NGA LTER & Gulf Watch Alaska: Cruise SKQ2022-07S

Seward Line Cruise Plan: 19 April to 8 May, 2022

Funding Source: NSF, NPRB, EVOS, AOOS, UAF

Chief Scientist: Ana Aguilar Islas, UAF, Chemistry

Co-Chief Scientist:

Scientific Personnel (21): Ana Aguilar-Islas, Lauren Block, Jake Cohen, Dan Cushing, Kerri Fredrickson, Josianne Haag, Gwenn Hennon, Russel Hopcroft, Mette Kaufman, Thomas Kelly, Hannah Kepner, Addie Norgaard, Emily Ortega, Jaide Phelps, Alex Poje, Isaac Reister, Peter Shipton, Caitlin Smoot, Emily Stidham, Suzanne Strom, Katie Williams

Scientific Purpose:
This cruise continues observations and sampling that begun in fall 1997 under the NSF/NOAA NE Pacific GLOBEC program, and subsequently via 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. The region covered was extended by the NSF's Northern Gulf of Alaska Long-term Ecological Program (NGA-LTER). This cruise is the 5th consecutive spring cruise for the NGA-LTER, it marks the 25th consecutive spring cruise for the Seward Line in the NGA, including Prince William Sound (PWS), and the 51th year of observations at GAK1. The scientific purpose is to contribute towards the development of an understanding of the response and resiliency of this marine ecosystem to climate variability.

Special Note: This cruise will be conducted during the COVID-19 Pandemic and will follow established protocols by UNOLS and *Sikuliaq* as outlined in the "Science Party Covid-19 Embarkation Check List" document.

Cruise Objectives
Ideally depart dock the evening of second mobilization day (April 20, 2022).
1. Determine thermohaline, velocity, light, and oxygen structure of the NGA shelf.
2. Determine macro- and micro-nutrient structure of the NGA shelf.
3. Determine particle structure and flux rates of the NGA shelf.
4. Determine phyto- and microzooplankton composition, biomass distribution, and productivity.
5. Determine the vertical and horizontal distribution and abundance of zooplankton species.
6. Conduct surveys of Seabirds and Marine Mammals
7. Determine carbonate chemistry (i.e. Ocean Acidification) at selected stations
8. Determine surface short-lived (223, 224) Ra isotopes at selected stations
9. Provide at-sea experience for UAF and WWU graduate students
10. Share the experience through outreach/media activities.
11. Recover moorings GEO1 and GEO2
12. Deploy moorings GAK1, GEO1, GEO2 and GEO3.
13. Seward Line DPI transect (~ 30 hrs – possibly moorings in the middle of this tow).
14. Collect water for Fe chemistry experiments (HNLC offshore regions)
15. Deploy and recover drifting Sediment Traps (~24hr deployments).

Data Gathering

The overall approach of the cruise is to occupy the Seward Line, Kodiak Line and Middleton Line transects across the shelf and a string of stations within western PWS. 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 occupy a selected "intensive" station that involves a greater number and range of collections than the other stations occupied that day. Station profiles are supplemented by underway measurements.

DAYTIME ACTIVITIES:

