet End	GAK9	07/10/19	18:11:09	58.6821	148.3468	278	Hopcroft	
312	CalVet Start	GAK9	07/10/19	18:21:43	58.6815	148.3477	278	Hopcroft	genetics
313	CalVet End	GAK9	07/10/19	18:27:31	58.6815	148.3468	278	Hopcroft	
314	CTD 42 Start	GAK9	07/10/19	18:35:53	58.6815	148.3468	278	Danielson	
315	CTD 42 End	GAK9	07/10/19	19:21:11	58.6827	148.3437	278	Danielson	
316	service Start	Before GAK10	07/10/19	20:10:43	58.5423	148.2116	NaN	Danielson	Uncontaminated seawater throughflow strainter changed
317	CalVet Start	GAK10	07/10/19	20:34:00	58.5421	148.2103	1450	Hopcroft	
318	CalVet End	GAK10	07/10/19	20:40:21	58.5427	148.2084	1450	Hopcroft	
319	CTD 43 Start	GAK10	07/10/19	20:55:07	58.5405	148.2162	1462	Danielson	
320	CTD 43 End	GAK10	07/10/19	22:22:53	58.5405	148.2121	1462	Danielson	
321	CalVet Start	GAK11	07/10/19	23:33:16	58.3886	148.0721	1413	Hopcroft	
322	CalVet End	GAK11	07/10/19				1414	Hopcroft	
323	CTD 44 Start	GAK11	07/10/19	23:53:34	58.3885	148.0716	1414	Danielson	
324	CTD 44 End	GAK11	07/10/19	1:10:46	58.3177	148.0054	1414	Danielson	
325	CalVet Start	GAK12	07/10/19	2:20:50	58.2454	147.9366	2139	Hopcroft	
326	CalVet End	GAK12	07/10/19	2:27:10	58.2447	147.9353	2139	Hopcroft	
327	CTD 45 Start	GAK12	07/10/19	2:42:41	58.2441	147.9336	2176	Danielson	
328	CTD 45 End	GAK12	07/10/19	4:01:11	58.2442	147.9334	2176	Danielson	
329	Sediment Trap End	GAK9	07/10/19	7:05:29	58.6447	148.3503	270	McDonald	

330	MultiNet Start	GAK9	07/10/19	7:59:33	58.6652	148.3435	270	Hopcroft	
331	MultiNet End	GAK9	07/11/19	8:52:29	58.6922	148.3360	270	Hopcroft	
332	Mapping End	GAK7-6I	07/11/19	11:21:01	59.0169	148.6978	233	Danielson	
333	CTD 46 Start	mooring survey	07/11/19	11:29:53	59.0163	148.6981	233	Danielson	mooring survey for sound speed
334	CTD 46 End	mooring survey	07/11/19	11:44:39	59.0142	148.6992	233	Danielson	
335	multibeam Start	mooring survey	07/11/19	12:07:12	59.0133	148.7262	230	Danielson	
336	Mooring Deploy	GEO3	07/11/19	16:51:54	59.0016	148.6801	230	Danielson	
337	Mooring Release	GEO3	07/11/19	17:50:52	59.0167	148.6969	230	Danielson	
338	CTD 47 Start	GEO	07/11/19	22:46:51	59.0170	148.6913	230	Danielson	
339	CTD 47 End	GEO	07/11/19	23:16:39	59.0170	148.6913	230	Danielson	
340	CalVet Start	GEO	07/11/19	23:34:24	59.0170	148.6913	230	Hopcroft	
341	CalVet End	GEO	07/11/19	23:40:58	59.0172	148.6913	230	Hopcroft	
342	CalVet Start	GAK6	07/11/19	0:31:04	59.1165	148.7690	151	Hopcroft	
343	CalVet End	GAK6	07/11/19	0:37:06	59.1168	148.7692	151	Hopcroft	
344	CTD 48 Start	GAK6	07/11/19	0:44:22	59.1170	148.7693	151	Danielson	
345	CTD 48 End	GAK6	07/11/19	1:11:36	59.1170	148.7693	151	Danielson	
