NEW research from the Bering Sea reveals how the changing ecosystem impacts America's most valuable fisheries.

It shows how marine mammals, birds, and fish are shifting where they eat, bear their young, and make their homes in response to changes in sea ice extent and duration. These patterns of change are documented in a special issue of the journal of Deep Sea Research II now available online.

The special journal issue represents newly published findings from a partnership between the NOAA Pacific Marine Environmental Laboratory (PMEL), NOAA Alaska Fisheries Science Center (AFSC), the Joint Institute for the Study of the Atmosphere and Ocean at the University of Washington, and several other academic and federal partners.

NOAA researchers and their partners studied Bering Sea ice and ecosystem conditions over six years in order to understand the processes that influence the eastern Bering Sea marine ecosystem. The special journal issue features multiple papers describing the changes in sea ice, the distribution of important nutrients, and how fish, seabirds, fur seals, and whales are responding.

Alaska waters host some of the most commercially valuable US fisheries. More than half of the seafood Americans eat from US waters is caught in Alaska. Understanding what role natural and human-influenced variations in temperature, nutrients, sea ice, and other factors play in the ecosystem will enable better predictions of climate impacts that affect the economy and people of the region.

“We examined how the whole ecosystem is affected by climate variability. Our new insights will better enable us to manage fisheries and protected resources in this large marine ecosystem,” said Jeffrey Napp, PhD, a co-leader of the Ecosystems and Fisheries-Oceanography Coordinated Investigations Program (EcoFOCI) research program and Alaska Fisheries Science Center oceanographer.

Findings of the NOAA-led studies include:

• Measurements made during the six-year study show a potential impact of climate change on species from zooplankton to whales living on the Bering Sea shelf, a relatively shallow portion of the sea directly off the Alaskan coast. The study, led by PMEL’s Phyllis Stabeno, PhD, projects warming of southern shelf waters will limit the distribution of Arctic species such as snow crab, while the distribution and abundance of whales will change as their food source moves.

• The presence or absence of sea ice was previously thought to have a large impact on the production of microscopic plant life, or phytoplankton. PMEL’s Calvin Mordy, PhD, and others found that the wind accounts for a larger piece of the phytoplankton production puzzle. They can now use this finding for future models of the Bering Sea ecosystem.

• In the past decade, Bering Sea shelf waters experienced a multi-year very warm spell followed by a very cold spell. James Overland, PhD, of PMEL and others investigated these events and compared them to a 95-year long weather record. Such extreme events were rare but not unique. The researchers found that while modest long-term warming due to climate change is expected in the North Pacific and south-eastern Bering Sea, the historical records suggest that the most important climate feature over the next few decades will be large random variability.

• Using an electronic fish finder on an icebreaker, Alex De Robertis, PhD, of AFSC, and Edward Cokelet, PhD, of PMEL, provide the first comprehensive observation of fish in the ice-covered portion of the Bering Sea. They conclude that each winter, sea ice and the cold water that comes with it force fish south-eastward, out of their summer habitat. Using similar electronic fish finders mounted on
NOAA Fisheries survey vessels, Patrick Ressler, Ph.D., of the AFSC and co-authors documented a recent increase in krill, which pollock eat, that coincided with the end of a warm period and the beginnings of a cold period in the eastern Bering Sea.

- Using historical data collected on larval fish surveys conducted by the AFSC, Tracey Smart, PhD, a JISAO post-doctoral fellow working at the AFSC, and colleagues documented a shift in the location of larval fish between warm and cold years. In cold years they were much closer to the edge of the shelf, while in warm years they were closer to the middle of the shelf. This has important implications for their transport and survival.

- PMEL’s Carol Ladd, PhD, and Stabeno examined NOAA historical data to demonstrate that stratification of the water – for example, when water is warmer at the surface and colder at the bottom – was not simply a matter of whether or not the water column was warm or cold. Strong stratification during the summer prevents nutrients from rising to the surface, which has a negative effect on phytoplankton production. Since phytoplankton are an important part of the food chain for fish, strong stratification also decreases fish production.

- The distribution of forage fish, which are used as food by other fish, seabirds, and marine mammals, is affected by the warm and cold cycles in the eastern Bering Sea. Anne Hollowed, PhD, of the AFSC and co-authors examined historical survey data collected by the AFSC in warm and cold years and described how they differ and the consequences of these shifts.

- Mike Sigler, PhD, of the AFSC and co-authors studied the differences in how seabirds and baleen whales hunt for food (krill and young pollock) and how their predatory patterns change when they are bearing and rearing their young.

Funding for this study was provided by the Bering Sea Project, which is a partnership between the North Pacific Research Board and the National Science Foundation, with substantial scientist and ship time support from NOAA. The six-year project invested approximately $50 million in research by more than 100 principal investigators and many post-doctoral and graduate students from 32 academic, federal, state, and private institutions across the United States and Canada.