1. Occupy the various hydrographic stations (no "intermediate" stations on cruises with the DPI) and collect vertical CTD-fluorescence-PAR-nitrate-oxygen and particle profiles
2. Collect from the ship's rosette system discrete bottle samples at these stations for nutrients, chlorophyll and microzooplankton. Chlorophyll Size Fractionation (20 µm) will be done at all whole numbered Seward Line and most other stations. Macronutrients samples will be pre-filtered prior to freezing. Chlorophyll will be extracted on fresh filters without freezing. DNA sampling.
3. Collect dissolved carbonate chemistry samples (265) along all three lines (GAK, KOD, MID) and PWS from bottle casts at selected stations and depths.
4. Collect samples for molecular microbial analysis along all three lines (GAK, KOD, MID) and PWS from bottle casts at selected stations and depths.
5. Collect oxygen samples at selected depths from all CTD bottle stations. Analysis will be carried out onboard
6. At intensive stations an additional CTD cast will collect water to be used for primary production incubations and gas samples.
7. Two daily trace-metal clean CTD cast will also be undertaken, one at the intensive station, and one at another selected station. (GAK 1, 3, 5, 7, 9, 11, 13, 15; MID 2, 5, 8, 10; KOD 2, 5, 8, 10; and PWS 2 and IB 1)
8. To complete the TM CTD cast, the Fe-fish will be deployed from the starboard crane as the ship departs from (or arrives to) the station. The Fe-fish will not be deployed in-between all stations as in other cruises
9. CalVet Net casts will be deployed from the starboard crane (CalVet frame has 4 nets) after most of the CTD casts to 100m. (NO CALVETs at the "i" stations).
10. At intensive stations there will be an extra Calvet collection, and along the Seward Line plus PWS2 there will be a vertical deployment of the 150 µm Multinet to 200m. Some of this material will be used for live sorting as well as post-cruise molecular analysis.
11. We will do one deep tandem vertical 150- µm Multinet tow (to maximum 1200 m) near the end of the Seward Line and one at PWS2 (800m). This normally happens during days but may be done at night in conjunction with Multinet work at those stations if time permits.
12. We will deploy drifting sediment traps at a subset of the intensive stations, the number to be determined by how they fit into daily logistics (6 to 8). Traps will ideally be deployed for 24 (or 48) hrs as time permits.

13. We will deploy 3 moorings and recover 2 at the GEO site (near GAK6i), and will deploy 1 mooring and recover 1 mooring at GAK 1
14. At intensive stations surface water collection for Ra isotopes will accomplished using a submersible pump deployed from the port side. Water will be collected on large plastic containers attached to the railing. Alternatively, if possible water will be collected from the underway clean seawater tap in the wet lab.
15. Seabird and mammal observations from the Bridge.

NIGHTTIME ACTIVITIES:

1. A towed 505-µm Multinet will be used to collected depth-stratified samples along the Seward Line, and at selected PWS Stations to 200m. (A multinet will be available as backup). Potentially an additional bongo at each station for NOAA samples.
2. On the Middleton and Kodiak Lines bongo net collections to 200 m. We hope to complete bongo nets along the Seward Line, dependent upon logistics.
3. Multinet tows may occur during the night shift as time permits (see #11 above).
4. A second 505- µm Multinet tow occurs at intensive station along the Seward Line and in PWS.

Estimated duration and sampling timing needs

In general, we estimate 1.5 days for PWS and 5 days for the Seward Line, and two days for each of the Middleton and Kodiak transects. We allocate 30 hrs for the DPI tow and 16 hours for the mooring activities. It is important that all Multinet collections (with the exception of those to 600m) be completed during darkness to allow comparison to prior years. We anticipate that 4-5 Multinets and/or Bongos can be conducted per night: sampling starts just after dusk and stops just before dawn, and can be extended slightly when overcast. There is always typically a greater period of light available than of darkness, so execution of daytime stations and activities are designed around being in position to commence night sampling as soon as it is sufficiently dark. Intensive stations must happen before noon. Sediment traps are flexible in their deployment timing

Sampling personnel requirements and sample protocol overview

- **CTD:** winch operator, martech (launch and recovery), 30m/min in upper 100m, 60m/min below 100m. Depending on schedule, casts may be limited to 1000m at deep-sea stations.
- **DPI:** Stern A-frame and winch operator, 2 scientists for launch & recovery. 1-2 scientists to communicate with bridge during towing operations. Sikuliaq's winch#1 with 0.322 EO cable will be used for towing the DPI. Ship speed 6 kts through water.
- **TMC CTD:** Crain operator, 2 scientists (launch and recovery and winch operation), 30m/min in upper 100m, 60m/min below 100m. Casts are limited to 1000m at deep-sea stations.
- **TMC towfish:** Crain operator, 2 scientist for launch and recovery (~15-20 min), A deck person to communicate with the bridge/science to ensure sample is collected as close to station as possible. Ship speed 3 kts through water. Arriving or departing fish at stations with TMC CTD.

