

Modeling predicts blue whales' foraging behavior, aiding population management efforts

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Blue whale, photo taken under NMFS permit no. 14856. Credit: Craig Hayslip, Marine Mammal Institute, Oregon State University

Scientists can predict where and when blue whales are most likely to be foraging for food in the California Current Ecosystem, providing new

insight that could aid in the management of the endangered population in light of climate change and blue whale mortality due to ship strikes, a new study shows.

The statistical model used for the predictions combines long-term satellite tracking data of the whales' movement patterns with environmental data such as ocean temperatures and depth, which helps researchers understand how climate variations might impact blue whales over time from a larger "ecosystem" view of the population.

"Most management decisions up to now have been based on locations where the whales tend to be found," said Daniel Palacios, who holds the Endowed Faculty in Whale Habitats position at Oregon State University's Marine Mammal Institute, and is lead author of the study.

"But it's not just where the whales are, but also the activity—are they actually eating there or simply moving through—that matters. This model can tell us which areas are the most important for actual foraging."

The findings were published today in the journal *Movement Ecology*.

Blue whales can grow 70 to 90 feet long and weigh 200,000 to 300,000 pounds, though their diet is primarily krill—tiny shrimp-like creatures less than two inches in length. They are listed as endangered under the U.S. Endangered Species Act and the International Union for Conservation of Nature's Red List.

An estimated 1,600 of the world's 10,000 blue whales, known as the North Pacific population, spend time in the waters off the West Coast of the Americas. The North Pacific blue whale population can travel from the Gulf of Alaska to an area near the equator known as the Costa Rica Dome. The majority spend the summer and fall in the waters off the

U.S. West Coast.

The California Current Ecosystem is the span of waters off the West Coast of North America extending roughly from the border with Canada at the north to Baja California, Mexico, at the south. Steady winds during spring and summer fuel a rich and biologically productive ecosystem. The study focused only on U.S. waters within this ecosystem.

The researchers' goal for the study was to better understand the blue whale behavior in the context of this ecosystem by examining the relationship between feeding behavior and ocean conditions during the feeding season.

Palacios and colleagues used long-term satellite tracking data from 72 tagged blue whales as well as ocean condition data from remote sensing during the same period, 1998 to 2008. Little was known about the blue whale until the 1990s, when Bruce Mate, director of OSU's Marine Mammal Institute, pioneered the satellite tracking studies that produced a wealth of data not previously available.



Blue whale tail. Credit: Craig Hayslip, Marine Mammal Institute, Oregon State University

The data used in the foraging study included several years of cool, productive ocean conditions as well as a couple of warm, low-productivity years, during which food was less likely to be plentiful.

The researchers found that blue whales were more likely to exhibit foraging behavior in areas known from earlier studies for hosting large whale aggregations, providing an improved understanding of the relationship between environmental conditions and whale habitat use.

"The same environmental parameters—water temperature, depth,

abundance of phytoplankton—that drive hotspots of whale aggregation also drive where foraging behavior is more likely to occur," Palacios said. "While this was not necessarily surprising, it was good to be able to demonstrate that we can predict whale behavioral states, as this helps inform management in terms of not just what areas are used more often by the whales, but also what they do once they get there."

They also found that whales were less likely to exhibit foraging behavior when they were further away from the coastline. The primary foraging hotspots are found in a few locations along the coast, where krill aggregations are typically most dense and persistent.

The study also supported findings from another recent paper by Palacios and colleagues that showed that blue whales rely on long-term memory to find the best places to forage, and return to them year after year. That makes them susceptible to climatic disruptions to their prey base, as the whales may take some time before they abandon their traditional foraging sites.

Improved understanding of the species-environment relationship, through an ecosystem view of whale behavior, can give researchers a better understanding of how climate change might impact whale feeding, Palacios said.

The study also could help with population management decisions. North Pacific blue whales tend to aggregate in three primary areas: Point Conception and the Santa Barbara Channel in southern California; around the Gulf of Farallones in central California; and between Cape Mendocino and Cape Blanco in northern California and southern Oregon.

Two of those hotspots are in areas of intense commercial shipping traffic near Los Angeles and San Francisco. Blue whale mortality due to ship

strikes is a growing concern.

"If there are some areas along the coast that are more biologically important for the whales, based on intensified foraging activity, that's important for management agencies to know, compared to areas where the whales are just passing through," Palacios said.

The researchers' next step is to look more closely at how whales' behavior shifts during years when ocean conditions are unfavorable for food production.

"How long will it take blue whales to abandon their historic feeding grounds if the food is no longer there?" Palacios said. "If they do respond to environmental changes, how do we predict that change long-term?"

More information: Daniel M. Palacios et al, Ecological correlates of blue whale movement behavior and its predictability in the California Current Ecosystem during the summer-fall feeding season, *Movement Ecology* (2019). DOI: 10.1186/s40462-019-0164-6

Provided by Oregon State University

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