Types of Stations and Activities at Each:

1) Short Station:

A short station normally will consist of a CTD cast from the starboard A-frame to near bottom and, on cross-shelf transects and at the ice edge, a Video Plankton Recorder (VPR) cast from the 3/8" wire off of the stern to 10 m off of the bottom or to a maximum depth of 300 m at locations where the bottom depth is greater than 300 m, a Calvet Net tow from the 3/8" wire off of the stern to 10 m off of the bottom, and, at stations shallower than 150 m, a 20 min deployment of the benthic camera from the port side of the fantail. It is hoped that the benthic camera can be deployed at the same time as other operations. For all operations, the ship should be stationary. Calvet net tows will be conducted at a subset of the short stations (number presently undetermined). At some stations, an additional CTD cast may be necessary to accommodate the Fe sampling of Wu.

List of Activities at Regular Short Station (not in order):

CTD Cast
VPR Cast
Benthic Camera (< 150 m water depth)
Calvet Net Tow
(CTD cast for Fe)

Order of Operations:

The order of operations will alternate between stations between starting with operations on the starboard side and starting with operations from the stern. For starts from the starboard side, the order will be CTD, Fe sampling, VPR, Calvet net, Extra nets (see below) with benthic camera work occurring during the CTD and Fe sampling (if it works out that the benthic camera can be deployed simultaneously with other sampling). For starts from the stern, the order will be VPR, Calvet net, Extra nets, CTD, Fe sampling with benthic camera work occuring during one of the operations.

2) Short Station plus Extra Net Tow:

Once per 24 hour period a second net tow will be conducted usually during the morning using a ring net from the 3/8" wire off of the stern. This will be a vertical tow (ship not moving) to a maximum depth of 100 m or to 10 m off the bottom where the bottom depth is less than 110 m.

This is in addition to the activities described for a short station.

3) Short Station plus Krill Fishing during the Night:

1-2 net tows will be conducted from the 3/8" wire off of the stern to collect krill at night.

This is in addition to the activities described for a short station.

4) Process Stations:

The following activities will occur at each process station:

- CTD casts (at least 4) from starboard A-Frame– Hydro Team
- Fe CTD cast (1) at some locations - Wu
- VPR cast (1) from stern A-frame, 3/8" wire – Ashjian
- Plankton ring net tows (4-5) from stern A-frame, 3/8" wire – Campbell/Ashjian/Iken/Prokopenko
- Calvet net tow (1) from the stern A-frame, 3/8" wire –Pinchuk
- Bongo Net tows (2-3) at night – Lessard
- Multinet or MOCNESS net tow (1) from stern A-frame, 0.68" conducting – Pinchuk
- Benthic grabs from the stern A-frame, 3/8" wire – Cooper/Grebmeier team, Gradinger/Iken team
- Benthic camera cast (1) from the starboard aft quarter using portable spool of wire – Cooper/Grebmeier Team
- Multicore (2) from stern A-frame, 9/16" wire – Devol

The following activities will be added at process stations in ice:

- On-ice sampling and deployment of sub-ice sediment traps (helicopter retrieval of traps may be necessary; see section below for description of ice work)
- ROV surveys under ice deployed from ice-Shull
- Benthic camera deployed from ice-Cooper/Grebmier team
- If necessary, small boat work to access ice- Gradinger

At up to 5-6 process stations located over the slope:

- Deployment of floating sediment traps, requires small boat – Moran

At 5-6 Open Water Stations:

- Van Veen Grab sampling from stern A-frame, 3/8" wire, 3 replicates – Gradinger et al.

A minimum of four CTD casts will be conducted at each process station. 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. The ship should remain stationary for all CTD casts.

VPR casts should be conducted as described above.

Benthic grabs and 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.

The benthic camera will be deployed for ~20 min using a manually spooled cable off of the aft deck. The ship should be stationary during the camera deployment. Camera deployment will only occur at stations of ≤150 m water depth.

The Multinet tow will be conducted with the ship stationary when in heavy ice or at a speed of 1-2 knots. The MOCNESS tow will be conducted at a speed of 1-2 knots.

At process stations in ice, the order of activities will be driven by the timing of daylight so as to maximize the period of time that the sampling teams can be deployed onto the ice. Once the ship is safely positioned next to the ice, a team of scientists (12) from the PI groups of Gradinger et al., Wu, Devol/Shull, Lessard/Harvey, and Hydro will be deployed onto the ice with equipment to begin the ice work (see more complete description below). The scientists will remain on the ice for up to 6 hours; during the first half of the cruise, a smaller team (Gradinger) will need to return to the ice ~12 hours after the deployment of sediment traps hanging below the ice surface. All ice work will be conducted during daylight hours and deployment of personnel to the ice will occur as soon as possible following the onset of daylight so as to potentially allow collection of the sediment traps 12 hours later. If the sun has set 12 hours after the deployment of the sediment traps and if the station is completed before daylight, the traps may be recovered during the following day by returning to the station location by helicopter. During the period of work on the ice, a small ROV will be deployed through a hole in the ice or potentially from the ship off of the stern at night, moving away from the ship under the ice (Shull).