- **Multinet & Bongo:** winch operator, 2-3 scientists (launch, recovery, wash-down, re-cock) – Ship speed: 2 knots, Wire speed: ~1 m/sec down, 0.5-1m/sec up (typically 30-40min per deployment). Stern A-frame deployment. Maximum depth on tows 200m. 0.322 EO cable (same as used for DPI). Both systems will have depth transducers to ensure we get close to, but not on the bottom when depths are less than 200m.
- **Calvets & Ring nets:** winch operator, 1-2 scientists (launch, recovery, wash-down) – Ship speed: station keeping, Wire speed: ~1 m/sec for Calvet, 0.5m/sec for Ring net (10 min/cast)**.**
- **Submergible pump for Ra sampling:** 1 deck person, 1 scientist to deploy and retrieve the pump
- **Acoustics:** Martech support for acoustics setup. We will trigger acoustics from the K-sync system to provide an interference-free time interval for each ping type. Over shallow waters (< 1000 m depth) all acoustic instruments can be run simultaneously. In deep water (>1000 m depth) we have two modes of operation. In “night operations mode” we secure the EM302 multibeam 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 “day operations mode” we will secure the EK-60 and run the EM-302 so as to map the seafloor along our trackline. As time allows, regions previously unmapped by multibeam acoustics should be preferentially selected for ship routes in order to map uncharted areas of the seafloor.
- **Drifting Sediment Traps:** 1 person to operate the TSE spooler, 2 scientists for deployment/recovery of equipment, 1 person (deck crew) for A-frame operation. Recovery via grapple hook on starboard side. Total length of line (top to bottom) is ~ 200 m. Operational time required is approximately 30 minutes for recovery or deployment.
- **Moorings:** Prior to mooring operations the mooring lead (Shipton) will meet with the Chief Scientist, Captain, Mar Techs, Bosun and Bridge crew to assess risk factors and clarify the plan for recoveries and deployments. The deck crew, marine tech and 2-3 scientist for deployment/recovery. Moorings GAK1, GEO1 and GEO3 are deployed anchor-last using the A-frame. Mooring GEO2 is deployed anchor-first using the A-frame and TSE spooler. When deploying anchor-last, we request that the "anchor release" command be communicated to the deck crew from the bridge when the transom of Sikuliaq is 20 meters past the target deployment coordinates. These moorings have a lay-back of about 20 m so this will allow the anchor to settle very close to the target location. Moorings to be recovered: GAK1, GEO1, GEO2; moorings to be deployed: GAK1, GEO1, GEO2 and GEO3 (See attached deployment sheets below.)

Equipment and Supplies

Ship's Science Equipment Needed:

- CTD Rosette
- Science Freezer in wet lab for chlorophyll extraction.
- -80 freezer for macro-nutrient, DOC, and genetic samples (x2).
- -20 freezer for organic iron ligand samples
- Forward walk-in incubator set at surface ambient temperature (somewhere near ~6 C).
- Aft walk-in incubator set at surface ambient temperature (somewhere near ~5 C).
- 300 and 75 KHz acoustic Doppler current profilers
- EK60 fisheries acoustics
- Underway sampling system (TSG, nav, met, etc)
- Access to uncontaminated seawater system & debubbler system
- Access to Ultra-pure water systems
- Access to bridge & NMEA GPS feed for seabird observer
- Hoods in wet, analytical and main labs
- Seawater manifold for three deck-based incubators w/possibly "paws for safety" manifold
- TSE spooler for DPI and mooring cable payout
- Ship's A-frame & starboard side crane
- Under-crane winch & line counter
- Access to compressed air for the Fe-fish pump
- DPI fiberoptics winch & cable
- Mustang suits as needed for some scientists

Scientist's Equipment Needed:

- Trace-metal clean CTD system (Baltic room storage), dedicated block, winch and line.
- Trace-metal clean towfish system (Deck storage) and spare (
- Wall-mounted racks for keeping TMC niskins during subsampling
- Positive pressure enclosure in the analytical lab. A cylinder of ultra clean nitrogen gas will be secured in the analytical lab.
- ISUS unit attached to flow-through system water
- Deep SUNA, UVP and LISST to install on ships CTD system
- 300 KHz Teledyne RDI Workhorse ADCP mounted in centerboard
- CalVet and ring nets [nets, flow-meters, frames, swivels, weights, spares]
- 2 Multinet system (coarse and fine nets, spare cod ends/nets)
- Bongo nets, & depressors
- Large deckboard incubators plumbed to flowing seawater system
- Filtration systems
- A tank of He gas for processing of Ra samples
- Fluorometers & Centrifuge
- Oxygen titration system
- Laptop computers
- 16 cases (24/cs) of 16-oz zooplankton sample bottles
- 5 cases (12/cs) of 32-oz zooplankton sample bottles
- Several coolers with nutrient and TMC bottles
- Microscopes (4) and supplies for handling and incubation of copepods

