Stones inside fish ears mark time like tree rings. How they're helping us learn about climate change

November 27 2023, by Clive Trueman

Otolith from a bluefin tuna. Credit: University of Southampton

As a marine biologist, I've always found it fascinating to learn about how animals adapt to their habitat. But climate change has made it more important than ever—wild animals' futures may depend on how much we understand about them.

Fish have a kind of stone in their ear that scientists can read like tree rings. My team's new research, published in *Nature Communications*, has found a way to decode the chemicals in these stones to measure how much energy they used when alive. What we learned could help bluefin tuna survive the climate crisis.

There is still so much we don't know about how animals respond when their habitat suddenly changes. Temperature is one of the most important puzzle pieces, as it affects the rates of the chemical reactions that define life.

For animals, rising temperatures act like inflation. Rising prices mean housing and food take up more of our budget, leaving less money for luxuries. More heat means more of an animal's bodily resources, like food and oxygen, are needed to fuel basic functions, like breathing and moving, leaving less energy for growth and reproduction.

However, heat changes don't affect all animals the same way. Just as the wealthy can use their large cash reserves to weather inflation, animals differ in how close they are to their energy "ceiling."

Warming waters

Animals living in temperatures in the middle of their species' range can increase the rate of their metabolism, meeting the extra cost of living in warmer waters. Those on the warm edge of their species' range might be closer to their limits, where increases in temperature push them into a form of energy debt.

Reserves that might have been used for growth must be diverted to maintain essential life processes. Rising temperatures, through their effects on metabolism, force species to adapt, move somewhere new or die.

Measuring energy expenditure in wild animals is no easy task. Fortunately, metabolic reactions leave chemical traces in the body.

The otolith is a stony lump in the fish ear. Otolith rings, much like tree rings, reveal a fishs's age. At the University of Southampton we have developed a technique to decode the chemistry of otoliths.

Different forms or isotopes of oxygen in the otolith indicate the temperature the fish experienced when it was alive. Carbon isotopes reveal how quickly food was converted into energy. Fish carry their fitness trackers in their ears.

Studying how animals' energy needs shift with temperature can help us predict which animals are most at risk from rising temperatures. Juveniles, for instance, which need to grow quickly so they are strong enough to evade predators, might be more vulnerable to the effects of global warming.

Recently, we applied this new technique to Atlantic bluefin tuna. These fish can grow to two meters long and can swim at 40mph. They also have a high metabolism which allows them to thrive in colder waters than most other tuna species.

Overfishing in the 20th century made Atlantic bluefin tuna populations crash. Fish management policies have allowed bluefin tuna populations in the north Atlantic to recover, and shoals of bluefin are once again regular visitors to waters around the British Isles and northern Europe.

Bluefin tuna spawn in both the western and eastern sides of the Atlantic. But these two spawning populations show different rates of recovery.

The proportion of adult fish with a western (Gulf of Mexico) origin has declined over time. Proportionally more eastern (Mediterranean) origin fish are surviving to adulthood each year.

Our study asked whether these differences in recovery can be explained by temperature. We discovered that the metabolic rates for young tuna peak at around 28°C. Tuna in warmer waters had lower metabolic rates, showing that their bodies were unable to keep up with the energy costs of living in temperatures over 28°C.

In the spawning and nursery grounds of the Gulf of Mexico, temperatures often surpass 28°C. While it has always warmer been in the Gulf of Mexico than the Mediterranean Sea, recent warming means that the area of suitable habitat below the 28°C threshold has become smaller and smaller. Sea temperatures in Florida exceeded 36°C in June 2023.

Slow recovery in western tuna populations could be attributed to these warm water conditions and its effect on growth of juvenile tuna. In contrast, most of the Mediterranean currently remains below 28°C during summer.

Looking ahead

The recent recovery of bluefin tuna may not last. We used climate models to predict how quickly ocean warming will start to affect juvenile tuna.

Even middle-of-the-road projections suggest that the eastern half of the Mediterranean Sea will cross the 28°C threshold within 50 years. In the last two years we have seen record average temperatures in the Mediterranean already approaching the 28°C threshold.

We need a long-term solution to protect tuna.

As the oceans continue to warm, tuna may establish new spawning and nursery areas in regions that were previously too cold, for instance further north on the US's eastern coastline. If so, juvenile tuna would be in danger of getting caught unintentionally by fisheries, also known as bycatch,

Bluefin tuna are a sought-after delicacy for sushi in Asia where a single fish can sell for over a million dollars. But they are more than culinary delicacies. Tuna fish are giving us a warning of the challenges that lie ahead for marine wildlife.

More information: Clive N. Trueman et al, Thermal sensitivity of field metabolic rate predicts differential futures for bluefin tuna juveniles across the Atlantic Ocean, *Nature Communications* (2023). DOI: 10.1038/s41467-023-41930-2

Provided by The Conversation

Citation: Stones inside fish ears mark time like tree rings. How they're helping us learn about climate change (2023, November 27) retrieved 28 April 2024 from https://phys.org/news/2023-11-stones-fish-ears-tree-theyre.html