Cruise plan for HLY0803 – July 3 to July 31, 2008

Third Healy Cruise of the Bering Ecosystem Study Project (BEST)

Chief Scientist:

Raymond Sambrotto
Lamont-Doherty Earth Observatory
of Columbia University
61 Rt. 9W
Palisades, NY 10964
Phone: 845-365-8402
Email: sambrott@ldeo.columbia.edu

1. Introduction and Overview

The Bering Ecosystem Study Project (BEST) focuses on the impact of seasonal sea ice on the environment of the eastern Bering Sea. More specifically, BEST seeks to clarify how sea ice influences the ecological pathways of nutrients and organic matter that lead to the abundant upper trophic levels and valuable fisheries on this extensive, high latitude continental shelf. More extensive background information can be found on the BEST home page (http://www.fish.washington.edu/research/best/). BEST also is part of a larger interagency effort to model the response of upper trophic levels to variations in climate forcing and more information on these collaborative efforts can be found on the web site of the Bering Sea Integrated Ecosystem Response Project (BSIERP; http://bsierp.nprb.org/index.htm).

The cruise described in this document is the third NSF funded, dedicated cruise for the BEST project. The first two took place in April-May of 2007 and 2008 and focused on the conditions directly associated with the retreating ice edge. HLY0803 will examine the summer conditions on the eastern Bering Sea shelf. Although this region is ice-free in summer, the presence of ice earlier in the year influences the subsequent development of physical and biological conditions. We hope to improve the understanding of these influences significantly during HLY0803. We will sample on the eastern shelf of the Bering Sea. The cruise will cover the entire shelf from the Aleutian Islands to St. Lawrence Island. A multidisciplinary sampling plan will be carried out that includes the deployment of moorings and physical oceanography, a hydrographic survey that will collect discrete samples for a variety of chemical and biological analyses, zooplankton and ichthyoplankton net hauls, sediment sampling with a coring device, a variety of biological rate measurements that will be done in on-board incubators on the bow, the deployment and retrieval of sediment traps that require small boat operations, as well as a variety of underway observations both from autonomous instruments sampling the sea chest water and visual observation of birds and marine mammals form the bridge.

The overall science objective for the cruise is to further the aims of the Bering Ecosystem Project that seeks to understand the role of sea ice in the structure and regulation of biological populations on the eastern Bering Sea shelf, and in particular the invertebrate, fish and marine mammal populations of importance to people. The specific objectives for the HLY0803 cruise will be to characterize summer conditions on the eastern shelf, particularly as they relate to the impact of the ice distribution from the prior winter. This includes the seasonal evolution of the nutrient and phytoplankton fields, as well as the distribution and abundance of the zooplankton and icthyoplankton.

2. Port Schedule for Cruise 0803

Load out at USCG base in Seattle (please provide participant names to chief scientist)	June 3-5, 2008
Healy leaves Seattle for transit to Dutch Harbor	June 25
Science berthing available on Healy in Dutch Harbor	July 2
Healy available for mobilization in Dutch Harbor	July 2 – 09:30
Cruise HLY0803 departs Dutch Harbor	July 3 -12:00
Educational outreach visit at St. George Island	July 11
Personnel exchange at St. Paul Island	July 17
Cruise ends in Dutch Harbor (science berthing available for night of 7/31)	July 31 – 09:00
Healy available for demobilization in Dutch Harbor until	August 1, 2008; 12:00
Healy returns to Seattle after HLY0804	

3. Participants and Sub-Project Goals

Twelve BEST/ BSIERP research projects will participate in HLY0803:

Physics – Tom Weingartner, Jim Johnson, Dave Leech, Kevin Taylor. This group will deploy 10 moorings during the cruise and require up to 6 hours of wire time at each deployment.

Hydrography – Cal Mordy, Bill Floering, Dean Stockwell, and either Sigrid Salo and Dave Kachel (leg 1) or Dylan Righi and Ned Cokelet (leg 2). This group will analyze salts, nutrients, oxygen and chlorophyll from the Niskin casts at each station as well as help manage cruise event information.

Carbon Productivity - John Casey and Matt Tiahlo. This group will collect water for productivity experiments on special casts and water for various other analyses from the standard casts.

Nitrogen uptake and cycling - Ray Sambrotto, Didier Burdloff and Kali McKee. This group will collect water for rate experiments on special casts and water for various other analyses from the standard casts.

Particle flux – Roger Kelly, URI. Roger will deploy floating sediment traps that will collect for 24 hr. periods as well as estimate productivity from the 3 isotopes of oxygen.

Iron analyses (leg 2 only) – Rob Rember, and Ana M Aguilar-Islas. This group will collect samples on special casts from trace metal clean samplers.

Euphausiid and macrozooplankton collections - Alexei Pinchuk, UAF, and Tracy Shaw, OSU. Alexei will collect macrozooplankton with a MOCNESS and CalVET net for quantitative distributions. Tracy will collect live euphausiids with a Bongo net for rate measurements and organic tracer assays.

