BENTHIC PROCESSES AND ECOSYSTEM CHANGE IN THE CHUKCHI SEA

Jackie M. Grebmeier, and Lee W. Cooper, University of Tennessee, Knoxville, TN, USA

High-latitude western Arctic shelf systems are highly productive under the influence of nutrient-rich Pacific water. Seasonal sea ice duration and extent, seawater temperature, and current dynamics are also critical for water column production, carbon cycling, and pelagic-benthic coupling. Short food chains are characteristic of high productivity areas in this region, so changes in lower trophic levels can affect higher trophic organisms rapidly, such as diving ducks, walruses, bearded seals and gray whales. Subsistence harvesting of these animals are locally important for human consumption and the vulnerability of this ecosystem to environmental change is therefore high.

Our participation in the 2004 U.S.-Russia cruise as the first activity under the Russian-American Long-term Census of the Arctic (RUSALCA) program provided a strategic opportunity to continue previous studies in both U.S. and Russian waters. In addition, the timing of these studies allowed us to link the RUSALCA program with our currently funded work on the Western Arctic Shelf-Basin Interactions (SBI) project (http://sbi.utk.edu) and the Bering Strait Environmental Observatory (http://arctic.bio.utk.edu); these studies are evaluating the impacts of environmental change in the Arctic. Past studies in the region over multiple US-Russian expeditions as part of the BERPAC program (Long-term Ecological Investigations of the Bering Sea and Other Pacific Ocean Ecosystems) allow a time-series comparison of the results from the RUSALCA cruise with past sampling (1988 *Akademik Korolev*, 1993 *Okean*, and 1995 RV*Alpha Helix*) and allow continuation of long-term observations for evaluating climatic impacts on this sensitive northern ecosystem.

The sampling program for our studies included five replicate sediment samples using a $0.1m^2$ van Veen grab. Samples were collected at 14 stations at depths ranging from 53-73m. The first grab was used for surface sediment sampling of total organic carbon (TOC) and nitrogen, sediment grain size, sediment chlorophyll *a* content, organic matter $^{13}C/^{12}C$ ratios, and ^{7}Be, a short-lived atmospherically-derived cosmogenic isotope that provides an indication of where sedimentation has recently occurred. We also cooperated in the use of our sediment sampling to provide samples for trace metal analysis at the University of Alaska Fairbanks and meiofaunal abundances at the Zoological Institute, St. Petersburg. The remaining four van Veen grabs were sieved separately through a 1 mm stainless steel mesh screen, preserved in 10% buffered formalin, and analyzed for macrofaunal species and biomass at the University of Tennessee. Because of additional simultaneous sampling by the SBI project, the RUSALCA sediment chemistry data can be interpreted in the context of the larger data set available from the wider Chukchi shelf and slope.

The majority of benthic stations sampled during the RUSALCA cruise were composed of silt and clay grain size fractions, although stations along the coast were dominated by coarse sediments (gravel and pebbles). Surface sediment TOC values were highest at the head of Hope Valley and downstream in Herald Valley as well as on the outer shelf/slope of the Chukchi Sea, the slope area of the Beaufort Sea, and in upper Barrow Canyon (Fig. 1a). There is a significant relationship between surface sediment TOC and silt and clay fraction ($\geq$5 phi; Fig. 1b). Surface sediment activities of the particle-reactive, atmospherically-

