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'Fishing down food chain' fails global test

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A tenet of modern fisheries science may be unfounded, suggests a study of how catches are affecting marine ecosystems. The finding has sparked a heated debate about how best to measure humanity's impact on the ocean.

A landmark study in 1998 found that we are 'fishing down the food chain' worldwide — in other words, exhausting stocks of top predators such as cod before switching attention to smaller marine animals. This has since become accepted wisdom. But a study published in Nature today¹ suggests that the indicator on which this claim is based — 'mean trophic level' or MTL — is severely flawed.

The authors of the 1998 paper have hit back, with one of them branding the latest research "completely invalid". But Trevor Branch, lead author of the Nature study¹ and a fisheries scientist at the University of Washington, Seattle, stands by the work. "At a global level we are not fishing down," he says. "The results are quite clear on that."

Branch says that fishing down may have occurred in some local areas, for example as happened with cod in the Atlantic. But in other places — such as the Gulf of Thailand — fisheries first targeted creatures low in the food chain, such as mussels or prawns, and are now 'fishing up'.

Up or down?

The MTL of animals caught in a particular fishery is the average of their positions in the food web. A fishery that exclusively targets top predators such as pollock could have an MTL of around four. One targeting only primary producers at the bottom of the food chain, such as seaweed, would have a trophic level of one.

In 1998, a paper published in Science found that the MTL of fish landed globally was declining by 0.1 per decade². "It is likely that continuation of present trends will lead to widespread fisheries collapses," the authors warned.

The assumption underlying such warnings, says Branch, is that catch MTL accurately reflects the MTL of the ecosystem itself, and the biodiversity of that system. According to his analysis, it does not. Using data from models and sources such as catches and scientific

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trawls, Branch's team found that the MTL of fisheries catches frequently diverged from the MTL of the ecosystem. They also looked again at the MTL of catches and found "substantially different" values than those quoted in the 1998 paper. Catch MTL, the new paper says, declined from the 1950s but has increased since the mid-1980s.

This is worrying because marine conservation efforts routinely rely on the MTL — it is the main indicator used by the Convention on Biological Diversity, for example. The new research "is not saying things are worse or better, but it is saying the indicator we were using doesn't tell us what we thought it was telling us", Branch says. "Instead of focusing on a simple catch-based measure we need to go out and track what's happening in the ecosystem."

Range issue

But Daniel Pauly, a fisheries scientist at the University of British Columbia and the lead author of the 1998 Science paper, is fiercely critical of the new work. Crucially, he says, the paper fails to account for the huge expansion in the area of fisheries over time. As fishing boats range further, they can catch more high-scoring predators in the open ocean, he points out. This would mask the fact that fisheries near shore, for example, had indeed been fished down.

"The results are therefore completely invalid," he says. His co-author Rainer Froese, of the Leibniz Institute of Marine Sciences in Kiel, Germany, agrees. "Expansion into high seas for tuna or deep shelf for rock fish and seamounts for orange roughy will obviously increase the MTL in landings, unrelated to previous catches in shallow waters," he says. "This will mask any fishing down effect that has typically occurred with the removal of groupers, jacks and sharks."

Pauly and Froese say that subsequent research has supported their conclusion that fishing down is happening around the globe. Pauly also warns that rapidly expanding fisheries in Asia and South America were poorly represented in Branch's study, so it may not represent fisheries worldwide.

In response, Branch says he still didn't see a fishing-down trend in scientific surveys or stock assessments, which measure the same area every year and wouldn't be affected by area expansion. "These are direct measures of what is happening in ecosystems, unlike catches, which measure only what is taken out of ecosystems, not what is left behind," Branch says. Range expansion will make the MTL even less reliable as an indicator, he suggests.

Timothy Essington, a fisheries researcher at the University of Washington, Seattle, whose work was cited by Branch, argues that for a detailed picture of what is happening in ecosystems, MTL must now be used in combination with other measures. Pauly's original paper took a "20,000-foot view", he says. "What we're seeing now is the view from that altitude isn't very clear."

Essington compares looking at MTL to a physician taking a patient's temperature. If the temperature changes dramatically it is probably an indication that something is wrong, he says. But if the doctor decided on a treatment based on temperature alone, "you would never go back to that doctor again".

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