346	CalVet Start	GAK7	07/11/19	2:19:45	58.9737	148.6283	240	Hopcroft	
347	CalVet End	GAK7	07/11/19	2:26:05	58.9733	148.6278	240	Hopcroft	
348	CTD 49 Start	GAK7	07/11/19	2:36:08	58.9731	148.6275	240	Danielson	
349	CTD 49 End	GAK7	07/11/19	3:05:33	58.9739	148.6261	240	Danielson	
350	CalVet Start	GAK8	07/11/19	4:29:39	58.8102	148.4935	290	Hopcroft	
351	CalVet End	GAK8	07/11/19	4:35:53	58.8107	148.4940	290	Hopcroft	
352	CTD 50 Start	GAK8	07/11/19	4:49:25	58.8107	148.4938	290	Danielson	writing failed at 250m (the bottom)
353	CTD 50 End	GAK8	07/11/19	5:03:01	58.8112	148.4933	289	Danielson	Failed to write data to archive
354	CTD 51 Start	GAK8	07/11/19	5:03:36	58.8112	148.4933	289	Danielson	Continuation of cast 50 starting at 250m
355	CTD 51 End	GAK8	07/11/19	5:27:46	58.8128	148.4918	289	Danielson	
356	Methot Start	GAK8	07/11/19	5:41:45	58.8123	148.4882	282	Hopcroft	
357	Methot End	GAK8	07/11/19	6:01:37	58.8047	148.4740	283	Hopcroft	
358	MultiNet Start	GAK8	07/11/19	6:18:59	58.8055	148.4813	283	Hopcroft	
359	MultiNet End	GAK8	07/11/19	7:09:49	58.8235	148.5356	283	Hopcroft	
360	Methot Start	GAK7	07/12/19	8:10:57	58.9574	148.6205	255	Hopcroft	

361	Methot End	GAK7	07/12/19	8:30:35	58.9669	148.6252	255	Hopcroft	
362	MultiNet Start	GAK7	07/12/19	8:43:15	58.9720	148.6289	243	Hopcroft	
363	MultiNet End	GAK7	07/12/19	9:27:47	58.9926	148.6423	240	Hopcroft	
364	Methot Start	GAK6	07/12/19	10:22:56	59.1045	148.7598	156	Hopcroft	
365	Methot End	GAK6	07/12/19	10:42:36	59.1139	148.7672	156	Hopcroft	
366	MultiNet Start	GAK6	07/12/19	10:55:57	59.1185	148.7719	151	Hopcroft	
367	MultiNet End	GAK6	07/12/19	11:39:55	59.1356	148.7952	151	Hopcroft	
368	Sediment Trap Start	GAK5	07/12/19	12:47:33	59.2454	148.8976	167	McDonald	
369	Methot Start	GAK5	07/12/19	12:56:24	59.2471	148.8989	167	Hopcroft	
370	Methot End	GAK5	07/12/19	13:16:47	59.2550	148.9065	165	Hopcroft	
371	Iron Fish Start	GAK5	07/12/19	13:33:16	59.2577	148.9089	167	Aguilar-Islas	
372	MultiNet Start	GAK5	07/12/19	13:42:48	59.2597	148.9090	167	Hopcroft	
373	MultiNet End	GAK5	07/12/19	14:25:11	59.2809	148.9070	167	Hopcroft	
374	Iron Fish End	GAK5	07/12/19	14:25:31	59.2811	148.9069	167	Aguilar-Islas	
375	Vert Multinet Start	GAK5	07/12/19	15:15:43	59.2619	148.9089	167	Hopcroft	
376	Vert Multinet End	GAK5	07/12/19	15:25:42	59.2619	148.9089	167	Hopcroft	
377	CalVet Start	GAK5	07/12/19	15:49:38	59.2619	148.9089	167	Hopcroft	
378	CalVet End	GAK5	07/12/19	15:55:26	59.2619	148.9089	167	Hopcroft	
379	CalVet Start	GAK5	07/12/19	16:07:07	59.2619	148.9089	167	Hopcroft	genetics
380	CalVet End	GAK5	07/12/19	16:13:23	59.2619	148.9089	167	Hopcroft	
381	CTD 52 Start	GAK5	07/12/19	16:19:34	59.2619	148.9089	169	Danielson	