- Incubators: 2 x 4 cu ft. required near zooplankton work area
- Refrigerated Circulators
- Liquid nitrogen dewar
- Mooring instruments, tools, anchors and line
- Dynacon CTD winch
- Optical flow-through system
- DPI towed system stored on backdeck
- Drifting sediment traps
- Large plastic containers, tubing, and in-situ pumps for Ra work

<u>Hazardous Materials (See Hazmat manifest and MSDS archive):</u>

- Formaldehyde – 2x20L carboy (Hopcroft); cubitaner (Shipton)
- Rose Bengal Stain 50g (Hopcroft)
- Ethanol – 40L (Hopcroft); 1L (Hennon)
- Mercuric Chloride – ? ml (Norgaard), 10 ml (Aguilar-Islas); ?ml (Shipton)
- 3N HCl (25% v/v) (500 ml) (Aguilar-Islas)
- 1 N HCl (1 L) (Strom); 500ml (Hennon)
- 12N HCl (2 L) (Strom)
- Acetone – 16L (Strom)
- DAPI stain – 10 mg (Strom)
- Glutaraldehyde (10%) – 2 L (Strom); 10ml (Hennon)
- Lugol's solution (1L) (Strom)
- Lithium batteries in instruments (Shipton)
- Liquid Nitrogen – 20 L (Hennon)

Deck Layout:

TM Winch: 4000lb; Loaded TM CTD: 200lb; Iron Fish gear: 120lb
Spooler: ? DPI: 1200 lb
Loaded Incubators: 100lb
Multi net: ? Multi net spare: ? Bongo: ?

Mooring gear:
4 train wheel anchors - 2 @ ~2400 lbs, 1 @ ~1400 lbs, and 1 @ ~ 800 lbs
7 single pallet buoys (4 ~ 400 lbs, 3 ~200-250 lbs)
1 spar buoy (2 pallets long) ~400 lbs
1 wire basket ~800 lbs
4 instrument frames (2 ~90-150 lbs, 1 190lbs, 1 ~350 lbs)
3 pallets of instrument cases and tools, (average ~600 lbs each)

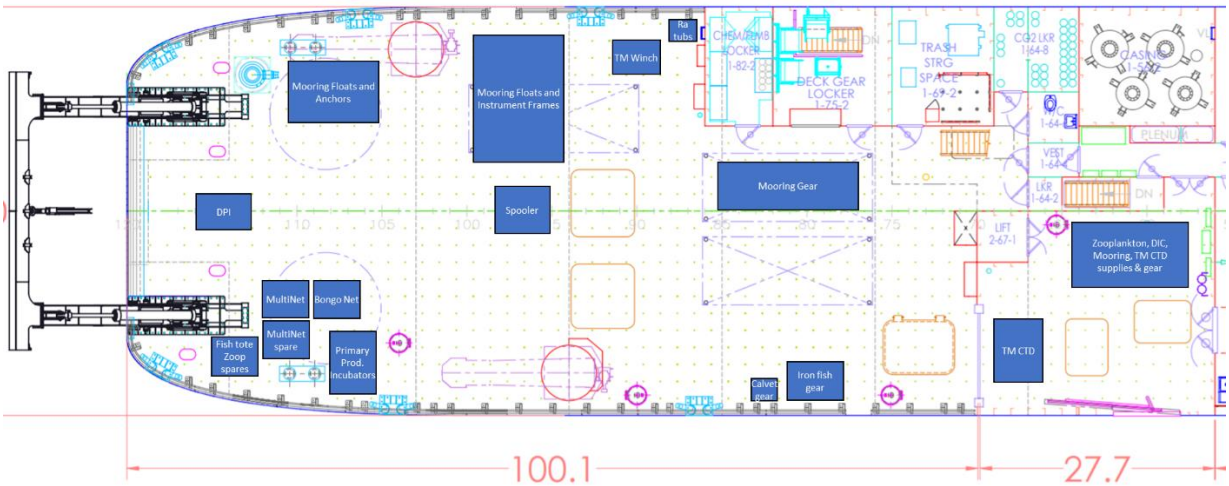

Figure 1. Draft layout of gear on deck with some weights included.