Euphausiid rate measurements - Megan Bernhardt, Tracy Shaw, Virginia Engel, UW (Lessard group) will perform grazing, growth and reproduction experiments with euphausiids collected with Bongo nets using water collected on CTD casts.

Organic tracers of trophic transfer/euphausiid population age structure - Rachel Pleuthner, Karen Taylor, Charles Morgan, UMD (Harvey Group) will extract organic pools from zooplankton and their prey from net tows and water from CTD casts.

Ichthyolplankton – Nicola Hillgruber, Elizabeth Siddon and Ron Heintz. This group will collect larval fish in collaboration with A. Pinchuk's net hauls.

Microzooplankton grazing – Diane Stoecker and Kristin Blattner, UMD. This group will perform grazing experiments on water collected with the Niskin rosette from special casts.

Benthic characterization and fluxes - David Shull, and Greg Brusseau WWU. This group will collect benthic samples with the multicorer in collaboration with Chris Moser.

Benthic biogeochemical fluxes - Heather Whitney and Amy Cash. This group will perform benthic flux measurements on cores retrieved from the multicorer.

Bird distribution and abundance – Paul Suchanek and David Porter (leg 1) and Tom Van Pelt and Mark Rauzon (leg 2). FWS. They will make observations from the bridge during the day.

CTD operations and support - Scott Hiller and Sue Reynolds.

Cruise data visualization - Steve Roberts and Tom Bolmer.

Data support - Janet Scannell (leg 1) and Scott Loehrer (leg 2)

In addition there will be an education component on board consisting of teachers Jillian Worsssam (PolarTrek) and John Karavias (Armada) as well as a MATE intern (Alex Nanez).

There also will be four guest investigators taking part in HLY0803:

Marine mammal distribution and abundance – Gary Friedrechsen, NOAA. Gary will make observations from the bridge during the day.

Bio-optical and phytoplankton variations - Lisa Eisner, NMFS Auk Bay. Lisa will add two instruments to the underway suite – a hyperspectral absorption instrument and a nitrate sensor. She will also collect samples from the Niskin rosette.

Water column bio-optics - Joaquim Goes, Eurico J. D'Sa, Puneeta Naik and Maria Fatima Helga do R. Gomes. This group will measure profiles in the upper 100 m with their own bio-optical package that includes an FRRF. They will also collect discrete samples from the Niskin rosette using newly developed fluorescent methods for phytoplankton characterization.

4. Sampling Operations

4.1. Bridge Observations

During daylight hours, quantitative observations for birds and marine mammals will be made from the bridge by the bird and marine mammal group. Both groups will use laptops on the bridge and may require a GPS feed.

4.2. Autonomous measurements from the Ship's Seawater system

Continuous and autonomous sensing will be done from the ship's seawater system. Water from 3 m is pumped from the sea chest to the science laboratory were several measurements will be made. These include temperature and salinity from a thermosalinograph, oxygen from a membrane electrode and chlorophyll *a* from a fluorometer. Lisa Eisner will install a nitrate sensor as well as a WetLabs ac-s that measures hyperspectral adsorption. Joaquim Goes will install an Advanced Laser Fluorescence System (ALFS) for phytoplankton characterization.

4.3. On Station, Over-the-side Operations

Most stations will begin with a CTD cast from the starboard A-frame that includes water sampling from a rosette of 12 - 30 L Niskin bottles to within 5 m of the bottom. This will provide water samples for nutrients and other hydrographic measurements such as chlorophyll *a*. A variety of additional discrete samples will be taken that will vary from station to station. The stations can most easily be grouped by length into short, intermediate and long stations as described below.

4.3.1. Short Stations

In addition to the CTD cast, a short station may include sampling activities that add not more than 30 minutes onto the length of the station. These additional sampling activities may include for example, a productivity cast, a CalVET Net tow or ring net tow from the 3/8" wire off of the stern and an optics cast from an ancillary winch. For these operations, the ship should be stationary. The optics casts are done only during daylight hours with the optimum time period being within several hours of local noon (~14:30). In addition, the side of the ship from which the optics package is deployed needs to face the sun. After the CTD, the order of order of operations for short stations will be the optics cast and then the net hauls.

4.3.2. Intermediate Stations

These stations may include almost any of the activities that will be performed on HLY0803 with the exception of the sediment trap deployments that have a 24 hr. requirement. The difference between the intermediate and long stations is based on the number of activities carried out and the total water depth. Some of the activities that can be done during an intermediate station in shallow water (multicorer or iron for example) require a long station over slope and basin regions. Intermediate stations provide time for a variety of process oriented and experimental work including - CalVET net tow from the stern A-frame, 3/8" wire (Pinchuk); Bongo Net tows (2-3) at night (Lessard group); MOCNESS net tow (1) from stern A-frame, 0.68" conducting wire (Pinchuk and Hillgruber). A number of MOCNESS only stations are planned in the first phase of the cruise to provide adequate sampling for the ichthyoplankton.