382	CTD 52 End	GAK5	07/12/19	16:50:58	59.2619	148.9089	169	Danielson	
383	TMCTD Start	GAK5	07/12/19	17:10:23	59.2618	148.9085	169	Aguilar-Islas	
384	TMCTD End	GAK5	07/12/19	17:39:30	59.2618	148.9085	169	Aguilar-Islas	
385	CTD 53 Start	GAK5	07/12/19	18:34:27	59.2618	148.9085	169	Danielson	
386	CTD 53 End	GAK5	07/12/19	19:06:24	59.2618	148.9085	169	Danielson	
387	Sediment Trap End	GAK5	07/12/19	20:18:30	59.2537	148.9563	173	McDonald	
388	CalVet Start	GAK4	07/12/19	21:22:38	59.4080	149.0486	202	Hopcroft	
389	CalVet End	GAK4	07/12/19	21:29:21	59.4082	149.0488	202	Hopcroft	
390	CTD 54 Start	GAK4	07/12/19	21:40:04	59.4084	149.0487	202	Danielson	
391	CTD 54 End	GAK4	07/12/19	22:06:58	59.4085	149.0504	202	Danielson	
392	CalVet Start	GAK3	07/12/19	23:19:38	59.5525	149.1872	202	Hopcroft	
393	CalVet End	GAK3	07/12/19	23:25:32	59.5525	149.1872	212	Hopcroft	
394	CTD 55 Start	GAK3	07/12/19	23:37:00	59.5525	149.1872	212	Danielson	

395	CTD 55 End	GAK3	07/12/19	0:10:36	59.5525	149.1872	212	Danielson	
396	CalVet Start	GAK2	07/12/19	1:20:10	59.6911	149.3278	227	Hopcroft	
397	CalVet End	GAK2	07/12/19	1:26:19	59.6911	149.3278	227	Hopcroft	
398	CTD 56 Start	GAK2	07/12/19	1:37:19	59.6911	149.3280	227	Danielson	
399	CTD 56 End	GAK2	07/12/19	2:09:45	59.6911	149.3280	227	Danielson	
400	Methot Start	GAK4	07/12/19	5:32:19	59.4039	149.0761	205	Hopcroft	
401	Methot End	GAK4	07/12/19	5:52:34	59.4137	149.0598	202	Hopcroft	
402	MultiNet Start	GAK4	07/12/19	6:05:00	59.4183	149.0585	202	Hopcroft	
403	MultiNet End	GAK4	07/12/19	6:52:08	59.4435	149.0905	202	Hopcroft	
404	Methot Start	GAK3	07/12/19	7:38:25	59.5212	149.1726	212	Hopcroft	
405	Methot End	GAK3	07/12/19	7:58:36	59.5316	149.1814	212	Hopcroft	
406	MultiNet Start	GAK3	07/13/19	8:13:37	59.5425	149.1875	216	Hopcroft	
407	MultiNet End	GAK3	07/13/19	8:24:24	59.5486	149.1914	216	Hopcroft	Tow Aborted
408	MultiNet Start	GAK3	07/13/19	8:29:32	59.5515	149.1935	216	Hopcroft	
409	MultiNet End	GAK3	07/13/19	8:36:11	59.5553	149.1964	216	Hopcroft	Tow Aborted. drough clogged with snail goop
410	MultiNet Start	GAK3	07/13/19	8:53:22	59.5559	149.1957	216	Hopcroft	
411	MultiNet End	GAK3	07/13/19	9:36:44	59.5432	149.1567	216	Hopcroft	
412	Methot Start	GAK2	07/13/19	10:47:51	59.6773	149.3137	220	Hopcroft	
413	Methot End	GAK2	07/13/19	11:07:23	59.6858	149.3226	220	Hopcroft	
414	MultiNet Start	GAK2	07/13/19	11:17:54	59.6903	149.3263	224	Hopcroft	
415	MultiNet End	GAK2	07/13/19	12:01:32	59.7100	149.3415	224	Hopcroft	Jelly hit flowmeter - net 5
416	Sediment Trap Start	GAK1	07/13/19	13:00:22	59.8291	149.4533	280	McDonald	
417	Methot Start	GAK1	07/13/19	13:23:49	59.8323	149.4572	274	Hopcroft	
