

HLY0601 (SLIPP06)**Climate-Driven Changes in Impacts of Benthic Predators in the Northern Bering Sea
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- Perry Pungowiyi, Savoonga local participant
- Helo component: Jim Dell (helo pilot), Charles Sims (mechanic), Alex Stone (helo manager)

A. PROJECT SUMMARY

Perhaps the most striking evidence of global climate change is decreased extent of arctic sea ice and recent studies indicate associated environmental changes south of St. Lawrence Island (SLI) in the SLI polynya region (SLIP). Despite research on the consequences of sea-ice change for physical oceanography and weather, effects on arctic marine food webs from microbes to top predators are by comparison very poorly understood. Our field research is investigating a major mechanism by which sea-ice change might affect the very productive, benthic-dominated food webs on shallow arctic shelves -expansion of the ranges and numbers of mobile benthic predators owing to increased temperature of bottom water. When winter sea ice melts on the north-central Bering Sea shelf, a pool of cold bottom water (<1°C) forms that persists through summer and reduces the numbers and growth of crabs and groundfish. The size of the cold pool decreases with decreasing ice extent. This area is currently the sole wintering site of the world population of the benthic-feeding Spectacled Eider (SPEI), a principal top predator. Expansion of competing crab and fish predators as ice cover declines and the cold pool contracts may affect food availability for the eiders. In this project, our main research questions are

Question 1: Is the benthic food web in the north-central Bering Sea limited by top-down control by predators? We are collecting data needed to model the total impact of predators on their main benthic prey in the northcentral Bering Sea. These predators include SPEI, groundfish, snow crabs, sea stars, and gastropods.

Question 2: Are the overwinter survival and/or prebreeding condition of SPEI being impacted by climate driven trends in ice cover that are allowing populations of competing crabs and groundfish to expand? We are using past and current data to simulate impacts on the energy balance of the main endotherm predator (SPEI) of variations in crab and groundfish populations expected to occur with changes in ice cover and resulting temperature of bottom water.

Question 3: Are the time-series benthic system changes observed south of St. Lawrence Island continuing and are they forced by bottom-up (hydrographic) or top-down (predator) interactions, or both? We are

collecting data to continue our long-term (1950-2005) record of benthic communities and carbon cycling processes in this area, which is essential to analyses in this project. These data will also indicate whether declines in organic matter supply to sediments that we have measured at a subset of stations have occurred throughout the area, and whether these declines correspond to a decrease in direct precipitation of phytoplankton during and after the ice-edge spring bloom.

B. OVERVIEW SUMMARY OF HLY0601 FIELD SAMPLING

In our shipboard sampling, we used a profiling conductivity-temperature-depth (CTD) and rosette system for collecting physical and hydrochemical samples. Water samples were taken using 12 30-liter-Niskin bottles. Subsamples from multiple CTD/rosette casts were used for chlorophyll content, nutrients, particulate organic carbon, dissolved organic carbon, zooplankton, benthic population measurements and sediment tracers. A vertical net was used to collect zooplankton for population measurements. Benthic van Veen grabs and a HAPS benthic corer were used to collect benthic fauna and sediment samples for population, community structure, food web, sediment chemistry and metabolism studies. An otter trawl was used to collect epifauna for population and stable isotope and lipid content measurements. Besides the standard ship sensors (atmospheric, seawater temperature, chlorophyll, multibeam), we collected atmospheric methane (a greenhouse gas) and beryllium-7 (a natural radioisotope used for tracing particulate deposition to the sediments). Both bridge and helicopter operations were used for seabird, marine mammal and sea ice surveys. Further details beyond this summary are provided in the full cruise report to be posted at <http://arctic.bio.utk.edu/> and the USCG website soon.

We occupied 118 stations during HLY0601 from the northern Bering Sea, starting south of St. Lawrence Island and extending to Bering Strait (Fig. 1).