The MOCNESS tow will be conducted at a speed of 1-2 knots. The multicore casts will be conducted with the ship stationary. Benthic sampling will likely occur at the end of the station or at a location slightly offset from the station location in order to minimize benthic disturbance at the station and in order to avoid washing sediment into the water column during sample sieving and processing and deck cleanup.

4.3.3. Long Stations

Several CTD casts may be conducted at each long station to assess diurnal variation. One should occur in the morning of each day with succeeding casts interspersed with activities occurring on the stern in order to maximize efficiency and minimize down time while the CTD bottles are being emptied. Diurnal sampling can also be done for the zooplankton collections. The long stations also will provide an opportunity for deep iron casts.

We anticipate up to 4 deep sediment trap stations as part of HLY0803. Sediment traps consist of a trap line (5/8" dia poly-dac rope) that is 110m long with samples collected at 25 m, 40 m, 50 m, 60 m and 100 m (Fig. 1). Stations will be limited to shelf-slope locations with water depths greater than 300 m, and deployments will last approximately 24 hours. The traps are deployed from the ship but must be retrieved using a small boat. At the two most southerly sediment trap deployments, we will attempt to continue spatial sampling during the trap deployment.

4.3.4. Mooring Deployments

5. Additional Logistical and Operational Considerations

5.1. Educational outreach visit to St. George on July 11

A visit to St. George Island by the Healy is planned on July 11 to interact with a Ocean Science Camp that will be directed by Michele Ridgeway. Twenty students from the Pribilof Islands between the 5th and 12th grades have signed up for the camp that runs from July 10 through 18. We plan either a visit by science personnel to the island, or a visit by at least some of the students to the ship (pending permission of the Coast guard). This outreach activity is planned during a sediment trap deployment in nearby slope waters.

5.2. Personnel exchange at St. Paul on July 17

A mid-cruise exchange of personnel will occur at St. Paul Island, Alaska on July 17. The Healy will deploy a small boat to the airport by 0900 and make additional trips as necessary. Lodging on St. Paul can be obtained at a hotel adjacent to the airport or at the NOAA bunkhouse nearby. Please contact Phyllis Stabeno to arrange a stay at the NOAA facility (206-526-6453).

5.3. Existing Moorings to Avoid

We will be working near four NOAA moorings. The positions are listed below.

Bering Sea 2 (M2) 56.877°N, 164.057°W, 73m water depth. (There are some other moorings within 1 nm).

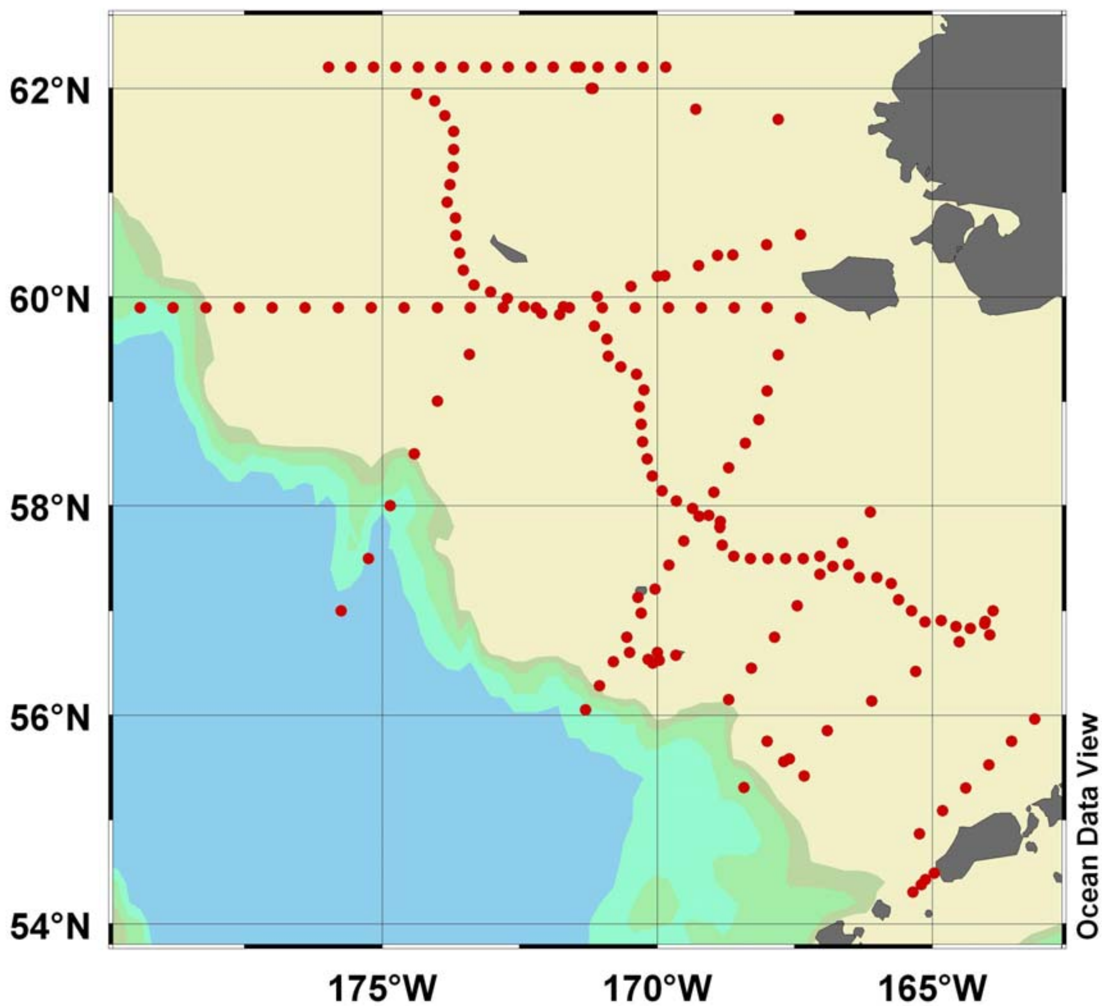
Bering Sea 4 (M4) 57.853°N, 168.870, 71m water depth (Note – This mooring is currently inoperable and some attempt to locate it will be made).

