Study reveals changes in seabirds' diets dating back 130 years

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Laysan albatrosses, such as this one housed at the Monterey Bay Aquarium, appear to maintain consistent diets because they can fly efficiently and forage over extremely large areas of the North Pacific. Less efficient flyers with smaller foraging ranges, like the brown booby, seem less adaptable to changing conditions and have to change their diets more dramatically. Credit: Monterey Bay Aquarium/Tyson Rininger

Today, the Monterey Bay Aquarium introduces another "first" – a new Ocean Memory Lab – as part of its scientific research program to protect the global ocean, its ecosystems and wildlife.

In the first paper from the lab, published February 14 in *Science Advances*, aquarium research scientists shed light on changing diets of North Pacific seabirds over the past 130 years as part of a new effort to leverage historical data and modern technology to understand how human and environmental impacts have affected the ocean and its inhabitants over time.

Research Results at a Glance

The paper, "The trophic signature of pelagic ecosystems in seabirds", analyzed the feathers of eight North Pacific seabird species dating back 130 years to learn how the birds' diets have changed since the 19th century.

Feather samples from 134 individual birds revealed that the birds' diets tended, on average, to decline in mean trophic level over time – meaning they are eating lower on the food web today than they did in the past. Birds that would have historically found and eaten more fish a century ago are now more likely to find squid and prey that are broadly less desirable to commercial fishing fleets, and that can thrive in more dynamic ocean conditions.

In line with other research, the study suggests that commercial fishing pressure, along with climate and the birds' varying ability to forage over wide areas of the ocean, is driving the change in their diets.

The seabird feather study exemplifies the promise of the Ocean Memory Lab—the brainchild of Aquarium science director Dr. Kyle Van Houtan, who co-authored the publication along with lead author Tyler Gagne of the Monterey Bay Aquarium and two Hawaii-based colleagues, Dr. David Hyrenbach of Hawaii Pacific University and Molly E. Hagemann of the Bishop Museum in Honolulu.

The Ocean Memory Lab

"To understand what's happening to ocean ecosystems at a time of rapid global change, satellites, robotic submersibles and other high-tech monitoring tools only tell part of the story," Van Houtan said. "They can gather impressive amounts of data to document current ocean conditions."

But, he asked, "What are the conservation targets? What are we managing for? How do we know when we're done?" We often don't have enough data or a sufficiently long-term record to provide informed answers to those questions."

To shed light on past conditions, you need a different sort of sensor – a form of ocean time machine, Van Houtan said. Preserved marine life specimens provide that capability.

"Organisms are gathering data all the time," he said. "Our task is a sort of reverse engineering – to find the sensor within the plant or animal, see what it's recording, and then translate that into useful information."

The Ocean Memory Lab uses preserved specimens from museum collections and compound-specific stable isotope analysis to unlock data from the tissues of long-dead sea creatures – data that will help inform international management decisions designed to maintain and restore the health of ocean ecosystems.

Seabird Feather Research Approach

For the seabird study, data was mined by grinding tiny samples from 134 individual birds and studying the milligrams of resulting powder using compound stable isotope analysis. Researchers gleaned information about the birds' diets from tracer particles within the feathers, and employed machine learning algorithms to find patterns in data that older analytic tools perhaps might have missed. For example, nitrogen is accumulated in tiny phytoplankton that are eaten by zooplankton, which in turn are eaten by forage fish, which might then get eaten by a larger fish, and ultimately by a seabird.

Unlike other research studies, the data about changes in fisheries abundance were not derived from observations made during commercial fishing operations. Those data only date back to the 1950s, and tend to focus on higher-value, more desirable species in the seafood trade.

"Rather than randomly sample from an ecosystem, fishery harvest is based on social and market forces," said Gagne, an assistant research scientist at Monterey Bay Aquarium. "What fish are we most interested in buying and eating? What offers the best return on investment from fishing?"

"What do seabirds tell us that maybe the fishery-dependent metrics didn't?" he asked. "It seems quite a bit in this case."

That the Ocean Memory Lab was able to scientifically demonstrate a novel way to assess the extent of change in fisheries abundance and ocean ecosystems is significant, Gagne said.

"In our field of science, even ten years of data is encouraging," he said. "This is a 130-year-long dataset, which is really amazing."

"My hope is that we are not only taking advantage of the work of our predecessors and essentially standing on the shoulders of giants, but also giving new scientific value to this wealth of data that have been archived for such a long time," Van Houtan said.

More information: Tyler O. Gagne et al. Trophic signatures of seabirds suggest shifts in oceanic ecosystems, *Science Advances* (2018). DOI: 10.1126/sciadv.aao3946

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