BEST-BSIERP
Bering Sea PROJECT
UNDERSTANDING ECOSYSTEM PROCESSES IN THE BERING SEA 2007–2013

Late Winter in the Northern Bering Sea

LOW PRODUCTION, BUT WIDESPREAD FORAGING OF STORED FOOD

It is well-known that the Bering Sea is productive, but it is also expected that the timing of productivity is tied to the availability of light. The availability of light to drive photosynthesis is related to both the return of sunlight as the spring equinox approaches, as well as the retreat of sea ice as winter's hold begins to ease. These are the expectations, but before the Bering Sea Project, conditions and animals using the northern Bering Sea (north of St. Matthew Island) in late winter were actually poorly known. We did know that the shallow shelf supports some of the most extensive marine invertebrate communities in soft sediments in the world ocean, and that certain specialized benthic-feeding predators, including walruses, spectacled eiders, and bearded seals, call these northern waters their winter home. How does this ecosystem function before the onset of the spring bloom? Where are these top predators foraging? What other birds are using these waters? Where there is open water within the ice (polynyas), is there enough light (and nutrients) to stimulate production?

How We Did It

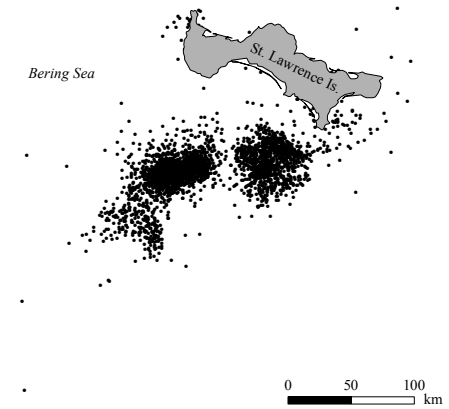
For three consecutive years (2008-2010), we had the extraordinary opportunity to sample the ice-covered northern Bering Sea in March and make observations of the water column, marine sediments and the animals living in this ecosystem. One of the objectives of the research was to determine where walruses and spectacled eiders were feeding on the sea floor,

continued on page 2

The Big Picture

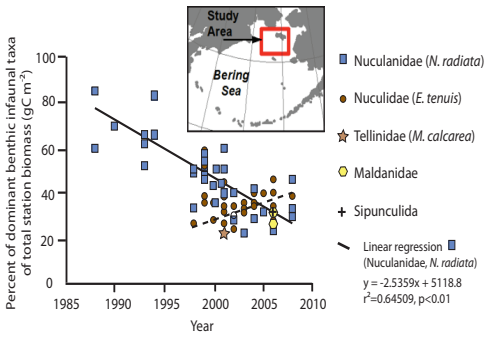
The Northern Bering Sea, roughly from St. Matthew Island north, is a distinct ecosystem that functions differently than the open seas to the south. This difference is particularly striking in the winter, when walruses, ice seals, and spectacled eiders congregate in large numbers to take advantage of abundant food supplies on the seafloor, and also, in some cases, from under-ice prey such as arctic cod and euphausiids. Productivity in the water column is low due to light limitations, but west-to-east decreases in chlorophyll and nutrients are already present, as they are later in the seasonal cycle when massive sea ice edge blooms occur. The biomass of the seafloor biological communities have been in decline over the past several decades, so additional changes in the ecosystem or the movement of industrial fishing northward may have negative consequences for the entire food web of the region.

Fig. 1



Spectacled eider satellite telemetry locations (n = 3,229) received from the primary wintering area in the Bering Sea south of St. Lawrence Island, Alaska in September-May in 2008-2009, 2009-2010, and 2010-2011. See Fig. 2 for study area inset map.

Fig. 2



Decline of clam populations in the prime spectacled eider winter foraging area south of St. Lawrence Island over the past several decades. Dashed line is possible (not statistically significant) increase since 2003 in Ennucula tenuis, *a bivalve species not favored by the eiders. Figure is modified from Grebmeier, 2012, Annual Review of Marine Science 4:63-78.*