Bering Sea 5 (M5) 59.898°N, 171.711°W, 72m water depth

Bering Sea 8 (M8) 62.194°N, 174.668°W, 73m water depth

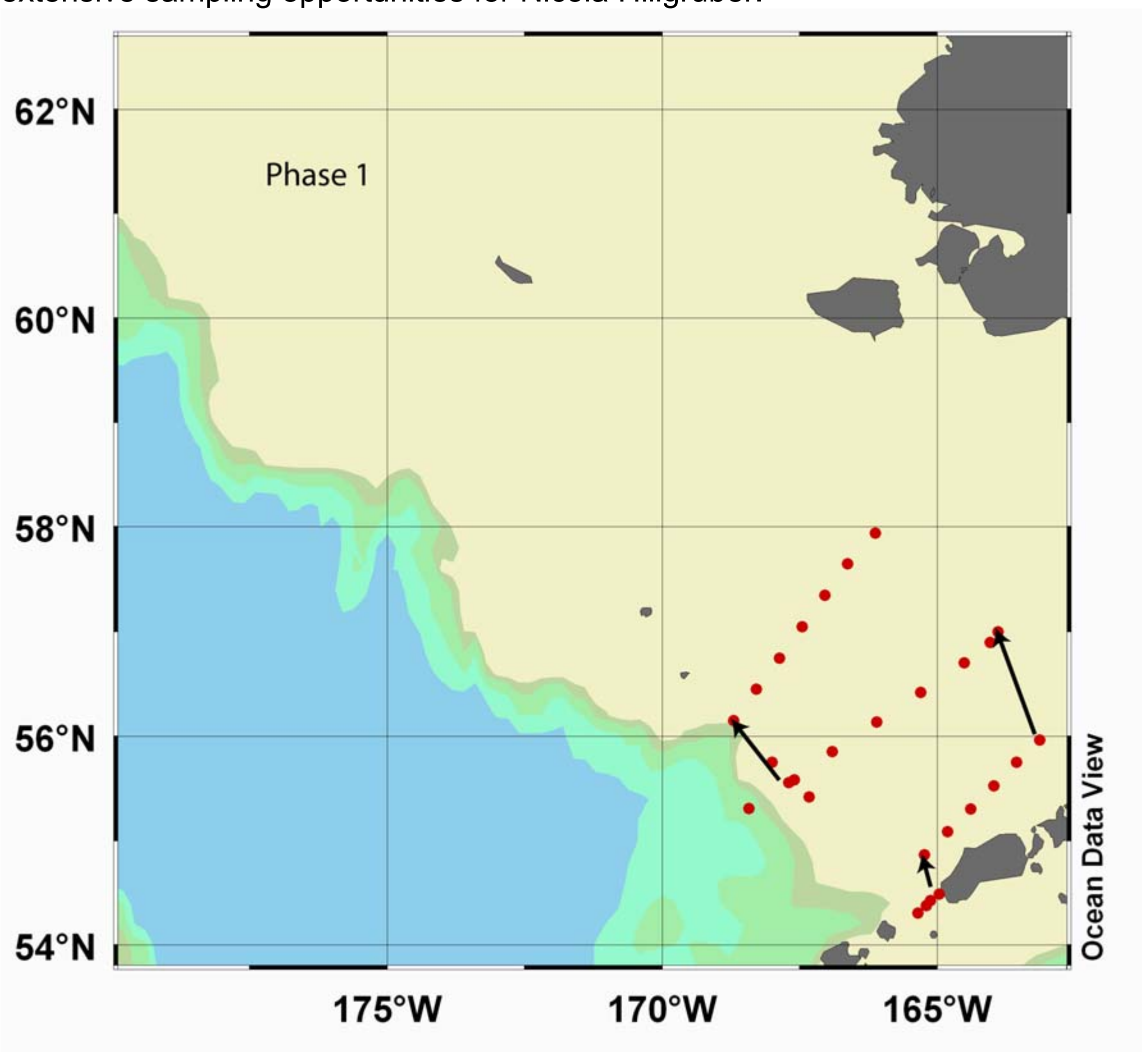
6. Cruise Track and Organization

The overall cruise track consists of several cross shelf sections together with a long shelf (70m) section that re-occupy regions that have been sampled in prior BEST cruises. An inshore line and 9 depth related locations have been added on this cruise to accommodate the mooring deployments.