418	Methot End	GAK1	07/13/19	13:43:08	59.8463	149.4642	274	Hopcroft	
419	MultiNet Start	GAK1	07/13/19	13:55:23	59.8490	149.4636	274	Hopcroft	
420	MultiNet End	GAK1	07/13/19	14:42:15	59.8757	149.4540	274	Hopcroft	
421	Vert Multinet Start	GAK1	07/13/19	15:20:49	59.8455	149.4655	276	Hopcroft	
422	Vert Multinet End	GAK1	07/13/19	15:34:39	59.8459	149.4657	276	Hopcroft	
423	CalVet Start	GAK1	07/13/19	16:02:20	59.8460	149.4657	276	Hopcroft	
424	CalVet End	GAK1	07/13/19	16:07:43	59.8463	149.4658	276	Hopcroft	
425	CalVet Start	GAK1	07/13/19	16:19:22	59.8465	149.4659	270	Hopcroft	genetics
426	CalVet End	GAK1	07/13/19	16:24:29	59.8466	149.4659	270	Hopcroft	
427	CTD 57 Start	GAK1	07/13/19	16:31:29	59.8467	149.4659	269	Danielson	
428	CTD 57 End	GAK1	07/13/19	17:16:39	59.8467	149.4659	269	Danielson	

429	TMCTD Start	GAK1	07/13/19	17:30:47	59.8467	149.4658	269	Aguilar-Islas	
430	TMCTD End	GAK1	07/13/19	18:01:45	59.8467	149.4659	269	Aguilar-Islas	
431	CTD 58 Start	GAK1	07/13/19	19:01:12	59.8467	149.4659	269	Danielson	changed CTD cast number in log from 56 to 58
432	CTD 58 End	GAK1	07/13/19	19:43:21	59.8467	149.4659	269	Danielson	changed CTD cast number in log from 56 to 58
433	Sediment Trap End	GAK1	07/13/19	20:50:47	59.8162	149.4665	269	McDonald	
434	Iron Fish Start	GAK1	07/13/19	21:33:34	59.8621	149.4400	269	Aguilar-Islas	
435	Acrobat Start	GAK1	07/13/19	21:45:34	59.8621	149.4400	269	Danielson	
436	Acrobat End	GAK15	07/14/19	18:22:51	57.7800	147.4792	269		both marks ~5 minutes late
437	Iron Fish End	GAK15	07/14/19	18:22:51	57.7800	147.4792	269	Aguilar-Islas	
438	EM 302 logging	GAK 1	07/14/19	18:30:00	57.7800	147.4792	269	Bern	
439	Methot Start	KOD9	07/14/19	5:34:37	57.3297	149.9207	1312	Hopcroft	
440	Methot End	KOD9	07/14/19	5:54:20	57.3164	149.9260	1312	Hopcroft	
441	Bongo Start	KOD9	07/14/19	6:15:35	57.3081	149.9227	1312	Hopcroft	
442	Bongo End	KOD9	07/14/19	6:40:20	57.2914	149.9117	1312	Hopcroft	
443	Methot Start	KOD8	07/15/19	8:15:59	57.4565	150.1420	661	Hopcroft	
444	Methot End	KOD8	07/15/19	8:35:31	57.4470	150.1381	661	Hopcroft	
445	Bongo Start	KOD8	07/15/19	8:46:19	57.4439	150.1377	704	Hopcroft	
446	Bongo End	KOD8	07/15/19	9:06:53	57.4344	150.1325	704	Hopcroft	
447	Methot Start	KOD7	07/15/19	10:22:08	57.5675	150.3388	172	Hopcroft	
448	Methot End	KOD7	07/15/19	10:42:46	57.5545	150.3342	172	Hopcroft	
449	Bongo start	KOD7	07/15/19	10:57:54	57.5554	150.3382	172	Hopcroft	
450	Bongo End	KOD7	07/15/19	11:20:29	57.5663	150.3398	172	Hopcroft	
451	Methot Start	KOD6	07/15/19	12:32:45	57.6841	150.5500	103	Hopcroft	
452	Methot End	KOD6	07/15/19	12:52:50	57.6688	150.5371	103	Hopcroft	
