Fish are shrinking around the world. Here’s why scientists are worried.

Figuring out the reason why has big implications, with billions of people depending on seafood for protein.

There’s something fishy going on in the water. Across Earth’s oceans, fish are shrinking — and no one can agree why.

It’s happening with salmon near the Arctic Circle and skate in the Atlantic. Nearly three-fourths of marine fish populations sampled worldwide have seen their average body size dwindle between 1960 and 2020, according to a recent analysis.

Overfishing and human-caused climate change are decreasing the size of adult fish, threatening the food supply of more than 3 billion people who rely on seafood as a significant source of protein.

As fish get smaller, there is less meat to cook per catch. So scientists are working to piece together why exactly fish respond to rising ocean temperatures by getting smaller.

“This is a pretty fundamental question,” said Lisa Komoroske, a conservation biologist at the University of Massachusetts at Amherst. “But we still don’t understand why.”

“How is it that we’ve known about this for so long but we don’t understand mechanisms?” she added.
The incredible shrinking fish

One undisputed reason so much marine life is getting smaller is fishing. Recreational anglers and commercial fishers alike like to catch large fish. That quest for the big ones leaves the small fries behind.

Rick Stuart-Smith, a marine biologist at the University of Tasmania in Australia, has surveyed coral reefs around the world. He said he can tell if a protected area has suffered from illegal fishing by the small size and sometimes even the shyness of the fish he sees while diving.

In truly protected areas “you’ll even see big fish in less than ideal habitats,” he said.

But there are plenty of marine species that face little fishing pressure that are still shrinking. To investigate why, Komoroske and her colleague, Joshua Lonthair, decided to grow their own fish.

The pair started their experiment on sardines in California until the pandemic closed the lab in 2020. “We get a call that the facility is shutting down at midnight,” Lonthair said. “I’m in the lab actually taking my final measurements on those fish for our first set of measurements.”

The pair restarted their work in Massachusetts with about 400 brook trout reared for up to eight months in tanks. The scientists kept some of the fish in waters set at 59 degrees Fahrenheit while others at 68 degrees Fahrenheit. All were fed the same diet.

By the end of the experiment, the difference was stark. The trout raised in warmer waters were on average less than half the size as the other fish.

“You look at the fish, it’s so obvious,” Komoroske said. “Not that you don’t need statistics, but they’re clearly different sizes.” In the ocean, the phenomenon is so widespread it has a name: the temperature-size rule.

Putting theory to the test

For years, the leading theory for why fish grow to smaller adult sizes in warmer waters had to do with their gills.

Fish, unlike humans, cannot regulate their body temperature well. So when the water temperature goes up, so too does the oxygen they require. But, some scientists thought, the limited surface area of fish gills couldn’t keep up with the extra demand of a bigger body, leading fish to cut their growth short.
“That is the crucial point,” said Daniel Pauly, a marine biologist at the University of British Columbia who developed what today is called gill oxygen limitation theory. “Gills don’t go as fast as volume.” Climate change wasn’t on his mind at all when he began developing the theory in the 1970s when studying tiny tropical fish.

But more recently, when Komoroske and Lonthair dissected the brook trout, they found the gills of the fish raised in warm water were more than large enough to meet the animals’ energy needs, according to a study published earlier this year. In the case of the brook trout, the leading theory for why fish were shrinking appeared to be wrong.

“It doesn’t matter which species we do it on,” Lonthair said. “If it’s a global theory that the gills are going to limit growth, it shouldn’t matter if it’s a brook trout or a sardine or any other species.”

But Pauly said there is a different way of interpreting the data on the metabolic rate that shows gills do limit growth, and that other studies of the gills of other fish support his theory, too. He added that other scientists attempting to refute his long-standing theory are trying to “harpoon a big whale.”

Komoroske said her team is not trying to “pick fights” with their research. “This is how science is supposed to work,” she said.

‘It’s a problem’

Figuring out exactly why fish shrink in warmer waters is key for helping managers prevent overfishing in the warming open ocean and for helping aquaculturists choose the right fish to farm.

“We’re blinded to fixing problems if we don’t understand what’s causing them in the first place,” said Timothy Clark, a professor at Deakin University in Australia who has conducted similar experiments on fish and temperature.

Other explanations are that fish have evolved to stay small to survive hot spells, or that some other body system besides gills is limiting oxygen uptake and growth.

Whatever the reason, the shrinking-fish phenomenon could refashion ecosystems. “In marine and other aquatic ecosystems, size determines whether you are a prey or predator,” said Asta Audzijonyte at the University of Tasmania, who also studies fish size.

Smaller fish can produce fewer eggs, potentially altering ecosystems as ocean temperatures rise. For those who depend on the sea for their livelihoods, all those smaller fillets fetch a lower price.

“It’s a problem for the fishery,” said Art Bloom, a salmon fisherman in Alaska’s Bristol Bay with more than three decades of experience. “They don’t present as well in the supermarket.” During his career, he has had to switch from using nets with 5¼ inch openings to ones with 4¾ inch openings as the salmon he caught got smaller.
But there are signs of ecosystem health. Inês Martins, an ecologist at the University of York in England who found that nearly three-fourths of marine fish were dwindling in size, said many of those same species are increasing in abundance even as average body sizes goes down.

“There's always a few winners and losers,” she said.

This article is part of Animalia, a column exploring the strange and fascinating world of animals and the ways in which we appreciate, imperil and depend on them.