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

# The Role of Edgy Phytoplankton in the Bering Sea Ice Environment

THEY DETERMINE WHO GETS WHAT AND WHERE

This project focused on the growth of phytoplankton, the small photosynthetic organisms that bloom in the spring in high-latitude seas throughout the world. We wondered how sea ice impacts the pattern and intensity of production in the eastern Bering Sea. One of the primary mechanisms we examined was the role of ice in determining the availability of nutrients, particularly nitrogen, required for the growth of all organisms. Some of the more detailed questions we addressed include:

- How does the formation and movement of ice influence the fertility of the region?
- Are the patterns consistent from year-to-year (or at least predictable from sea ice patterns)?
- What is the relative importance of dissolved nitrogen transported onto the shelf from deeper waters, relative to organic nitrogen that is recycled on the shelf?

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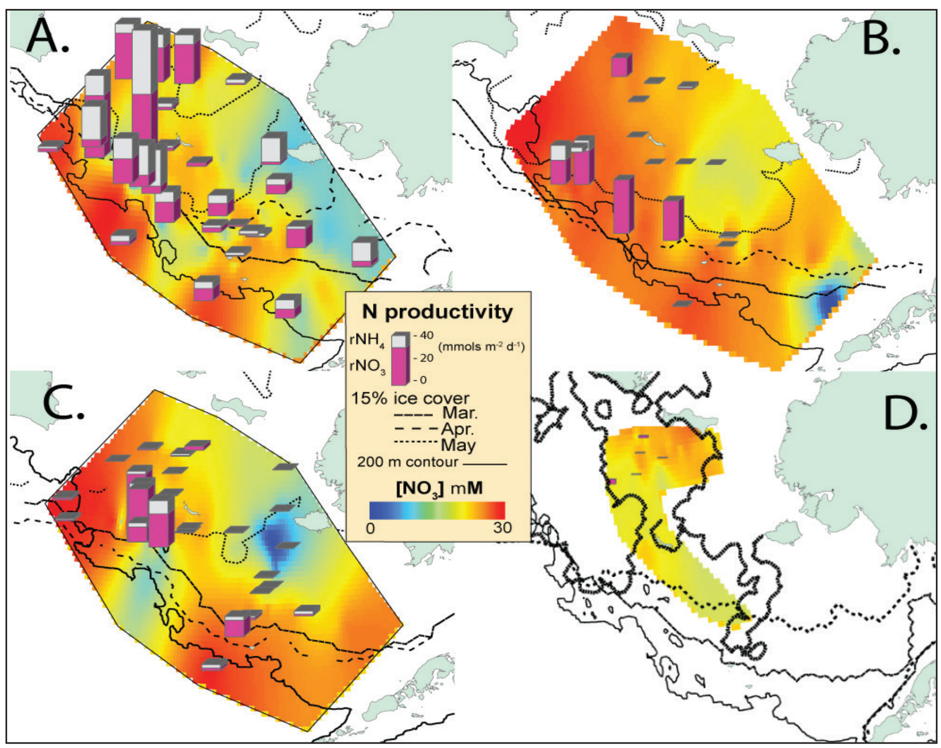
## The Big Picture

Although we know that the extent of sea ice has varied in the eastern Bering Sea, the impact of these variations on the fish, birds, and marine mammals is not well understood. Some of this gap is due to the limited oceanographic sampling of ice that has taken place, particularly in relation to plankton growth and its relationship to nutrient levels. A detailed, mechanistic understanding of how physical environmental changes propagate from the plankton to the populations of upper food web levels is needed to better manage stocks and predict future ecological conditions.

*Fig. 1*




*Nitrogen (N) productivity, surface nitrate concentrations, and ice extent in the eastern Bering Sea in A. 2007; B. 2008; C. 2009; and D. 2010. In each panel, the color map represents surface nitrate concentrations (nitrate is the preferred form of nitrogen for phytoplankton growth). Note that the data in 2010 are from a smaller region of the shelf than in the other years. The vertical bars represent nitrogen productivity (a measure of the rate of phytoplankton growth). For each N-productivity bar, purple represents the amount of nitrate productivity and gray represents the amount of ammonium productivity (the two different forms of nitrogen; ammonium is less preferred). The solid line is the 200 m depth. The dashed lines represent the ice extent in March, April and May in each year, and together with the nitrogen productivity rates show the elevated productivity associated with the ice edge on the western shelf.*

NITROGEN SUPPLY FOR NEW PRODUCTION AND ITS RELATION TO CLIMATIC CONDITIONS ON THE EASTERN BERING SEA SHELF
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## How We Did It

We found that, when it comes to phytoplankton productivity, not all ice edges are created equal: some were associated with dense phytoplankton blooms, but others were not. An exception was the region of the outer shelf, from just north of the Pribilof Islands to beyond Zhemchug Canyon, where we found heavy growths of phytoplankton in each of the four years we sampled it (Figure 1). The ice appears to consistently create good growth conditions here. Also, there was a cross-shelf pattern in the use of nitrogen by phytoplankton in the spring: The outer shelf ice edge blooms were fueled mainly by deep-water nitrogen, while phytoplankton growth in shallower, inshore waters had a much greater dependence on nitrogen that was recycled from previously produced organic matter. This pattern showed up clearly in the phytoplankton incubations we did, as well as in isotopic measurements that were made on the nutrients themselves.

## Why We Did It

The fish, birds, and marine mammals that were the focus of the Bering Sea Project depend on the food web, of which they are a part, to supply them with enough resources at appropriate times in their lives. Food for all organisms can be traced to the initial formation of organic material by photosynthetic organisms; in the sea, this mainly comes from phytoplankton. A challenge for marine animals, however, is the extreme variability of phytoplankton production. Phytoplankton are dependent on a combination of oceanographic factors such as wind, ocean currents, and ice that control when and where light and nutrients provide suitable conditions for growth. Phytoplankton growth impacts the upper food web levels in a bottom up fashion, and as the spatial pattern of phytoplankton productivity changes from year-to-year, the fish, birds, and marine mammals must deal with resulting variations in their food supply.

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*Photograph of the ice edge in the Bering Sea showing the dense growth of algae that turns the bottom of the ice brown. The ice releases these algal cells as it melts, and these contribute to dense phytoplankton blooms at the ice edge.*



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