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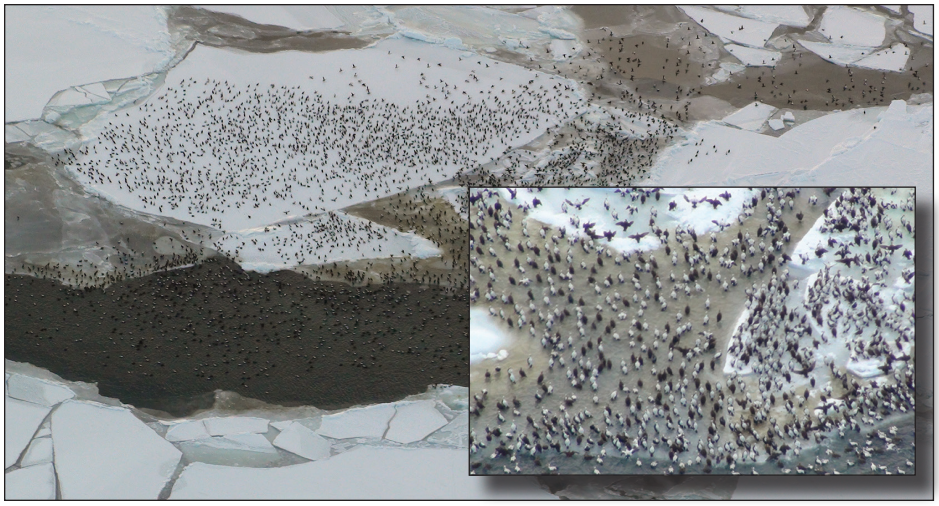
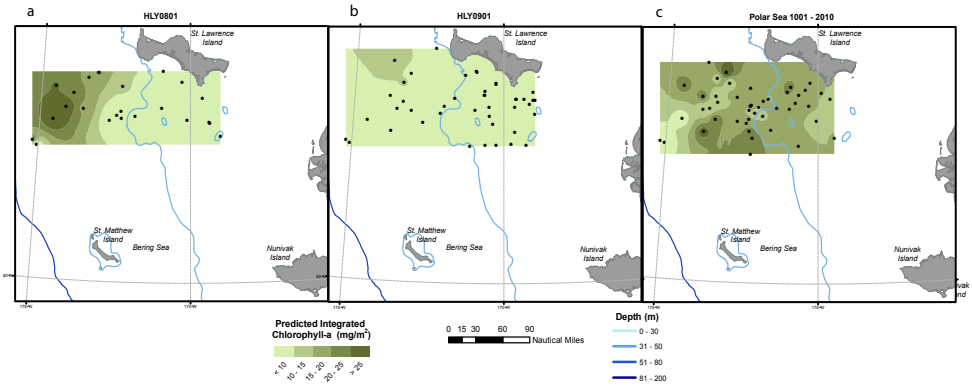


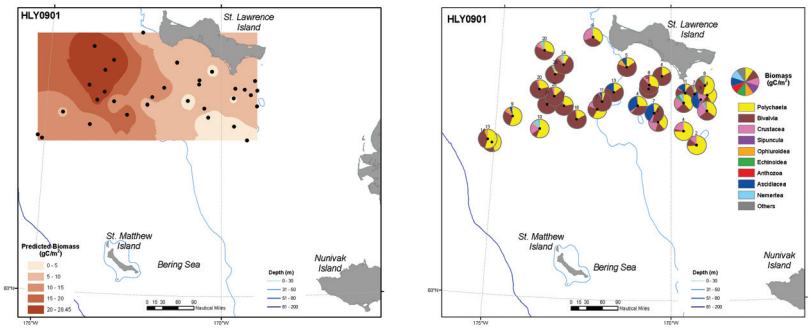
Spectacled eiders use openings in the sea ice of the northern Bering Sea to reach clam populations on the sea floor 40-60 m below. Other seabirds that use the open leads in winter and spring include black guillemot and Kittlitz's murrelet, which feed on small fish, euphausiids and amphipods that are aggregated at the ice edge. ***Inset:*** *A close-up view; spectacled eiders use the ice for rest between feeding bouts and use less energy to remain on the ice than to rest in the open water.*

Fig. 3



Predicted integrated Chlorophyll-a in the study area in March of 2008 (panel a), 2009 (b), and 2010 (c). Black dots are sampling stations. Water column chlorophyll (plotted in mg/m² over the whole water column) is characteristically one-to-two orders of magnitude lower than is observed during the peak of the spring bloom in May, but west-to-east decreases are also evident due to differences in water mass productivity and nutrient content.

Fig. 4



Benthic biomass per square meter (left) and dominance of clams (right, brown color in circles) from 2009. Note the alignment of clam populations with spectacled eider distributions determined using satellite telemetry (see Fig. 1).

and to match that feeding with the distribution of food resources, as well as the ever shifting sea ice that might impact the ability of these air-breathing predators to return to the sea surface.

Why We Did It

The northern Bering Sea shelf is fundamentally different from more southerly Bering Sea shelves where commercial fisheries dominate. Cold bottom water temperatures influenced by ice formation are in part responsible for the ecosystem structure, which includes walruses, gray whales, and other bottom feeding predators that depend upon abundant biological communities on the seafloor. However, satellite observations indicate that the duration of seasonal sea ice, particularly north of St. Lawrence Island, is decreasing. Continuation of these patterns could bring fish north, as well as commercial interests. Industrial trawling could negatively impact these rich benthic communities that Yupik and Iñupiat communities on both Saint Lawrence Island and the mainland depend upon indirectly through subsistence harvests of top predators such as walruses.

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