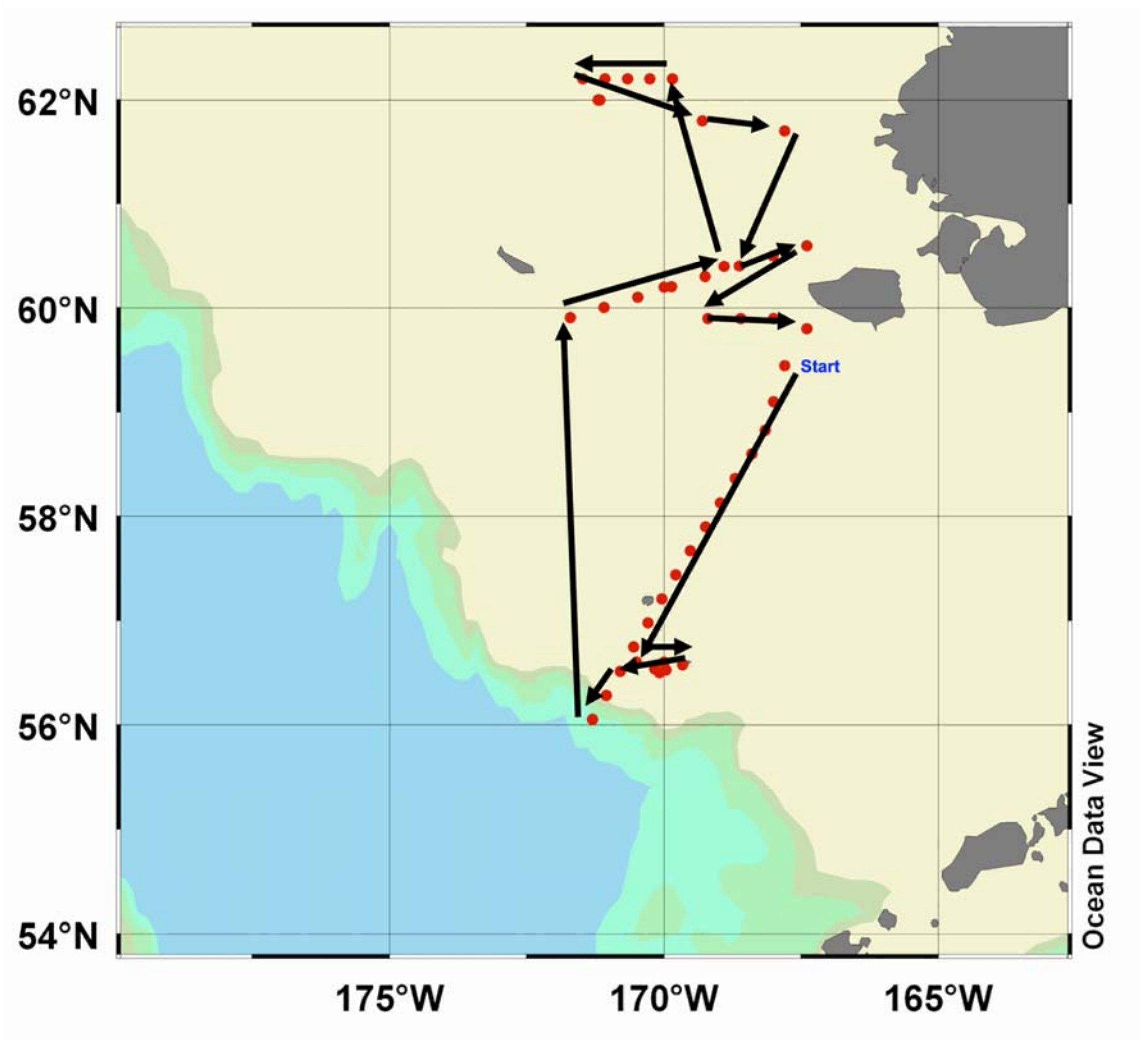


In addition to the division of HLY0803 into 2 legs by the personnel exchange at St. Paul, the sampling activities have been further organized into 4 phases of operation (2 phases before the St. Paul stop and 2 afterwards). The 4 phases and their major focus areas are as follows:

