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

Warm and Cold Years in the Southeastern Bering Sea WEATHER MATTERS

The Bering Sea is ice-free during summer, but beginning in November or December, sea ice begins to form along the coast. In January and February, strong winds out of the north push the ice southward 1,000 km, covering much of the shelf. Air temperature and the timing and persistence of these "arctic blasts" varies widely from year to year. While there is always ice on the northern shelf in winter and much of spring, the maximum southern extent of the ice can vary by 100s of kilometers between years (Figure 1). In "warm" years, there is little ice in March and April south of latitude 57° 30', whereas in "cold" years the ice persists in the south for many weeks in early spring.

Sea ice plays an important role in the physics and biology of the eastern Bering Sea. It results in colder spring ocean temperatures, an early ice-associated phytoplankton bloom, a less saline water column and a summer cold pool where temperatures in the bottom water layer remain below 2 °C.

In February 2000, the southeastern Bering Sea entered an almost 6-year period of little ice and "warm" conditions. After a transition year in 2006, extensive sea ice returned to the southern shelf, and these cold conditions

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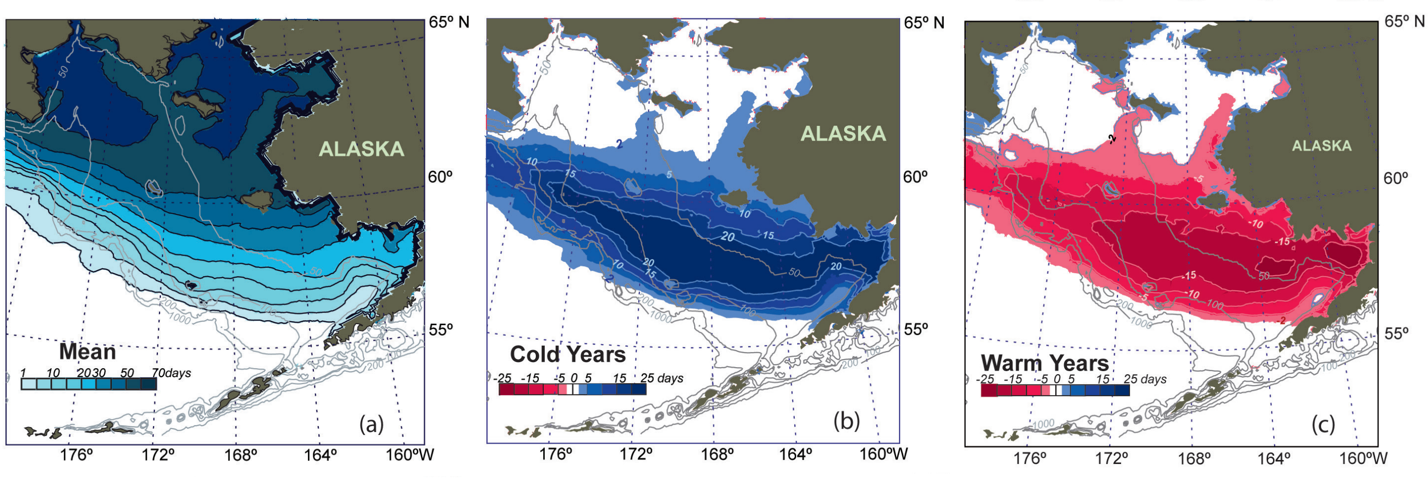
The Big Picture

The transition between the Arctic and subarctic occurs in the southern Bering Sea, and the boundary between the two is very sensitive to climate changes. Changes in the temporal patterns of variability can also impact this system. Seasonally icy seas, like the Bering Sea, respond differently to changes in ice cover than Arctic seas that presently have year-round ice. Recent multiple consecutive years of warm conditions with less ice in winter and spring yielded fewer large zooplankton, an important prey species in this ecosystem, and led to lower pollock recruitment.

Fig. 1



(A) Average number of days in which sea ice was present in March and April during 2001-2010. The anomalies of sea-ice coverage during March and April during (B) the cold years, 2007-2010, and (C) the warm years, 2001-2005.