453	Bongo Start	KOD6	07/15/19	13:02:54	57.6618	150.5316	103	Hopcroft	
454	Bongo End	KOD6	07/15/19	13:20:35	57.6469	150.5206	103	Hopcroft	
455	Sediment Trap Start	KOD5	07/15/19	14:58:52	57.7799	150.7596	86	McDonald	
456	Iron Fish Start	KOD5	07/15/19	15:30:10	57.7995	150.7565	86	Aguilar-Islas	
457	Iron Fish End	KOD5	07/15/19	17:49:14	57.7854	150.7713	86	Aguilar-Islas	
458	CalVet Start	KOD5	07/15/19	16:26:52	57.7876	150.7628	86	Hopcroft	81m
459	CalVet End	KOD5	07/15/19	16:33:55	57.7851	150.7663	86	Hopcroft	
460	CalVet Start	KOD5	07/15/19	16:45:38	57.7841	150.7702	86	Hopcroft	genetics
461	CalVet End	KOD5	07/15/19	16:53:06	57.7816	150.7746	86	Hopcroft	
462	CTD 59 Start	KOD5	07/15/19	17:25:04	57.7860	150.7627	86	Danielson	

463	CTD 59 End	KOD5	07/15/19	17:43:36	57.7854	150.7692	86	Danielson	
464	TMCTD Start	KOD5	07/15/19	18:10:04	57.7858	150.7638	86	Aguilar-Islas	
465	TMCTD End	KOD5	07/15/19	18:28:05	57.7842	150.7708	86	Aguilar-Islas	
466	CTD 60 Start	KOD5	07/15/19	19:15:37	57.7885	150.7623	86	Danielson	
467	CTD 60 End	KOD5	07/15/19	19:36:32	57.7939	150.7660	86	Danielson	
468	Sediment Trap End	KOD5	07/15/19	21:19:16	57.7889	150.8994	86	McDonald	
469	CalVet Start	KOD4	07/15/19	22:03:37	57.8993	150.9682	78	Hopcroft	73m
470	CalVet End	KOD4	07/15/19	22:09:30	57.9010	150.9675	78	Hopcroft	
471	CTD 61 Start	KOD4	07/15/19	22:25:24	57.8992	150.9688	78	Danielson	
472	CTD 61 End	KOD4	07/15/19	22:43:20	57.9042	150.9671	78	Danielson	
473	CalVet Start	KOD3	07/15/19	23:52:23	58.0134	151.1810	83	Hopcroft	
474	CalVet End	KOD3	07/15/19	23:58:52	58.0139	151.1792	83	Hopcroft	
475	CTD 62 Start	KOD3	07/15/19	0:11:20	58.0145	151.1773	83	Danielson	
476	CTD 62 End	KOD3	07/15/19	0:32:28	58.0153	151.1716	83	Danielson	
477	CalVet Start	KOD2	07/15/19	1:43:27	58.1322	151.3832	130	Hopcroft	
478	CalVet End	KOD2	07/15/19	1:53:01	58.1319	151.3838	130	Hopcroft	
479	CTD 63 Start	KOD2	07/15/19	2:02:53	58.1320	151.3822	130	Danielson	
480	CTD 63 End	KOD2	07/15/19	2:24:30	58.1325	151.3755	130	Danielson	
481	CalVet Start	KOD1	07/15/19	3:51:45	58.2458	151.5939	70	Hopcroft	65m
482	CalVet End	KOD1	07/15/19	3:58:45	58.2415	151.5924	70	Hopcroft	
483	CTD 64 Start	KOD1	07/15/19	4:11:45	58.2373	151.5926	70	Danielson	
484	CTD 64 End	KOD1	07/15/19	4:26:27	58.2315	151.5931	70	Danielson	
485	Methot Start	KOD1	07/15/19	5:39:50	58.2523	151.5890	70	Hopcroft	
486	Bongo Start	KOD1	07/15/19	6:11:54	58.2380	151.5770	70	Hopcroft	
487	Bongo End	KOD1	07/15/19	6:25:16	58.2321	151.5711	70	Hopcroft	
488	Methot Start	KOD2	07/15/19	7:32:10	58.1455	151.3940	154	Hopcroft	
489	Methot End	KOD2	07/15/19	7:52:19	58.1356	151.3788	154	Hopcroft	
