Big fish are getting smaller, and little fish are replacing them, says new research

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Organisms are becoming smaller through a combination of species replacement, and changes within species, according to new research led by the University of St Andrews.

The research, published in *Science*, looked at data from across the world over the last 60 years, and from many types of animals and plants.

The study was carried out by an international team of scientists from 17 universities, as part of a working group led by scientists from the University of St Andrews' Center for Biological Diversity and School of Biology; and the University of Nottingham.

Previous research showed that the size of trophy fish in fishing competitions has decreased, and that many of the most threatened species are large.

The new study joins the dots and shows change in body size is coming from both individuals within species becoming smaller, but also larger species being replaced with smaller ones.

Lead author Dr. Inês Martins, from the University of St Andrews, said, "In some locations, for example, smaller and smaller individuals of thorny skate are being observed, while smaller-bodied species like mackerel are increasing in abundance.

"Whether it's because of what humans prefer to eat, or their habitats getting warmer, big fish just can't seem to catch a break."

Shrinking was most common among fish, but among other groups of organisms—such as plants and invertebrates—changes were more varied. By looking across groups of species, the study reveals there are some complex changes taking place, with some organisms becoming bigger while others shrink.

Senior author of the paper, Professor Maria Dornelas of the University of St Andrews, said, "We think this suggests that, when large organisms disappear, other ones try to take up their place and use up the resources

that become available."

Reflecting on the importance of these results Dr. Martins added, "Recognizing and exploring this complexity is imperative if we want to understand the mechanisms involved in how body size is changing through time."

The study also noted the replacement of a few large organisms with many small ones, while keeping the total amount of life—known as biomass—constant. This surprising result supports the idea that ecosystems tend to compensate for change by keeping overall biomass of the studied species in a particular habitat stable. This stability is attributed to a trade-off between reductions in body size and concurrent increases in abundance among the organisms.

These findings have far-reaching implications for our understanding of how various organisms are adapting to the challenges posed by the Anthropocene era.

Professor Dornelas said, "It's clear the widespread species replacement we see around the world is having measurable consequences. Organisms becoming smaller has important effects as the size of animals mediates their contribution to how ecosystems function, and how humans benefit from them. Bigger fish can usually feed more people than smaller fish."

Working group co-lead Dr. Franziska Schrodt, from the University of Nottingham, said, "Our study highlights the importance of considering changes in species' characteristics at both the individual level and across species if we want to understand the effects of environmental change and human influences on biodiversity globally.

"Unfortunately, we currently lack data on many organisms other than fish to draw clear conclusions—future research will benefit from a

greater investment in these kinds of measurements, particularly when exploring food webs and other species interactions."

More information: Inês S. Martins et al, Widespread shifts in body size within populations and assemblages, *Science* (2023). DOI: 10.1126/science.adg6006

Provided by University of St Andrews