Why biodiversity among marine mammals and birds generally rises in cold, temperate waters

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An African penguin (Spheniscus demersus) on a beach in South Africa. A new study examines why biodiversity among warm-blooded marine predators such as whales, seals and penguins rises in cold, temperate waters. Credit: Adam Wilson

In ecology, the diversity of species generally increases as you move toward the warmer latitudes of the tropics.

A new study explores a curious exception to this trend, examining why biodiversity rises in cold, temperate waters among warm-blooded marine predators such as whales, seals and penguins.

The research—published on Jan. 25 in the journal *Science*—presents a possible explanation for this unusual pattern.

"We show with data and theory that cold waters slow fishes' and sharks' metabolism, causing sluggish movement and giving mammals and birds important hunting and competitive advantages," says John Grady, a postdoctoral research associate at the National Great Rivers Research and Education Center and former postdoctoral researcher at Michigan State University, who led the study. "Sharks are easier to avoid and fish are easier to catch when the water is cold."

"As we conclude in the paper, 'Overall, warm-bodied predators are favored where prey are slow, stupid and cold,'" says co-author Adam Wilson, Ph.D., a biogeographer at the University at Buffalo. Wilson is an assistant professor in the Department of Geography in the UB College of Arts and Sciences.

A humpback whale (Megaptera novaeangliae) pictured in Cape Cod Bay off the coast of Massachusetts in the United States. Credit: Adam Wilson

"We are living through an era of rapid environmental change and biodiversity loss," Wilson adds. "Understanding the mechanisms that led to the current spatial distribution of biodiversity is critical to conserving it for future generations."

The study was an international collaboration, with contributors from Michigan State University, Bryn Mawr College, the University of Arizona, the University of New Mexico, the University of Freiburg in Germany, Dalhousie University in Canada, the U.N. Environment Programme World Conservation Monitoring Centre in the United Kingdom, UB, the National Great Rivers Research and Education

Center, and Washington University in St. Louis.

Using data to quantify and explain marine predator diversity

As part of the study, Wilson co-developed a workflow that the team used to quantify and summarize the geographic distribution of almost 1,000 species of sharks, fish, reptiles, mammals and birds.

"We used these data to show how warm-blooded marine predators such as seals, whales and penguins do not follow the typical geographic pattern of increasing biodiversity near the tropics. Our analysis showed that the diversity of these predators systematically increases toward the poles relative to cold-blooded competitors such as large sharks and fish," Wilson says. "This curious fact led to the development of the theory presented in the paper, which explains the patterns of biodiversity by taking into account the relative speed at which predators pursue their prey in different water temperatures."

Magellanic penguins (Spheniscus magellanicus) near Navarino Island, Chile. Credit: Adam Wilson

Scientists found evidence to support this hypothesis when they examined consumption patterns among warm-blooded seals and active-hunting cetaceans (including dolphins, porpoises, beluga and narwhal).

"Analyzing global patterns of marine mammal abundance and consumption, we find seals and dolphins collectively consume approximately 80 times more of the available food near the polar seas than the warm equator," Grady says.

This may help to explain why these warm-blooded predators are more abundant and diverse in cold seas, Grady adds.

More information: John M. Grady et al. Metabolic asymmetry and the global diversity of marine predators, *Science* (2019). DOI: 10.1126/science.aat4220