Computer model predicts vastly different ecosystem in Antarctica's Ross Sea in the coming century

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Adelie penguins cross ice floes near a lead in the sea ice at Cape Royds. Credit: Peter Rejcek, National Science Foundation

The Ross Sea, a major, biologically productive Antarctic ecosystem, "clearly will be extensively modified by future climate change" in the coming decades as rising temperatures and changing wind patterns create longer periods of ice-free open water, affecting the life cycles of both predators and prey, according to a paper published by researchers funded by the National Science Foundation (NSF).

To make their predictions, the researchers used information drawn from

the Regional Ocean Modeling System, a computer model of sea-ice, ocean, atmosphere and ice-shelf interactions.

While conceding that "predicting future changes in ecosystems is challenging," the researchers note in a paper published in *Geophysical Research Letters*, the changes predicted by the computer model have the potential to create "significant but unpredictable impacts on the ocean's most pristine ecosystem."

The wind and temperature changes, the authors note, will affect the ecological balance at the base of the Antarctic food web—including changes in distributions of algae, shrimp-like krill and Antarctic silverfish—which, in turn, may be expected to cause disruptions in the upper portions of the food web, including penguins, seals and whales, which depend on those species for food.

A team of four researchers from the Virginia Institute of Marine Science (VIMS) at the College of William and Mary and the Center for Coastal Physical Oceanography at Old Dominion University in Norfolk, Va., jointly authored the paper.

Walker O. Smith, Jr., a professor at VIMS and the lead author of the study, said: "The model suggests that the substantial changes in the physical setting of the Ross Sea will induce severe changes in the present food web, changes that are driven by global climate change. Without a doubt the Ross Sea 100 years from now will be a completely different system than we know today."

The research was funded by the Polar Programs and the Ocean Sciences divisions in NSF's Geosciences Directorate.

The U.S. Antarctic Program (USAP) coordinates all U.S. research on the Southernmost Continent and in the Southern Ocean as well as providing

the necessary logistical support for that science. NSF manages the USAP.

The researchers note that over the last 50 years the distribution and extent of Antarctic sea ice, or ice that floats on the ocean surface, have drastically changed. Among these changes are a documented decrease of sea ice in the Bellingshausen-Amundsen sector, but an increase of sea ice in the Ross Sea sector of Antarctica.

Observations show, they write, that "the duration of ice-free days on the Ross Sea continental shelf has decreased by over two months over the past three decades," which may have had effects on the current balance of biological productivity and the roles of various creatures and microscopic plants in the ocean ecosystem.

But, they also note, "future projections of regional air temperature change, however, suggest that substantial warming will occur in the next century in the Ross Sea sector" while wind speeds are predicted to increase in some areas while decreasing in others.

"These changes are expected to reverse the sea-ice trends in the future; however the projected changes in heat content on the continental shelf and ecosystems dynamics that will occur as a result of such changes remain far from certain."

The model, however, indicates that summer sea ice in the Ross Sea could decrease by more than half, or 56 percent, by 2050 and by more than three-quarters, or 78 percent, by 2100. At the same time, the summer mixing of shallow and deep waters in the region as a result of other changes is expected to decrease.

While increased open water would benefit diatoms, the preferred food source of many plant-eating predators such as krill, some krill species,

such as crystal krill, prefer a habitat with more ice, which they use as a refuge from predators.

In turn, minke whales, Adelie and Emperor penguins and crabeater seals that feed on crystal krill would have less food available if the crystal krill population were reduced.

With less sea-ice cover, however, more humpback whales could enter the Ross Sea in the summer, increasing krill predation. Adelies, which prey on silverfish at the ice edge, would have to travel further from their nests and, as a result, be potentially more vulnerable to leopard seal predation.

While it is difficult to know specifically what changes the Ross Sea ecosystem will see, the model predictions, if they are accurate, suggest that they are likely to be far-reaching.

"Regardless of the exact nature of the alterations," the researchers write, "substantial portions of the food web that depend on ice in their life cycles will be negatively impacted, leading to severe ecological disruptions."

Provided by National Science Foundation

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