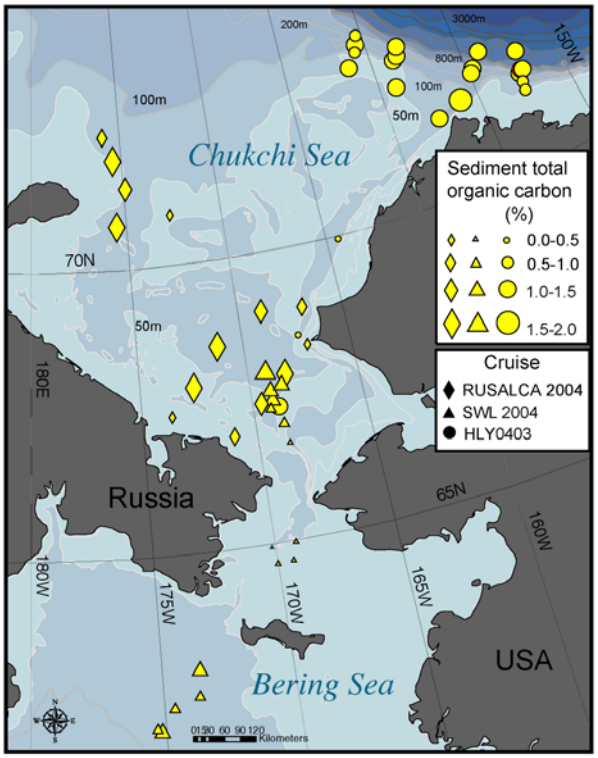

Figure 1a. Total organic carbon (%) in surface sediments in the northern Bering, Chukchi and western Beaufort Seas and Arctic Ocean.

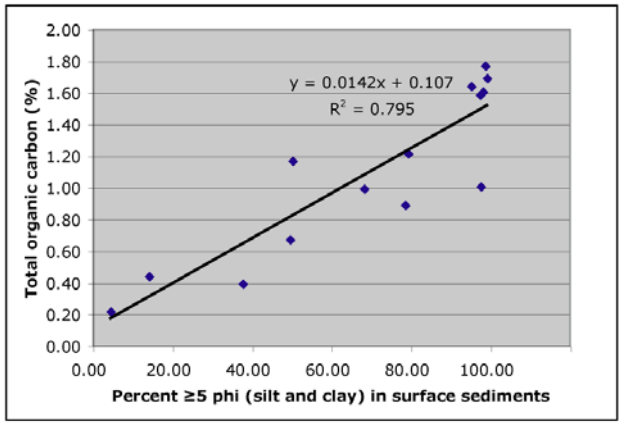

Figure 1b. Total organic carbon (TOC) vs. silt and grain content (≥5 phi) in the RUSACLA stations (diamonds in Fig. 2a).

derived radioisotope ^{7}Be (half-life 53d) indicate activities are highest in sediments immediately north of Bering Strait, and in down-slope portions of Herald and Barrow Canyons where Pacific-origin waters flow off the continental shelf. These data suggest areas of tight pelagic-benthic coupling of organic carbon. Chlorophyll *a* concentrations in surface sediments show similar high concentrations on the shelf, with low concentrations in deep basin sediments. C/N ratios and δ^{13}C values of bulk organic carbon in sediments co-vary with lower C/N ratios and less depleted δ^{13}C values on the Russian shelf, consistent with less refractory and more readily usable, recently deposited organic materials (see Fluxes section of meeting summary).

Benthic infaunal biomass was very high in the southern Chukchi Sea stations in a known region of high water column production. Previous measurements of sediment community oxygen consumption (SCOC), an indicator of carbon supply to the underlying benthos, show persistent patterns of carbon flux to sediments in the RUSALCA study area in the southern Chukchi Sea. In our studies, we converted wet weight benthic biomass to carbon benthic biomass, which allows removal of heavy carbonate test value. SCOC and benthic carbon biomass identify "foot prints" of high carbon deposition and benthic biomass on the shallow continental shelves. Macrobenthic infaunal biomass in the south-central Chukchi Sea stations ranged from 24-59 g C/m^2 (500-1400 g wet wt./m^2), exceeding 117 g C/m^2 (>3000 g wet wt./m^2) at one station (Stn. 13), which is extremely high for the world's oceans. Taxa in this region in the southeastern and south-central Chukchi Sea included an infaunal community composition dominated by the bivalves *Macoma*