Draft Cruise Activity Schedule

Note: all dates are approximate and subject to change based on weather, operations, supply of coffee and chocolate, and other factors.

4/18 Science Party arrives in Seward. All scientist overnight at hotel(?)
4/19 Ship loading begins at 8am. Setup of labs
4/20 Set up labs. Sikuliaq sails after dinner (~7 pm)
First station (RES 2.5) is under 1 hour from dock.
Sample station RES 2.5. Transect towards KOD Line
4/21 KOD Line sampling activities begin, with day and night splits
4/22 Continue KOD Line Sampling
4/23 Continue KOD Line Sampling
4/24 End KOD Line; Steam to MID Line
4/25 Begin MID Line sampling activities (Day night splits)
4/26 Continue MID Line sampling
4/27 Continue MID Line stations
4/28 Steam to PWS and begin sampling activities
4/29 Continue sampling PWS; Steam to GAK1
4/30 GAK 1 Mooring; DPI to GEO
5/1 GEO Moorings; DPI to GAK 15
5/2 GAK Line sampling activities begin, with day night splits
5/3 GAK Line activities continue
5/4 GAK Line activities continue
5/5 GAK Line activities continue
5/6 GAK Line activities continue
5/7 Return to Seward by 4 pm, begin demobilization
Science party sleeps on board
5/8 Finish demobilization, science party departs Seward

Pre- and Post- Cruise Activity Schedule

4/18 – Russ's Van, UAF vehicles and UHaul depart for Seward, arrive ~ dinner time. Sleep at Breeze Inn, the appartments or the ship (Russ and Hannah)
4/19 – Begin ship setup at ~8am SMC dock. Gwenn's truck departs for Seward
4/20 – Continue ship set-up. Depart if possible in the evening to do RES2.5.
4/21 – Sikuliaq definitely underway by 6am
5/7 – Sikuliaq returns to dock by mid-afternoon – packup begin.
5/8 – Finish pack up and Demob. Science party departs for Fairbanks by early afternoon using UAF vehicles, Russ' van.

Transport:
Russ' Van: (up to 6)
Rental car: WWU team (3)
UAF Truck: Ana, Mette and gear (samples on way back)
UAF vehicle: Emily (up to 11)
Personal Transport: Gwenn + 3
UHaul*: Tom + 1 and equipment/supplies
* Not available on way back

Station Locations

The maps and tables below provide an overview for the NGA LTER station locations. See the Way Point Tool spreadsheet with the stations that will be visited during this cruise.

Table 1: Stations along the Seward Line (GAK Line) and in Prince William Sound.
Highlighted in green are intensive stations. In grey are stations not visited during this cruise.

Latitude N (degrees, minutes)		Longitude W (degrees, minutes)		Station Name
Resurrection Bay Station				
60	1.5	149	21.5	RES2.5
Seward Line				
59	50.7	149	28	GAK1
59	46	149	23.8	GAK1I
59	41.5	149	19.6	GAK2
59	37.6	149	15.5	GAK2I
59	33.2	149	11.3	GAK3
59	28.9	149	7.1	GAK3I
59	24.5	149	2.9	GAK4
59	20.1	148	58.7	GAK4I
59	15.7	148	54.5	GAK5
59	11.4	148	50.3	GAK5I
59	7	148	46.2	GAK6
59	2.7	148	42	GAK6I
58	58.3	148	37.8	GAK7
58	52.9	148	33.6	GAK7I
58	48.5	148	29.4	GAK8
58	44.6	148	25.2	GAK8I
58	40.8	148	21	GAK9
58	36.7	148	16.7	GAK9I
58	32.5	148	12.7	GAK10
58	23.3	148	4.3	GAK11
58	14.6	147	56	GAK12
58	5.9	147	47.6	GAK13
57	***56.6***	***147***	***39***	***GAK14***
57	***47.5***	***147***	***30***	***GAK15***
Prince William Sound Stations				
60	7.5	147	50	KIP0
60	16.7	147	59.2	KIP2
60	22.78	147	56.17	PWS1
60	32.1	147	48.2	PWS2
60	40	147	40	PWS3
60	49..25	147	24	PWSA
60	45	147	14	PWSB
60	38.1	147	10	PWSC
60	31.5	147	7.6	PWSD