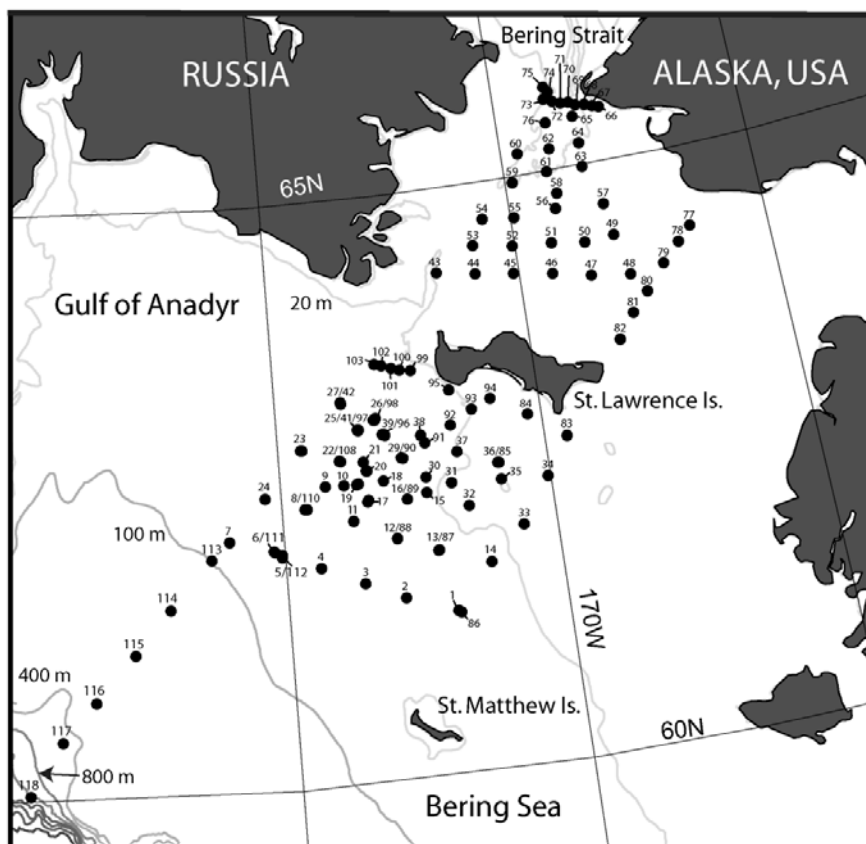


Fig. 1. Final station grid for HLY0601. Note that we remained 30 miles offshore from St. Lawrence Island (SLI) until the first week of June per an agreement with local hunters to minimize contact with marine mammal hunting. However, local Gambell and Savoonga IRA leaders approved our request to work within the 30-mile limit south of SLI upon our 2nd return to the region.

The overall approach in this study is as follows:

1. We are continuing our time-series benthic measurements with multiple van Veen and HAPS benthic corer deployments. We have provided sediment subsamples for paleoclimate studies to U Massachusetts participants to develop a training set of modern sediments and diatom content in order to infer sea-ice duration on diatom assemblages.
2. We are measuring the densities (by size class) of clams, predatory gastropods, sea stars (asteroids), snow crabs, and groundfish in the wintering area of (SPEI) collected via trawling.
3. Profiles of salinity and temperature, macronutrients, $\delta^{18}\text{O}$ values, and chlorophyll *a* in the water column were measured at each station from CTD rosette samples. These data provide an oceanographic water mass context for our study, including data to analyze contributions of nutrients, sea ice melt, brine and runoff contributions. In addition, we deployed a PAR/UV vertical measuring meter in the water column to 100 m depth after retrieval of the CTD.
4. We are investigating the diets of predators collected using analyses of gut contents, stable isotopes, and fatty acids of zooplankton and benthic collections. We are measuring prey size class of both predators and prey when possible. Based on the literature, we will develop estimates of the food intake per individual per day of the predators, considering the size classes of each predator.
5. We mounted a methane detector on the upper forecandle deck, upwind of the stacks for atmospheric methane measurements for the full duration of the cruise.
6. Satellite observations of ice were evaluated via normal bridge obtained imagery and free web accessed products during the course of the cruise. In addition, we also obtained SAR satellite imagery data to investigate linkages between sea ice variability, polynyas (persistent openings in sea ice cover), and chlorophyll biomass throughout the northern Bering Sea region.
7. We had observations of marine mammals in association with sea-ice, along with seabirds, through cooperative programs of the University of Virginia and the USFWS.
8. The multibeam system used through collaboration with a participant from the University of Hawaii, with a study focus on the region SW of SLI. The shipboard service team also maintained various sensor systems on the Healy, including the multibeam system.
9. Limited ice seal observations, tagging and tissue collections were undertaken via small boat operations with a colleague from the Alaska Dept. of Fish & Game to investigate ice seal stock structure, migration routes, and dispersal patterns of ice seals that occur in the northern Bering Sea.
10. We hosted a middle school teacher and an Editor from Scholastic, Inc. for the full length of the cruise as part of the TREC (Teachers and Researchers Experiencing the Arctic), with PI Cooper as the lead organizer. These educators maintained shipboard catalog postings on the web, wrote articles and hosted conference calls during the cruise. We also interacted with school children and teachers in Gambell and Savoonga on St. Lawrence Island during the first few weeks of the cruise while they were still in school. Our middle school participant prepared her own journals on the science project and answered many email questions from peers across the U.S. Further information is available at the TREC website: <http://www.arcus.org/TREC>.
11. We interacted with the local Native communities in the region and sponsored a participant from Savoonga, St. Lawrence Island in Alaska for 5 days during the cruise.
12. We included two media representatives on the ship the last week of May, 2006.

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