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Scientists Question Widely Adopted Indicator of Fisheries Health and Evidence for ‘Fishing Down Marine Food Webs'

The most widely adopted measure for assessing the state of the world's oceans and fisheries led to inaccurate conclusions in nearly half the ecosystems where it was applied, according to new analysis by an international team. The team was led by a fisheries scientist at the University of Washington, and evolved from a working group organized by UC Santa Barbara's National Center for Ecological Analysis and Synthesis (NCEAS).

The findings are published in the Nov. 18 issue of the journal Nature. "Applied to individual ecosystems, it's like flipping a coin: Half the time you get the right answer and half the time you get the wrong answer," said Trevor Branch, a UW assistant professor of aquatic and fishery sciences.

"Refining scientific concepts is a process of iterative testing," said Stephanie Hampton, deputy director of NCEAS. "This group accelerated the call-and-response dialog that normally occurs among scientists, by doing what we do here at NCEAS –– assembling experts with different perspectives under the same roof, with all the data they can find, and using some really sharp analytical tools to challenge important concepts."

In 1998, the journal Science published a groundbreaking paper, the first to use trends in the trophic levels of fish that were caught to measure the health of world fisheries. The trophic level of an organism shows where it fits in food webs, with microscopic algae at a trophic level of one and large predators such as sharks, halibut, and tuna at a trophic level of around four.

The 1998 paper relied on four decades of catch data and averaged the trophic levels. The authors determined that those averages were declining over time and warned that we were "fishing down the food web" by overharvesting fish at the highest trophic levels and then sequentially going after fish farther down the food web.

Twelve years later, newly compiled data has emerged that considers such things as the numbers and types of fish that actually live in these ecosystems, as well as catch data. The analysis in the Nov. 18 issue of Nature reveals weaknesses in the study's assessment of ecosystem health, related to changes in the trophic levels of catch.

"This is important because that measure is the most widely adopted indicator by which to determine the overall health of marine ecosystems," said Branch, first author of the new analysis in Nature. Those involved with the U.N.'s Convention on Biological Diversity, for instance, chose to use the average trophic level of fish being caught as the main measure of global marine diversity.

An example of the problem with the measure is found in the Gulf of Thailand, where the average trophic level of what is being caught is rising, which should indicate improving ecosystem health, according to proponents of that measure. Instead, it turns out that fish at all levels have declined tenfold since the 1950's because of overharvesting.

"The measure only declines if fisheries aimed for top predators first, but for the Gulf of Thailand the measure fails because fisheries first targeted mussels and shrimps near the bottom of the food web, before shifting to predators higher up in the food web," Branch said.

Including the Gulf of Thailand, Branch found that changes in the average trophic levels of what was being caught and what was found when fish populations were surveyed differed in 13 of the 29 trawl surveys from 14 ecosystems. Trawl surveys, generally done from research vessels, count the kinds and abundance of fish and are

repeated over time to reveal trends.

Branch and his co-authors are the first to combine so many trawl surveys for analysis –– no one had combined more than a handful before. The trawl survey data came from efforts started three years ago by fisheries scientists and ecologists gathered at NCEAS. They brought together worldwide catch data, stock assessments, scientific trawl surveys, small-scale fishery data and modeling results. What emerged from their efforts is the most comprehensive set of data yet for fisheries researchers and managers.

It paints a different picture from previous catch data and has revealed another major new finding: On a global scale, humans don't appear to be fishing down the food web, Branch said.

The new catch data also reveal that, following declines during the 1970's in the average trophic levels of fish being caught, catches of fish at all trophic levels have generally gone up since the mid-1980's. Included are high-trophic predators such as bigeye tuna, skipjack tuna and blue whiting.

"Globally, we're catching more of just about everything," Branch said. "Therefore, relying on changes in the average trophic level of fish being caught won't tell us when fishing is sustainable or if it is leading to collapse." That's because when harvests of everything increase about equally, the average trophic level of what is caught remains steady. The same is true if everything is overfished to collapse.

Both scenarios were modeled as part of the Nature analysis.

The work was supported by the National Science Foundation, Gordon and Betty Moore Foundation and the UW School of Aquatic and Fishery Sciences. It used data from the NCEAS working group and the stock assessment database funded by the Canadian Natural Sciences and Engineering Research Council, and the Canadian Foundation for Innovation. Data from the Sea Around Us project, funded by Pew Charitable Trust, was also used.

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