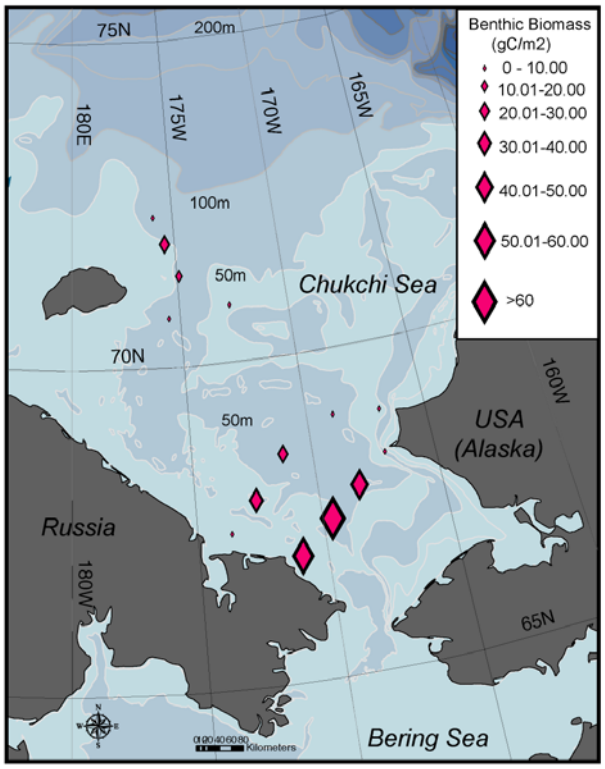

Figure 2a. Benthic biomass (g C/m^2) in the Chukchi Sea collected during RUSALCA 2005.

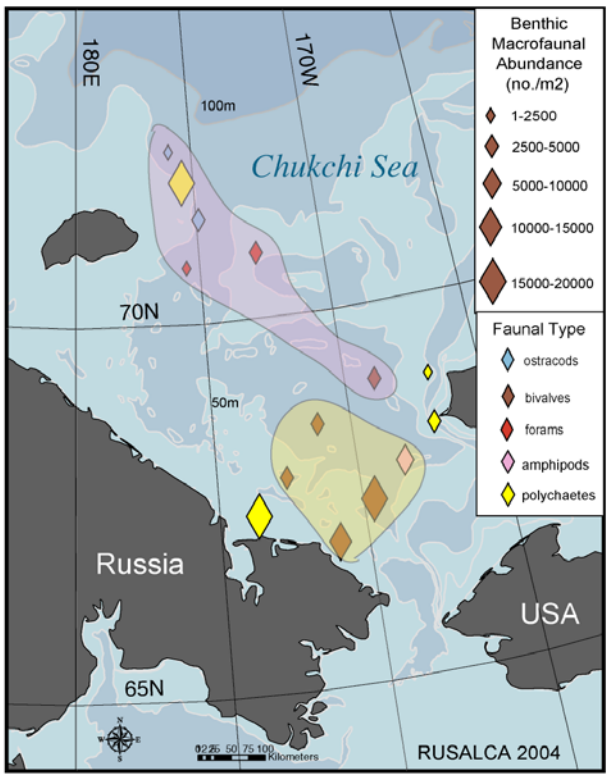

Figure 2b. Benthic community structure, based on macroinfaunal macrofaunal biomass (number/m^2), along with identification of dominant faunal type.

calcarea and *Nucula belloti*, and amphipods (*Byblis* sp.; Fig. 2b) and it does not appear to have changed dramatically in community composition from previous sampling in this productive area. The northernmost region in Herald Trough and its vicinity was dominated by polychaetes, ostracods, and foraminifera (Fig. 2b), with a benthic biomass ranging from 5-26 g C/m^2 (113-588 g wet wt./m^2; Fig. 2a). An unexpectedly rich settlement of sedentary epifaunal organisms (soft corals, sponges and bryozoans) encrusting both pebbles and manganese nodules was encountered in the northwestern area in Herald Trough (Stn. 62B; B. Sirenko, pers. comm.). The northwestward transit of Pacific water through Bering Strait and northward in the Chukchi Sea, ladened with high nutrients and carbon content, is a driving factor for the high productivity of the underlying benthos in the southcentral Chukchi Sea.