490	Bongo Start	KOD2	07/16/19	8:02:32	58.1311	151.3701	136	Hopcroft	
491	Bongo End	KOD2	07/16/19	8:22:57	58.1222	151.3516	136	Hopcroft	
492	Methot Start	KOD3	07/16/19	9:22:28	58.0296	151.1929	84	Hopcroft	
493	Methot End	KOD3	07/16/19	9:42:18	58.0230	151.1779	84	Hopcroft	
494	Bongo Start	KOD3	07/16/19	9:51:45	58.0196	151.1720	84	Hopcroft	
495	Bongo End	KOD3	07/16/19	10:01:48	58.0158	151.1661	84	Hopcroft	
496	Methot Start	KOD4	07/16/19	11:09:27	57.9134	150.9876	82	Hopcroft	

497	Methot End	KOD4	07/16/19	11:29:36	57.9036	150.9805	82	Hopcroft	
498	Bongo Start	KOD4	07/16/19	11:38:36	57.8999	150.9770	77	Hopcroft	
499	Bongo End	KOD4	07/16/19	11:46:28	57.8957	150.9756	77	Hopcroft	
500	Methot Start	KOD5	07/16/19	12:49:47	57.8011	150.7710	87	Hopcroft	
501	Methot End	KOD5	07/16/19	13:09:19	57.7900	150.7668	87	Hopcroft	
502	Bongo Start	KOD5	07/16/19	13:20:32	57.7832	150.7648	87	Hopcroft	
503	Bongo End	KOD5	07/16/19	13:28:38	57.7781	150.7651	87	Hopcroft	
504	CalVet Start	KOD6	07/16/19	14:34:33	57.6735	150.5488	100	Hopcroft	
505	CalVet End	KOD6	07/16/19	14:41:58	57.6713	150.5487	100	Hopcroft	
506	CTD 65 Start	KOD6	07/16/19	15:23:50	57.6729	150.5488	100	Danielson	
507	CTD 65 End	KOD6	07/16/19	15:43:23	57.6704	150.5515	100	Danielson	
508	CalVet Start	KOD7	07/16/19	16:50:27	57.5592	150.3383	177	Hopcroft	
509	CalVet End	KOD7	07/16/19	16:58:44	57.5567	150.3403	177	Hopcroft	
510	CTD 66 Start	KOD7	07/16/19	17:11:07	57.5551	150.3412	179	Danielson	
511	CTD 66 End	KOD7	07/16/19	17:40:43	57.5481	150.3457	179	Danielson	
512	CalVet Start	KOD8	07/16/19	18:55:45	57.4367	150.1273	732	Hopcroft	
513	CalVet End	KOD8	07/16/19	19:02:06	57.4363	150.1280	732	Hopcroft	
514	CTD 67 Start	KOD8	07/16/19	19:13:48	57.4356	150.1282	732	Danielson	
515	CTD 67 End	KOD8	07/16/19	20:11:18	57.4315	150.1341	732	Danielson	
516	CalVet Start	KOD9	07/16/19	21:20:30	57.3235	149.9221	1306	Hopcroft	
517	CalVet End	KOD9	07/16/19	21:26:59	57.3228	149.9246	1306	Hopcroft	
518	CTD 68 Start	KOD9	07/16/19	21:36:44	57.3225	149.9259	1306	Danielson	
519	CTD 68 End	KOD8	07/16/19	22:54:59	57.3202	149.9331	1309	Danielson	
520	Sediment Trap Start	KOD10	07/16/19	0:21:50	57.2030	149.7212	1309	McDonald	
521	CalVet Start	EDDY and the JETS	07/16/19	3:44:34	56.6668	150.1341	4975	Hopcroft	Also called EATJ or KOD EDDY
522	CalVet End	EDDY and the JETS	07/16/19	3:51:27	56.6660	150.1347	4975	Hopcroft	Also called EATJ or KOD EDDY
523	CTD 69 Start	EDDY and the JETS	07/16/19	4:03:17	56.6637	150.1335	4975	Danielson	Also called EATJ or KOD EDDY
524	CTD 69 End	EDDY and the JETS	07/16/19	5:10:30	56.6497	150.1335	4975	Danielson	Also called EATJ or KOD EDDY