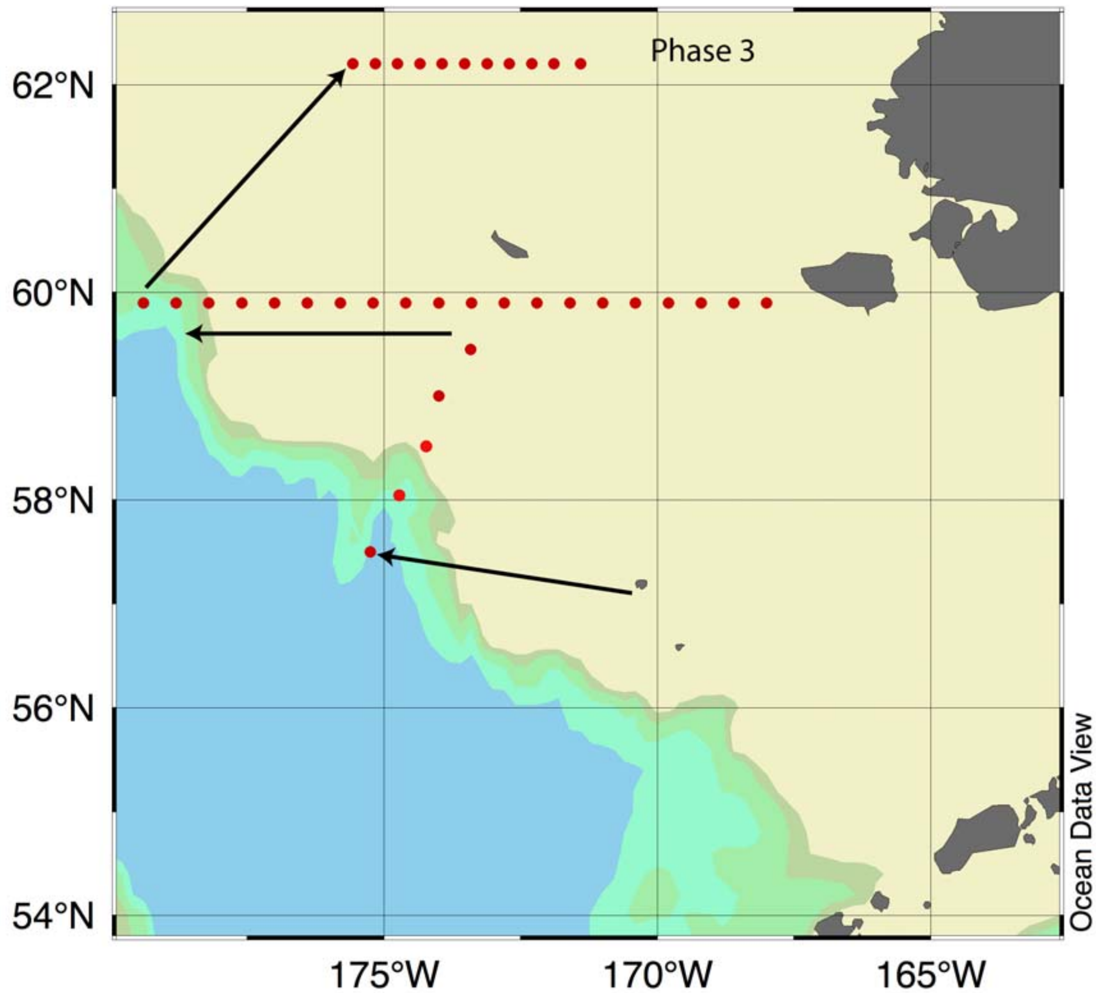
Phase 1 – July 3 – 8: *Sampling of the non-ice impacted region of southeastern Bering Sea and ichthyoplankton collection*. The southern region was the only one not impacted significantly by ice this year and provides a contrast to the heavily ice-impacted northern shelf. In addition, it is the main spawning region for pollock and other important commercial species and this phase will provide extensive sampling opportunities for Nicola Hillgruber.



