NGA LTER & Gulf Watch Alaska
Cruise SKQ2023-07S

Seward Line Cruise Plan
20 April to 9 May, 2023

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

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Scientific Purpose:
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 third cruise of the NSF's Northern Gulf of Alaska Long-term Ecological Program (NGA-LTER). The scientific purpose of the core Seward Line project is to develop an understanding of the response and resiliency of this marine ecosystem to climate variability. This cruise marks the 24th consecutive spring cruise for the Seward Line in the NGA, including Prince William Sound (PWS), and the 50th year of observations at GAK1.

Special Note: SKQ2023-07S will follow mitigation measures outlined by UNOLS to reduce the risk of COVID-19 transmission.

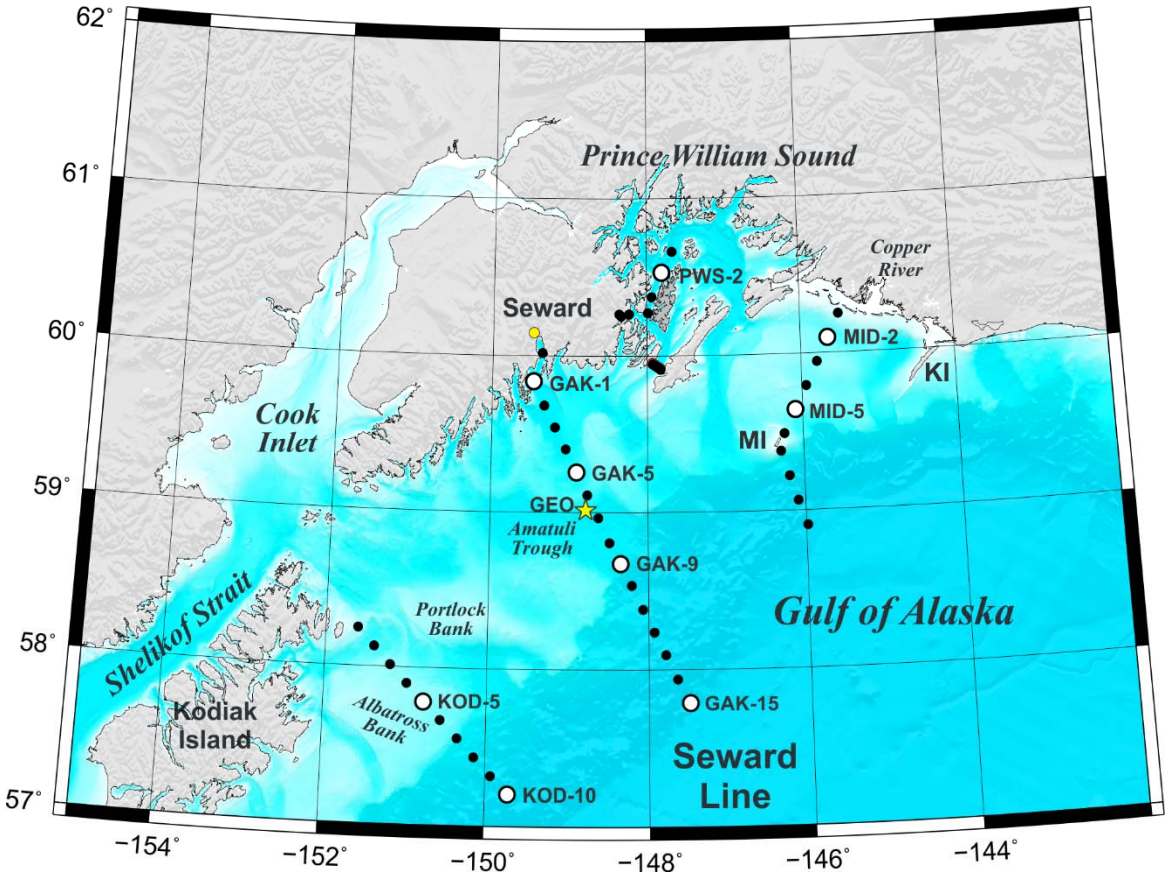

Figure 1. NGA-LTER sampling stations along the stations sets for the Seward Line (GAK), Middleton Island (MID), Kodiak (KOD) and Prince William Sound (PWS, MS, KIP, IB, CG).

Station naming convention and referencing etiquette note: The NGA hydrographic and biological sampling station transects have both transect names and station acronyms. These include the Seward Line with GAK stations (not the GAK Line!). The Middleton Island Line with MID stations. The Kodiak Island Line with KOD stations. And Prince William Sound stations with PWS, MS, KIP, CG and IB stations, which stand for Prince William Sound, Montague Strait, Knight Island Passage, Columbia Glacier and Icy Bay, respectively. The Seward Line naming convention was adopted for consistency with the Newport Hydrographic line (with NH stations) and other long-established hydrographic transects.