525	TMCTD Start	EDDY and the JETS	07/16/19	5:35:59	56.6630	150.1325	4975	Aguilar-Islas	Also called EATJ or KOD EDDY

526	TMCTD End	EDDY and the JETS	07/16/19	6:08:15	56.6593	150.1334	4975	Aguilar-Islas	Also called EATJ or KOD EDDY
527	Bongo Start	EDDY and the JETS	07/16/19	6:26:25	56.6607	150.1348	4975	Coyle	Also called EATJ or KOD EDDY
528	Bongo End	EDDY and the JETS	07/16/19	6:52:22	56.6658	150.1570	4975	Coyle	Also called EATJ or KOD EDDY
529	Iron Fish Start	EDDY and the JETS	07/16/19	7:26:26	56.6646	150.1379	4975	Aguilar-Islas	Also called EATJ or KOD EDDY
530	Acrobat Start	EDDY and the JETS	07/16/19	7:27:02	56.6646	150.1375	4975	Danielson	Also called EATJ or KOD EDDY
531	Acrobat End	KOD10	07/17/19	13:05:12	57.2118	149.7109	2501	Danielson	
532	Iron Fish End	KOD10	07/17/19	13:17:23	57.2166	149.7059	2501	Aguilar-Islas	
533	Bongo Start	KOD10	07/17/19	13:31:19	57.2149	149.7046	2501	Coyle	
534	Bongo End	KOD10	07/17/19	13:52:59	57.2004	149.7117	2501	Coyle	
535	Methot Start	KOD10	07/17/19	14:07:27	57.1946	149.7130	2501	Coyle	
536	Sediment Trap End	KOD10	07/17/19	15:54:04	57.0836	149.7377	2501	McDonald	
537	CalVet Start	KOD10	07/17/19	16:56:47	57.2049	149.7150	2501	Hopcroft	
538	CalVet End	KOD10	07/17/19	17:03:53	57.2044	149.7140	2501	Hopcroft	
539	CalVet Start	KOD10	07/17/19	17:13:44	57.2044	149.7201	2501	Hopcroft	genetics
540	CalVet End	KOD10	07/17/19	17:21:27	57.2040	149.7193	2501	Hopcroft	
541	CTD 70 Start	KOD10	07/17/19	17:33:37	57.2038	149.7192	2501	Danielson	
542	CTD 70 End	KOD10	07/17/19	17:34:05	57.2038	149.7192	2501	Danielson	Par sensor was not on. must recover and do again
543	CTD 71 Start	KOD10	07/17/19	17:42:35	57.2038	149.7192	2501	Danielson	
544	CTD 71 End	KOD10	07/17/19	17:58:42	57.2038	149.7192	2501	Danielson	
545	CTD 72 Start	KOD10	07/17/19	18:40:06	57.2038	149.7192	2501	Danielson	
546	CTD 72 End	KOD10	07/17/19	20:08:29	57.2017	149.7187	2501	Danielson	
547	TMCTD Start	KOD10	07/17/19	20:30:00	57.1985	149.7236		Aguilar-Islas	
548	TMCTD End	KOD10	07/17/19	21:36:01	57.1985	149.7236	2501	Aguilar-Islas	
549	CTD 73 Start	GAK1	07/18/19	15:07:23	59.8449	149.4671	270	Danielson	
550	CTD 73 End	GAK1	07/18/19	15:44:12	59.8449	149.4671	270	Danielson	
551	CalVet Start	GAK1	07/18/19	15:48:35	59.8449	149.4671	270	Hopcroft	
552	CalVet End	GAK1	07/18/19	15:54:43	59.8449	149.4671	270	Hopcroft	
553	CalVet Start	RES2.5	07/18/19	17:27:34	60.0240	149.3578	293	Hopcroft	
554	CalVet End	RES2.5	07/18/19	17:33:38	60.0243	149.3580	293	Hopcroft	

555	CTD 74 Start	RES2.5	07/18/19	17:46:56	60.0244	149.3580	293	Danielson	
556	CTD 74 End	RES2.5	07/18/19	18:21:21	60.0244	149.3580	293	Danielson	
557	tied up End	dock	07/18/19	19:53:47	60.0984	149.4425	0	Hopcroft	