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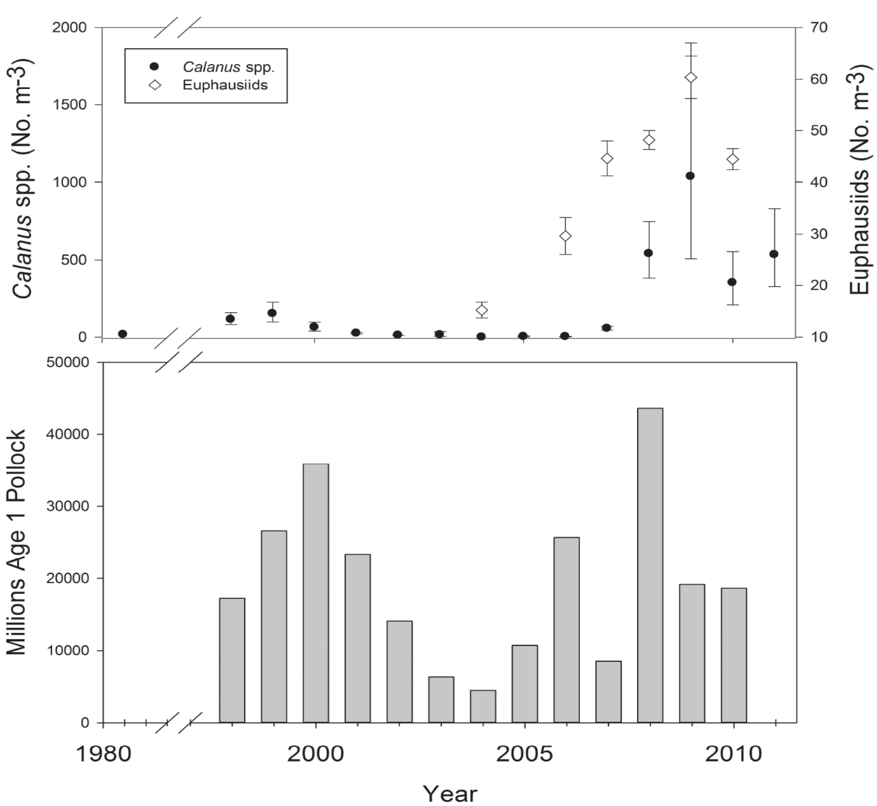
were still present in 2013. Scientists originally hypothesized that warmer conditions would favor walleye pollock and other fish species that prefer temperatures above 2°C; however, with warmer conditions, there was a sharp decrease in the availability of key prey items for young-of-the-year pollock, limiting the survival of fish during their first winter (Figure 2). An interesting question that remains is “has the Bering Sea shifted from strong year-to-year variability to a multiyear pattern, which is more common in the Gulf of Alaska?” Such a change would have important repercussions on this ecosystem.

How We Did It

We utilized a wide range of data from cruises, moorings, the National Snow and Ice Data Center, and Alaska Fisheries Science Center trawl surveys to examine the relationship between ice in March and April and depth-averaged temperature from long-term mooring on the southeastern shelf, M2. The timing of the spring phytoplankton blooms was also obtained from the chlorophyll fluorescence data on the moorings, showing that when ice was present after mid March on the southern shelf, there was an increase in fluorescence and a decrease in nutrients. Plankton net tows from ships maintaining the moorings provided data on prey availability.

Fig. 2



*Large crustacean prey and year class strength of walleye pollock. (Top) Abundance of copepods (*Calanus *spp) and adult and juvenile euphausiids (krill) sampled during the summer. Copepods were sampled with plankton nets and euphausiid abundance was estimated with acoustics. (Bottom) Estimated number of pollock surviving to age-1 for each year class. Estimates obtained from stock assessment models (Ianelli et al., 2012, Table 1.23).*

Why We Did It

The southern Bering Sea is a rich ecosystem that supports large numbers of marine mammals and seabirds, and provides approximately 40% of the U.S. catch of fish and shellfish. We now know that changes in the weather patterns and ice extent over the southern shelf affect zooplankton abundance and distribution patterns, which in turn impacts the fishes, large baleen whales, and seabirds that feed in these waters. Climate models predict that the southern Bering Sea will become warmer, with reduced sea ice in the next couple of decades. If the warm period (2000-2005) is any indication of how the ecosystem will respond to warming, such a change will strongly affect the existing ecosystem. Understanding how shifts in climate impact this system will help scientists predict who the winners and losers could be, and provide the opportunity to help cushion the impact of the changes on humans who utilize this ecosystem.

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Literature cited

Ianelli, J., T. Honkalehto, S. Barbeaux, S. Kotwicki, K. Aydin and N. Williamson (2012). Assessment of the walleye pollock stock in the eastern Bering Sea. 2012 North Pacific Groundfish Stock Assessment and Fishery Evaluation Reports for 2013.

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