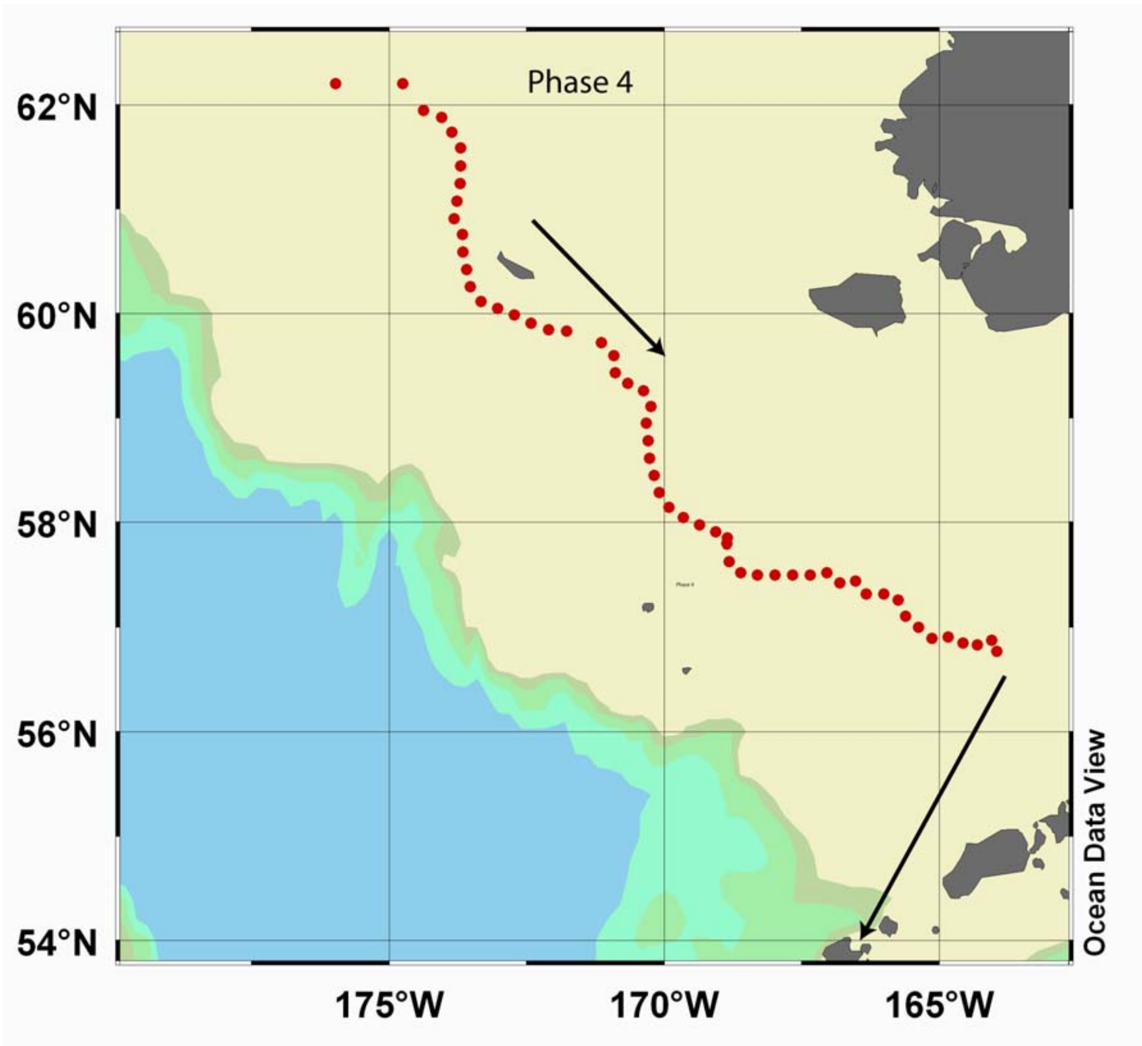
Phase 2 - July 8-16: *Deployment of moorings in inner and middle shelf regions*. These 10 moorings will be deployed by Tom Weingartner's group. The deployments are also part of cross shelf hydrographic lines. The southern-most moorings (S40 & S55) will be deployed first to gauge the station time that will be needed for the rest of the deployments. Then, the NP line will be sampled from shallow to deep to provide time for the mooring group to make any adjustments to their deployment procedures before deploying the other 8 moorings.



Phase 3 - July 18-26: *Sampling of outer shelf region in the north*. This is the region of the most extensive ice cover. The region supported intense primary production in spring 2008 and scattered production in spring 2008. This sampling will characterize the seasonal development of the production in this region and how it is influenced by the earlier ice cover. Of particular interest is the shelf break frontal region (at locations between approximately 100-200 m water depth). This region supports prolonged production in the summer in the southern shelf and its structure is associated with the physical mixing of deeper shelf waters to the surface. We will carry out collaborative observations of nutrients, iron, productivity and phytoplankton status, and particle flux in these regions.



Phase 4 - July 26-31: *Mid-shelf sampling along 70 m isobath across southern and northern cold pool*. This will provide a mid-summer sampling of the middle shelf and provide a summer time point for the seasonal evolution of the cold pool.



7. Appendix – Details for sampling and deployment procedures

7.1. CTD rosette water sampling

Priority/Order for CTD Rosette Water Sampling – HLY0803. Circulate clockwise around the rosette, beginning at the deepest Niskin bottle (No. 1).