Cruise Objectives

Ideally depart dock evening of second mobilization day.

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 intensive stations
8. Provide at-sea experience for UAF and WWU graduate and undergraduate students
9. Provide samples/observations for collaborators
10. Share the experience through outreach/media activities.
11. Mooring operations at GAK1 and GEO sites
12. Seward Line DPI transect (~ 30 hrs –).
13. Test the new Fe-Fish (optimal towing speed 9 kots)
14. Drifting Sediment Trap deployments.
15. Glider recovery.

SAMPLING

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 and collect vertical CTD-fluorescence-PAR-Oxygen-nitrate and particle profiles (see **Figures** & **Tables)**.
2. Collect discrete bottle samples at these stations for nutrients, dissolved organic carbon, chlorophyll and microzooplankton. Chlorophyll size fractionation (20 µm) will be done offline. Macronutrients samples will be pre-filtered prior to freezing. Chlorophyll will be extracted on fresh filters without freezing. DNA sampling.
3. At a subset of stations along the Seward Line and within Prince William Sound collection of samples from the CTD bottles for the analysis of dissolved carbonate chemistry (tentatively Odd numbered GAK, GEO, KIP2, PWS2).
4. At intensive stations an additional CTD cast will collect water to be used for primary production incubations and nutrient samples. Additionally, samples for carbonate chemistry could come from these casts.
5. CalVet Net casts will be done (CalVet frame has 4 nets) after most the CTD casts to 100m. (NO CALVETs at the “i” stations).

6. A trace-metal clean CTD cast will also be undertaken at all intensive stations, and a subset of other stations. A dedicated winch and block will be provided.
7. A towed-body for sampling near-surface TM clean water will occur just prior arriving to or just after departure at stations where trace-metal CTD is deployed.
8. 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.
9. We will do one deep 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.
10. 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. Traps will ideally be deployed for 24 (or 48) hrs.
11. We will deploy 1 and recover 1 mooring at the GEO site (near GAK6i), and at GAK 1 we will also deploy 1 and recover 1 mooring.
12. We will recover 1 glyder at the GEO mooring site most likely, but it might be done at another station along the Seward Line.
13. Hand-net tows while at a subset of stations
14. Seabird 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. We hope to complete bongo nets along the Seward Line, dependent upon logistics.

3. Deep Multinet tows may occur during the night shift as time permits (see #9 above).

4. A second Multinet tow occurs at each intensive station.

Sampling Strategy: Time estimates and sampling requirements

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 8 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 a 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.

Sediment trap operations are flexible in their deployment timing, and somewhat flexible in their recovery time.

Sampling personnel requirements and sample protocol overview

- **CTD:** winch operator, 1-2 scientists (launch and recovery), deployment speed:30m/min in upper 100m, 60m/min below 100m. Depending on schedule, casts may be limited between 1000 - 1500m at deep-sea stations.
- **DPI:** A-frame & winch operator, 2-4 scientists for launch & recovery. 1-2 scientists to communicate with bridge during towing operations. Ship speed 6 kts through water.
- **TMC CTD:** Side crane operator, 3 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:** Side crane operator and 2 scientist for launch and recovery (~15-20 min), A deck person, martec, or scientist to watch towfish during towing and communicate with the bridge/science. 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. 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)**.**
- **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 Captain, Mar Techs, Bosun, Deck Crew and Mate on Watch to assess risk factors and clarify the plan for recoveries and deployments. The bosun, deck crew, marine tech and 2-3 scientists are needed for deployment/recovery. See attached deployment sheets for order of operations.
- **Glider:** The glider has pick-up points. It will be position on the starboard side of the ship for pick up with crane. Crane operator, bosun, deck crew and 2 scientist are needed for recovery

Equipment and Supplies

Ship's Science Equipment Needed:

- CTD
- Science Freezer 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 mooring cable payout
- Ship's Aframe & starboard side crane
- Under-crane winch & line counter
- DPI fiberoptics winch & cable
- Access to compressed air for the Fe-fish pump
- Mustang suits as needed for some scientists
- MapServer with ocean color, true color and sea surface temperature data feeds

Scientist's Equipment Needed:

- Trace-metal clean CTD system (Baltic room storage), dedicated block, winch and line.
- Trace-metal clean towfish system (Deck storage 3 palettes)
- Wall-mounted racks for keeping TMC niskins during subsampling
- Positive pressure enclosures. A large one in the analytical lab, and a small one in the Wet lab. Both enclosures need to be near a sink. 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
- 2-pi PAR sensor mounted on ship's superstructure
- 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
- 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

