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Study reveals rapid shift in loggerhead sea turtles' range

by Ula Chrobak, Stanford University

Co-author Larry Crowder poses with a loggerhead sea turtle. Credit: Dana Briscoe

Loggerhead sea turtles are sentinels for changing oceans. In a new analysis covering nearly 30 years of data on turtle movements, sea surface temperatures, and seawater chlorophyll levels, Stanford scientists found that the reptiles are shifting their range at a record pace, racing to keep up as their favorite foraging grounds move northward.

"Changes to the ocean are happening faster than expected," said Dana Briscoe, a lead data scientist with the Stanford Doerr School for Sustainability and first author of the Jan. 22 study

published in *Frontiers of Marine Science*. "Animals are moving farther north at a rate faster than anticipated to be able to synchronize with favorable habitats."

As Earth's atmosphere warms, surface temperatures in the seas have climbed too. Some of the most dramatic changes have occurred in the last decade, with a surge in marine heat waves—sustained periods of sea surface temperatures higher than 1°C above average. "In the past decade in the Eastern North Pacific, we've seen an increase in the frequency and the strength of these marine heat waves," said Briscoe. "That has profound implications for marine life."

To better understand these changes, the Stanford scientists analyzed 16 years of turtle tracking data from the National Oceanic and Atmospheric Administration ending in 2013 and additional data from a project they launched in 2023 to track the migrations of satellite-tagged loggerheads from Japan.

Loggerhead sea turtles are cold-blooded and sensitive to slight shifts in water temperatures. Even turtles raised in captivity, which comprised most of those tracked across the past three decades, have a keen ability to find cool waters that host their favorite foods—namely, invertebrates like crabs, barnacles, and jellyfish.

The loggerheads of the North Pacific are one of five loggerhead populations considered endangered. Juvenile turtles flock from the coasts of Japan to a region known as the North Pacific Transition Zone, an area teeming with life at the boundary of subarctic and subtropical waters. "It's basically the buffet line for the North Pacific," said study co-author Larry Crowder, the Edward F. Ricketts Provostial Professor and a professor of oceans in the Doerr School of Sustainability.

Lead author Dana Briscoe (left) and co-author Catherine Lee Hing (right) attach a satellite tag to a North Pacific loggerhead sea turtle at the Port of Nagoya Public Aquarium in Nagoya, Japan. Credit: Laura Jim

The scientists combined records of turtle travels in this buffet with satellite data on sea surface temperature and chlorophyll-a, the main form of chlorophyll used by ocean organisms in photosynthesis. Greener, chlorophyll-rich water indicates an abundance of phytoplankton, the base of the ocean food chain, and thus a more productive ecosystem.

The team found that between 1997 and 2024, turtles shifted their foraging northward by an average of 200 kilometers (about 125 miles) per decade—a rate six times faster than the average for most marine species. Even with this northward shift, average surface temperatures in the turtles' foraging area warmed by 1.6°C over the 27-year period. Meanwhile, chlorophyll concentrations dipped by 19%, suggesting lower ecosystem productivity. In other words, "the buffet has less food in it than it used to," said Crowder.

The results suggest that the turtles are, so far, capable of adapting to the rapid marine changes. "At least in the short term, I expect the turtles to be able to adapt effectively," said Crowder. "They seem to be able to keep up and stay in the habitats that provide them with the most food."

But rapid range shifts don't come without risks for the turtles. As they follow foraging sites north, the turtles may risk increased entanglements and collisions with fishing equipment. These risks might also extend to other species that inhabit the foraging grounds alongside the turtles, such as

seabirds, marine mammals, and sharks. The turtles' movement signals that these species are likely also moving their ranges.

It remains unknown how the turtles' greater migration patterns may be affected. Historically, some turtles have voyaged to coastal waters off Baja California. If turtles attempt to reach coasts farther north, they risk getting caught in cold currents that can render them weak and unable to swim, or "cold-stunned." Last year, cold-stunned loggerhead turtles washed ashore on Oregon beaches in record numbers.

The researchers will continue to pursue these questions as part of their turtle-tracking project, known as Loggerhead Sea Turtle Research Experiment on the Thermal Corridor Hypothesis (STRETCH). In July, they will release 25 satellite-tagged turtles into the North Pacific, the project's third cohort. The turtles are allowing the scientists to test hypotheses about ocean currents and migration that were previously unknowable.

"With each year that we release more turtles, we're finding new and novel things," says Briscoe. "In a lot of ways, the animals are the oceanographers, and we're the ones that are learning from them."

More information: Dana K. Briscoe et al, Multi-decade northward shift of loggerhead sea turtle pelagic habitat as the eastern North Pacific Transition Zone becomes more oligotrophic, *Frontiers in Marine Science* (2025). DOI: 10.3389/fmars.2024.1513162

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