5) Short station plus ice work only

At some locations, the Gradinger et al. team may need to conduct ice work for ~6 hours (standard activities) at a short station (rather than waiting for the next process station) in order to achieve 10 ice stations during the first portion of the cruise. These stations will be planned for days between process station dates.

Other Activities:

1) Small Boat Use

Moran: The small boat will be used to deploy and retrieve the floating sediment traps close to the ice edge at stations located over the slope (~300 m). For deployment, the traps will be carried to the ice edge on the boat and deployed from the boat. For recovery, the small boat will secure the upper end of the trap string and gently move that upper end to the stern of the Healy where a line through a block off of the stern A-frame will be used to bring the full traps directly on board Healy. The traps weigh 300-350 #.

The small boat also will be used to recover the traps when deployed in open water (traps can be deployed in open water directly from Healy). As for the ice edge situation, the traps will be secured to the small boat and brought over to the stern of Healy where they will be lifted on board using the stern A-frame.

Gradinger: We would work within 1 mile around the ship with a science party of three for our project. The payload would consist of five action packers, two ice corers and a power generator (total weight about 150lbs). Everything fits nicely in the small boats we used frequently during our 2005 expedition. We only want to use the small boats during daylight hours.

We will bring our own gasoline for science operations as discussed during the planning meeting.

Lessard/Harvey: Will work in conjunction with other PIs using the small boat to sample krill and ice biota (using hand nets and slurp guns) at the ice edge.

2) Sampling Activities on the Bridge

Both the Kuletz group (seabirds) and the Gradinger et al. group (sea ice) will post observers on the bridge during daylight hours to monitor ice conditions and to enumerate and identify seabirds. Both groups will use laptops on the bridge. Kuletz requires a GPS feed to her laptop. Gradinger et al. requires a feed of ship position, heading, speed etc. that will be arranged by Chayes.
The Moran team, led by Kelly, will need to install a "Gonio" box and antenna on the bridge in order to track the floating sediment traps (RDF tracking). Kelly has discussed antenna installation with Chayes. Both the Gonio box and the antenna are quite small (1.5' x 1.5' x 8" for the box).

3) Acoustic detection of plankton using a fish sonar (Simrad EK 60)

This will be conducted by Alex De Robertis. As for HLY0701, the sonar will be installed in the sonar well by Alex working together with D. Chayes. Data will be collected on a computer in the Future Lab. **We request that the ship minimize the use of the Sperry SRD500 Doppler speed log when not required for navigation as this device interferes with scientific acoustic equipment (Simrad EK60 echosounders).** During HLY0701, the Sperry SRD500 was turned off except when entering or leaving port.

4) Open-Water Deep Sediment Trap Deployment (Moran Group)

Number of sediment trap stations
We anticipate at least 5 deep sediment trap stations as part of HLY-08-02 (not to be confused with the Gradinger ice sediment trap). 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 (Fig. 1). Stations will be limited to shelf-slope locations with water depths greater than 300 m, and deployments will last approximately 24 hours. Several of these stations may be conducted in ice conditions requiring the sediment traps to be anchored to ice floes.

Operational procedure of typical sediment trap deployment:

(1) Preparation for deck operations

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.

(2) Bridge permission

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.

(3) Sediment trap deployment

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.

It may be helpful to deploy a helicopter to assist with searching for the sediment traps. This should not be necessary for every deployment, but should remain an option if circumstances require it.

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.

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5) Helicopter

The primary use of the helicopter for science will be by R. Gradinger who will need it to return to locations where he has deployed under-ice sediment traps to recover the traps after Healy has left that station (during daylight the day following the deployment of the traps). Gradinger may also use the helicopter for 1 hour trips to sample ice floes while the ship is underway.

The helicopter also may be used for personnel transfers at St. Lawrence Island and at St. Paul. At the moment, it is anticipated that a minimum of 11 people will disembark at St. Paul and 10 will embark in their place. It is also anticipated that 2 additional people will disembark at St. Lawrence. Additional people (press, local community members, teachers) may also need to embark or disembark at mid-cruise. These needs will be identified.