Hazardous Materials (See Hazmat manifest and MSDS archive):

- Formaldehyde – 2x20L carboy (Hopcroft)
- Rose Bengal Stain 50g (Hopcroft)
- Ethanol – 40L (Hopcroft)
- Oxygen Fixation (Sodium hydroxide, Sulphuric acid, Manganous Chloride) (Kelly)
- Mercuric Chloride (for DIC fixation) (Hauri)
- 3N HCl (25% v/v) (500 ml) (Aguilar-Islas)
- 1 N HCl (1 L) (Strom)
- 12N HCl (2 L) (Strom)
- Acetone – 16L (Strom)
- DAPI stain – 10 mg (Strom)
- Glutaraldehyde (10%) – 2 L (Strom)
- Lugol's solution (1L) (Strom)
- Lithium batteries in instruments (Shipton)
- Liquid Nitrogen (Hennon)

Deck Layout:

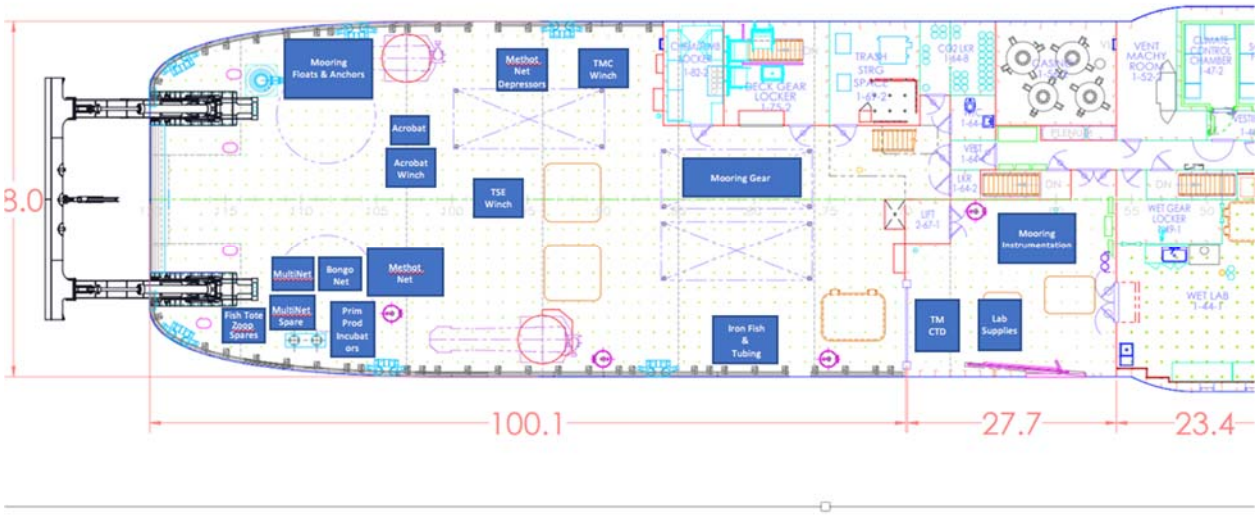

Figure 2. Draft layout of gear on deck.

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 Nutrient group travels to Seward and stays at hotel
4/19 Nutrient group begins set-up of analytical lab. The rest of the science party travels to Seward and stays at hotels.
4/20 Full Mobilization begins. The rest of the science party begins loading and set up
4/21 Continue Set up of deck and labs.
4/22 Get underway after breakfast. Sample RES 2.5 and GAK 1. Transect to MID Line (MID7)
4/23 Start MID Line with Night work and continue with day work
4/24 Continue MID Line sampling
4/25 Finish MID Line and transect to PWS
4/26 Start Night Work at PWS and continue with day work
4/27 Continue PWS work, if time allows DPI testing in deep areas of PWS
4/28 Transect to KOD Line and begin with night sampling
4/29 KOD Line sampling
4/30 KOD Line sampling
5/1 Finish KOD and transect to GAK Line. Begin night sampling
5/2 GAK Line sampling
5/3 GAK Line Sampling/Mooring ops at GEO site
5/4 GAK Line Sampling
5/5 GAK Line Sampling
5/6 GAK Line sampling/DPI transect
5/7 DPI Transect
5/8 Make way towards Seward Mooring GAK 1 Sample RES2.5. Arrive Seward by dinner
5/9 Demob activities, science party departs Seward

Transport:
Transportation plan can be found at

https://docs.google.com/spreadsheets/d/1tUPZb6XvqjA2eIquFtcnAOReXhm7kJXXeCMpuHvMJzs/edit#gid=0

Table 1. STANDARD STATIONS (intensive stations highlighted)

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 (unlikely)				
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 (intensive stations highlighted)

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