Endangered seabird shows surprising individual flexibility to adapt to climate change

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Balearic Shearwater in the Balearic Islands. Credit: Wikimedia Commons, CC BY-SA 3.0

How individual animals respond to climate change is key to whether populations will persist or go extinct. Many species are shifting their ranges as the environment warms, but up to now the mechanisms underlying this have been unclear. For Europe's most endangered seabird, the Balearic shearwater (Puffinus mauretanicus), new research has revealed that individual behavioral flexibility and not evolutionary selection is driving this species' rapid migratory range shift.

The study, led by University of Oxford biologists, is published in the journal *Proceedings of the National Academy of Sciences*.

The findings could help inform conservation strategies for vulnerable migratory bird species. The results also suggest that individual animals may have greater behavioral flexibility to respond to climate change impacts than previously thought, although this behavioral adaptation may have hidden costs, making the long-term impact on this species unclear.

Balearic shearwaters are long-lived but Critically Endangered mainly because of declines driven by fisheries by-catch, as they can get caught on baited longline hooks and gill nets. They breed in remote corners of the Mediterranean's Balearic Islands, then migrate to spend the summer off the Atlantic coasts of Spain, France, and increasingly the UK.

Since 2010, researchers from Oxford University's Biology Department and from the University of Liverpool, together with collaborators working in Ibiza, have been tracking colonies in Mallorca using miniature on-board geolocation devices. This revealed that the birds have been migrating further and further north once they leave the Mediterranean.

It was unknown, however, whether this change was being driven by individual birds altering their behavior, or through natural selection favoring birds that travel further.

To answer this, the researchers compared the migration tracks of the same individuals tagged in multiple years. This revealed that individual birds were shifting their range northwards by an average of 25km per year.

Co-lead author Joe Wynn (Department of Biology, University of Oxford & Institute of Avian Research "Vogelwarte Helgoland"), said, "We found that the best predictor of this change in migratory behavior was the average sea surface temperature in the summering-grounds, suggesting that the birds may well be following changes in underlying marine resources. The fact that individuals can be this flexible in the face of rapid climate change is encouraging."

But despite this flexibility in their summer destination, Balearic shearwaters are much more constrained in where they breed, so that migrating further north means they have further to fly back in the autumn.

Co-author Professor Tim Guilford (Department of Biology, University of Oxford) added, "We found that individuals speed up their return migration the further north they have gone, but this only partially compensates for the extra distance and they still arrive back in the Mediterranean late. We don't yet know how such delays may affect their breeding success or survival."

This raises the intriguing question of how the birds know how far away from home they are, when they set off back for the colony. To investigate this, the researchers compared the distance estimates of the different kinds of map that shearwaters might use to guide their migration decisions.

Co-lead author Patrick Lewin (Department of Biology, University of Oxford), said, "We found that the route individual birds took on

previous migratory journeys was a much better predictor of return speed than an estimate of the straight line distance back to the colony. This suggests that birds do not rely on a large-scale navigational map on migration, but instead have some memory of the route they have flown in the past."

"It is possible that individual route memory plays an important role in the migration of many other long-lived seabirds, but further research is needed to clarify this' he added.

Balearic shearwaters belong to one of the most threatened groups of birds on earth, and are themselves facing potential extinction as a species. This includes both land-based threats, such as predation by invasive species and habitat degradation, and at-sea threats, such as fisheries bycatch, overfishing, pollution, and windfarm development.

Collaborator Pep Arcos from SEO/Birdlife said, "In addition to direct threats both on land and at sea, the increasing threat of climate change poses a challenge for a species that breeds in such a restricted habitat. Results from this study suggest that individual flexibility might help with distribution shifts driven by climate change outside the breeding season, but the question is still open about what might be the consequences of climate change for the birds during breeding, when their movements are constrained by the location of the colony."

More information: Lewin, Patrick J. et al, Climate change drives migratory range shift via individual plasticity in shearwaters, *Proceedings of the National Academy of Sciences* (2024). DOI: 10.1073/pnas.2312438121. doi.org/10.1073/pnas.2312438121

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