Ashjian and the Captain, XO, or Ops have been invited to visit Gambell by Merlin Koonooka to discuss the science of the cruise with the whalers. If our scheduled closest approach to Gambell does not coincide with whaling, we will make this trip. We will coordinate this with Merlin Koonooka during the cruise. One-two people may disembark (see preceeding paragraph) at St. Lawrence Island.

The helicopter may be used to search for the floating sediment traps deployed by the Moran group (Kelly contact). See sediment trap section.

The helicopter also may be used by the ship for ice reconnaissance. It is anticipated that this will be a particularly heavy ice year, based on conditions now and the ongoing La Niña event.

6) Ice Station Detailed Operational Plan

Teams Working on the Ice
Gradinger (2-3 people)
Rember (2 people)
Shull (2 people)
PMEL (2 people)
Lessard/Harvey (1-2 people)
Media (1-2 people; will join one of the teams and not work alone)

Number of off-ship ice coring sorties (ice stations)
(1) At least10 stations; each with a mean time of 6 hours on the ice, depending on ice conditions (snow and ice thickness, dimensions of the ice floe, weather) and progress of work. Stations can be conducted *mainly in parallel* to the water column and benthic stations.
(2) Recovery of sediment traps by helicopter 12-24 hours after each ice station.

Operational procedure of typical ice station:

(1) PMEL team notified of arrival at ice station 1 hour prior to arrival.

(2) Selection of ice floe to be sampled
R. Gradinger and R. Rember will be notified 40 min prior to arrival at selected position. Gradinger and Rember select together with ship officers a suitable ice floe for the sea ice research. Shull, PMEL, and Lessard/Harvey teams will sample ice floes selected by Gradinger.

Ashjian will resolve disputes regarding location (of course, there will be no disputes).

(2) Safety briefing

Prior to be deployment on ice a safety briefing will be held on the bridge for final approval by the ship's command. A polar bear watch will be identified by the CG. All science teams will attend.

(3) Transfer of equipment and personnel

- *Personnel:*

Gradinger Team: At each station 2-3 people will be transferred to the ice at the start and end of the station (typically 6 hrs duration).
Rember Team: 2 people to the ice for ~ 2 hours.
Shull Team: 2 people on ice for ~ 6 hours, depending on the CTD and multicore sampling schedule.
PMEL Team: 2-3 people on the ice for ~4 hours
Lessard/Harvey Team: 1-2 people for ~1-2 hours at some point during Gradinger's time on the ice (Lessard/Harvey will join the Gradinger team for their sampling)

- *Access to ice during ongoing work:*

To allow intermediate sample transfer, access to the ship by crane/basket needs to be available at any time, also for safety reasons.

- *Equipment and samples*:

At each station the following pieces of equipment would have to be hauled to the ice and back:

Gradinger Team:
- 1 ice corer (4 ft long, 20 lbs), 1 ice auger (4 ft long, 20 lbs), coring equipment (3 boxes 3x2x2 ft, 60 lbs each), electric generator (3x2x2 ft, 80 lbs)
- 2 boxes (3x2x2) containing biological sampling and measuring devices, (ca 15 lbs each)
- 1 box with video equipment, camera, monitor etc. (ca. 30 lbs)
- 2 10-gallon containers for samples (100 lbs full each on way back to ship)
- 3 coolers (4x2x3 ft, 70 lbs full), 1 sample box (2x2x2 ft, 30 lbs full)
- 2 sleds
- 2 sediment traps with floatation and mounting equipment (4x3x2 ft, 10lbs)

Rember Team:
-1 ice corer (20 lbs)
-1 cooler for sample collection (20 lbs full)
-1 cooler with battery (50 lbs)
At some stations we may collect water and will require:
-1 ice auger (10 lbs)
-1 box with inverter, pump, tubing and sample bottles (40 lbs)

Shull Team:
- 1 crate containing a mini ROV with oxygen microprofiling adapter, control box, light meter, picoammeter, and 100m cables (about 40 lbs).
- 1 ROV control box (in pelican case, 25 lbs.)
- 1 marine battery with transformer for powering ROV in a case (about 40 lbs.)

PMEL Team:
-Red box (4x0.5x0.5 ft, ~30 lbs) containing: ice corer, core sun shade, meter stick
-White box (2x2x1 ft, ~20 lbs) containing: gasoline engine for ice corer
-Blue equipment bag (4x1x1 ft, ~25 lbs) containing: ice auger, ski poles, slurp gun, water-sampling bottle, ice screws, rope, ice cutting board, radiometer stand, electric drill, etc.
-Orange Pelican box (~20 lbs) containing: GPS, compass, camera, ice-thickness gauge, ice saw, air and water PAR sensors, Zip-Loc bags, thermometer, drill bits, log sheets
-2 coolers (4x2x3 ft, 30 lbs full)
-2 sleds (brought by PMEL)