Priority/ Order	Sampling	Sampler(s)	Sample Vol. /Niskin	Depths	How Often?	Notes
1	Radon	Shull/ Brusseau	20 L	A few		Separate casts
1	Triple oxygen Isotopes	Moran	0.5 L	A few		
	Other	Moran				
2	O_2 (Winkler)	Calvin Mordy (NOAA/PMEL)	0.7 L (1.4L total for dup.		Every station	Dup. At 2 depths
2	DIC & Alkalinity???	PMEL for Jeremy Mathis	1.5 L	6 depths	~1/3 of stations	
2.5	$d^{18}O$	Weingartner, and Others	50ml	3	Selected-all	
3	N Production	Sambrotto/ Burdloff	5-8 L	7	daily	Prod. casts
	C production	Casey/ Tiahlo	1-2 L	7	daily	Prod. casts
	microzooplankton	Stoecker	5 L	10	Half of stns.?	Prod. casts et al.
3	Particulates/DON/	Sambrotto/ Burdloff	4 L	10	~1/3 of stations	
3	zooplankton	Taylor/ Pleuthner	30L	Chl Max	Every station	Separate casts
3	Phyto. Fluorescent properties/ALPS	Goes and others	0.5			
3	Total Chl	PMEL	1.5L	6	Every station	
3	Fractionated Chl	PMEL	1.5L	6	~1/3 station	
4	$\delta^{15}N\text{-}NO_3$	Sambrotto/ Burdloff	0.125 L	All	~12 stns	
4	$\delta^{15}N\text{-}DON$	Sambrotto/ Burdloff	0.125 L	All	~12 stns	
4	Nutrients	Calvin Mordy (NOAA/PMEL)	0.1 L	All	All	
4	Salinity	SIO	0.6 L	selected	All	

7.2. Niskin Bottle Positions in Various Water Depths

Niskin Bottle no.	Niskin depth	Niskin depth	Niskin depth
1	0	0	0
2	10	10	10
3	20	20	20
4	30	30	30
5	40	40	40
6	50 or 60	50 or 60	50 or 60
7	bottom	75	75
8	chl max	100	100
9		125	150
10		150	200
11		bottom	bottom
12		chl max	chl max

7.3. Sediment Trap Deployment (Moran Group)

Number of sediment trap stations

We anticipate 4 deep sediment trap stations as part of HLY-08-03. Deep traps consist of a trap line (5/8" dia poly-dac rope) that is 110m long with samples collected at 25 m, 40 m, 50 m, 60 m and 100 m. Stations will be limited to shelf-slope locations with water depths greater than 300 m, and deployments will last approximately 24 hours.

Operational procedure of typical sediment trap deployment:

<u>(1) Preparation for deck operations</u>

Prior to arriving on station - Fantail should be prepared for sediment trap deployment. This includes: (a) placement of deck snatch-block, (b) start-up for the capstan hydraulics, (c) setting the trap line in the A-frame block and (d) placement of ballast, sub-surface, surface and spar buoys on fantail where they can be accessed (Fig. 2).

On station – The Healy's bow should be directed into the wind/swell (whichever is dominant), and the stern props should be used as little as possible to maintain this orientation. The sediment trap holders, tubes, will then be brought out and placed near the transom. Trap ballast (135 – 150 lbs) will be secured to trap downline.

<u>(2) Bridge permission</u>

Prior to be deployment of sediment traps, the bridge will be contacted to confirm permission to put equipment over the side. It may be deemed necessary to drop the life-lines spanning the transom at this time.

<u>(3) Sediment trap deployment</u>

Using the capstan to control payout, the trap ballast will be lifted and passed over the transom. If sea conditions require, a tagline may be used to stabilize the load. The ballast will be lowered to the first trap stop, where the first crosspiece will be attached to the line and the first set of tubes inserted into the crosspiece. The traps will be lowered until all 5 stops are completed. Following the last set of traps, 3 sets of sub-surface buoy strings will be attached to the downline. After the shock cord and back-up trap line pass through the A-frame block and the trap top is at deck height, the array will be secured to the vessel with a tagline. Finally, the surface buoy string will be attached.

(4) Sediment trap release

At this point contact will be made with the bridge to verify permission to release the sediment traps. The strobe light, RDF beacon, and ARGOS beacons will be activated at this time, then the buoys will be cast into the water. The tagline will be released, and the capstan will be used to allow the trap array to drift ~10 m from the ship, at which point a slip knot will be released to allow the array to drift freely.

(5) Sediment Trap Tracking

The position (lat and long) of the sediment trap will be recorded every 15 min using the Gonio 400P receiver and a laptop. If the array drifts beyond the vessels line-of-sight, the positions will also be relayed every 6 hours via email to shipboard scientists via the ARGOS satellite network. In addition, the spar buoy will be fitted with an RDF beacon, strobe light, and radar reflector to aid in tracking and recovery.

(6) Sediment Trap Recovery

After the 24 hour soak time, the traps will be recovered. The Healy will steam to the last known position of the sediment traps, and begin to search for them from there. Upon their sighting, a small boat will be launched to tow the traps to the stern of the Healy. Again, the Healy should be positioned with its bow into the wind/swell. A lead line will be connected to the trap downline, and the capstan will be used to haul in the traps. When the top of the downline is at deck height, the surface buoys will be disconnected and recovered. The sub-surface buoys and traps will be hauled in and removed from the downline as they are brought to the surface. Finally, the trap ballast will be brought on deck and the lifelines made secure on the transom.

Additional request for support from ship

(1) Additional array tracking

It would be helpful for drifter recovery if the trap GPS positions, radar bearings, or RDF bearings could be logged into the electronic navigation chart if possible/when available.

(2) The Gonio box will need to be installed on the bridge.

7.4. Deployment of moorings (Weingartner group)