60	24.3	147	58.3	PWSE
60	24	146	45	PWSF
Columbia Glacier				
61	7.4	147	3.8	CG0
60	59.5	147	4.2	CG1
60	57.6	147	5.9	CG2
Icy Bay				
60	16.3	148	21.7	IB0
60	14.5	148	20.1	IB1
60	16.3	148	14	IB2
Montague Strait Line				
59	57.257	147	55.602	MS1
59	56.6	147	53.7	MS2
59	55.9	147	51.4	MS3
59	55.2	147	49.7	MS4

Table 2. New LTER Stations. Highlighted in green are intensive stations.

Latitude N (degrees, minutes)		**Longitude W (degrees, minutes)**		**Station Name**
Kodiak Line				
58	14.7	151	35.4	KOD1
58	7.8	151	23.07	KOD2
58	0.9	151	10.74	KOD3
57	54	150	58.17	KOD4
57	47.1	150	45.6	KOD5
57	40.26	150	32.97	KOD6
57	33.42	150	20.34	KOD7
57	26.37	150	7.95	KOD8
57	19.32	149	55.56	KOD9
57	12.27	149	43.17	KOD10
Middleton Island Line				
60	15	145	30	MID1
60	10.5	145	34.5	MID1i
60	6	145	39	MID2
60	1.5	145	43.5	MID2i
59	57	145	48	MID3
59	52.5	145	52.5	MID3i
59	48	145	57	MID4
59	43.5	146	1.5	MID4i
59	39	146	6	MID5
59	34.5	146	10.5	MID5i
59	30	146	15	MID6

59	25.7	146	10	MID6i
59	23	146	18	MID7
59	18.267	146	15	MID7i
59	13.534	146	12	MID8
59	4.067	146	6	MID9
58	54.6	146	0	MID10

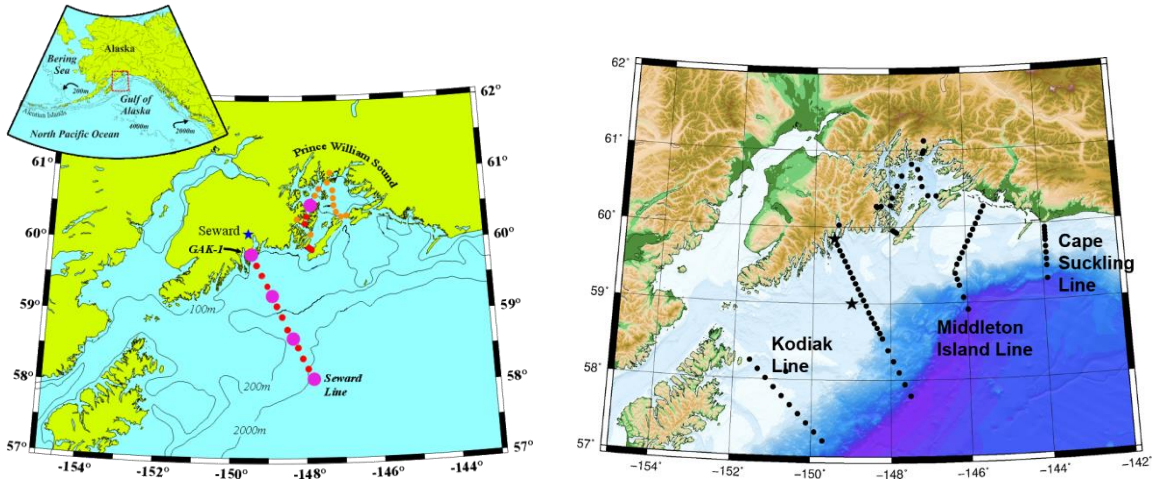

Figure 2. NGA-LTER sampling stations. Left: Seward Line (GAK Line) stations and PWS stations with intensive stations highlighted in pink. The orange stations in PWS will not be sampled during this cruise. Right: Includes added lines near Kodiak, Middleton Island and Cape Suckling. The Cape Suckling line will not be sampled during this cruise