Lessard/Harvey Team:
- 3 coolers (4x2x3 ft) for ice, krill and water samples (ca 80 lbs. on return trip)
- 2 boxes (2x3x2) of biological sampling devices (small nets, slurp gun, bags, containers) ca 20 lbs.
- 2 10L containers for water (ca. 45 lbs on return trip)

<u>(4) Work on ice</u>

Gradinger Team:
The progression of a typical ice station is as follows:
a) select final sampling location on ice
b) take two ice cores
c) deploy primary productivity incubation (for four hours)
d) deploy sediment traps (about 50m from sampling site) – no other sampling can take place close to the trap, - if floe is very small than they will be deployed at the very end of the station.
e) collect water and ice samples
f) make snow measurement transect (200x200m around the sampling area

After completion of all sampling, walk to second and a third sampling site on same ice floe (if of sufficient size) and repeat e and f).

After completion of three sampling sites (total time demand about four hours) return to site 1 and recover primary productivity incubation. Take ice cores for other working groups interested in ice samples – return to ship.

Rember Team:
Select ice sampling location in conjunction with other researchers. We will require that other researchers maintain some distance (50-100 ft) from our sampling sight so that we can maintain a somewhat cleaner environment. Others may use our locations for snow sampling etc once we have completed our sampling.
We will likely take 5 ice cores from each station.
If we collect water then we drill an auger hole and pump water into bottles from varying depths.

We are available to collected cores and water once our work is completed at most stations.

Shull Team:
a) select final sampling location on ice based on Gradinger's assessment
b) create opening for ROV (with help from Gradinger group)
c) calibrate microelectrode probe with water from station (compare to optode)
d) fly ROV under ice for O2-profile measurements and PAR measurements at several stations (about 2 hours)
e) fly video/PAR transects under ice (about one hour)
After completion of all sampling, and if time remains, walk to second or a third sampling site on same ice floe (if of sufficient size) and repeat d and e).
After completion of sampling (about four hours) return to ship.

PMEL Team:

a. select final sampling location on ice
b. observe ice conditions and snow depth
c. drill chlorophyll core, characterize, photograph, measure ice thickness, sample in 10 cm increments, measure PAR above and below ice
d. auger sequence of brine holes 20, 40, … cm deep,
e. drill salinity/nutrient core, characterize, photograph, measure ice thickness, sample in 10 cm increments
f. drill temperature/productivity core, characterize, photograph, measure ice thickness, measure temperature at 5, 15, … cm depth, sample in 10 cm increments, measure PAR above and below ice
g. sample brine holes
h. drill a fourth core if requested by other investigators

After completion of all sampling, walk to a second sampling site on same ice floe (if of sufficient size) and repeat (b) to (h).
After completion of two sampling sites (total time demand about four hours) drill other cores if requested by other parties. Return to ship.

Lessard/Harvey Team:
a) At sample location designated by Gradinger, take 1-3 ice cores, depending on biomass. Sample the bottom section of ice cores.
b) Take water samples
c) Take net tows
d) Return to ship
Work will be conducted in consultation with Gradinger.

<u>(4) Use of helicopter for ice access</u>

Gradinger Team:
A helicopter is requested for recovery of ice sediment traps. Dale Chayes still needs to provide information regarding locating the ice floes after 12 to 24 hours.

Also we would like to use helicopters for short time ice sampling (<1h) to collect ice samples while the ship is underway if approved by chief scientist.

PMEL Team:
Some *ad hoc* experiments may be devised and left behind on the sea ice for 12 to 24 hours and retrieved via helicopter. Loads will be the size of 1 or 2 ice chests.

(5) Additional requests for support from ship

(a) Equipment

Gradinger:
- radio communication (hand-helds) for communication with ship (2 radios on the ice)
- 3 larger sleds for transport of equipment on the ice) – had been available on the Healy in 2002, 2004 and 2005.

Shull: Request the use of a Healy sled for moving equipment on the ice (if available).
PMEL Team: as per Gradinger. PMEL group has own hand-held radio.
Lessard/Harvey: Same equipment as Gradinger.

(b) Polar bear watch
As we are limited in the number of personnel in our team, we would require polar bear protection support from the ship. Ideally, this would consist of one additional person on the ice and a person on the bridge responsible for scanning the vicinity of the ship for polar bears and communication with the ice team.

Other Operational Considerations

We will be working near four NOAA moorings. The positions are listed below. Note that there are additional moorings within 1 nm of NOAA mooring M2.

Bering Sea 2 (M2) 56.877°N, 164.057°W, 73m water depth. There are some other moorings nearby, within 1 nm
Bering Sea 4 (M4) 57.853°N, 168.870, 71m water depth
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