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by Ray Hilborn

# Concept of 'fishing down food webs' shown to be a myth

Perhaps no image of the impact of fish has captured the public as much as "fishing down food webs."

The idea is very simple: Fishing begins, quite naturally, on the largest, most valuable fish. Once those are gone, fishermen move down the food webs to smaller, less valuable fish, and so on until the oceans are empty.

As Daniel Pauly, the prime apostle of the concept, has often said, we will soon have nothing to eat but jellyfish and zooplankton soup. This neatly fits the "apocalyptic" narrative that is so beloved by some environmental activists, but like many of these narratives, it is wishful thinking.

Pauly's original paper, published in 1998, showed that the average fish caught in the world was becoming smaller and ever lower on the food web. This has been one of the most influential papers in the history of fisheries science. The "food web index" has been adopted by the Convention on Biodiversity and other groups as the best indicator of the health of marine ecosystems.

For this and other work, Pauly has received a wide range of international awards, including the prestigious Cosmos Prize worth $400,000.

But over the last five years, more careful analysis has shown that every element of the fishing-down-food-webs image is wrong.

A 2006 paper in the *Proceedings of the National Academy of Sciences* by Tim Essington and others showed that far from declining, the catch of fish from high on the food web was rising in most of the marine ecosystems of the world. Where the catch's average rank in the food web was declining, it was often because the catch of fish from lower on the food web was rising faster than catch of larger fish.

> ***'If we are going to identify ecosystems that are in trouble, we are wasting our time looking at where the catch comes from in the food web. We need to look specifically at the abundance of the species in the ecosystem.'***

Then, this summer, another paper in *Proceedings of the National Academy of Sciences* by Suresh Sethi and others showed that the fundamental assumptions of Pauly's image were wrong.

First, there is no relationship between the value of fish and where they are on the food web. Top predators are no more valuable than filter feeders. In retrospect this is obvious. At any fish market, it is lobsters, oysters, crab, and shrimp that are the most expensive products. Within species, generally the larger sizes are more valuable. The economic incentive is to catch the biggest size possible within each species, but this has no relationship to where that species ranks in the food web. So there are no economic incentives to begin fishing high on the food web.

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# Favorite fish prophecy tool discredited

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 led by a University of Washington fisheries scientist.

"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.

In 1998, the journal *Science* published a groundbreaking paper that was 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 1 and large predators such as sharks, halibut, and tuna at a trophic level of around 4.

The 1998 paper relied on four decades of catch data and averaged the trophic levels of what was caught. The authors determined those averages were declining over time and warned we were "fishing down the food web" by over-harvesting fish at the highest trophic levels and then sequentially going after fish further 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. An analysis in the Nov. 18, 2010, issue of *Nature* reveals weaknesses in assessing ecosystem health from changes in the trophic levels of what is being caught.

"This is important because that measure is the most widely adopted indicator by which to determine the overall health of marine ecosystems," said Branch, lead author of the new analysis in *Nature*.

*– University of Washington*

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Sethi also showed that fisheries do not begin with top predators. The location on the food web has nothing to do with the sequence of exploitation.

Two of the underlying, and seemingly obvious, assumptions of fishing down food webs were demolished by a University of Washington graduate student — Sethi — who took a little time to test some assumptions of a concept that had been widely touted for a dozen years.

No proponents of fishing down food webs ever asked such elementary questions.

A silver spike was driven through the heart of the concept in November. A paper in *Nature* by Trevor Branch and several co-authors updated the data Pauly used. They showed that the place in the food web of the average catch of the world has been increasing, not declining. More importantly, by actually looking at abundance trends of the fish in different ecosystems, researchers showed that what fishermen catch simply does not reflect what is going on in the ecosystem. The species being caught could rank higher in the food web, while its abundance was declining — or just the opposite.

Using location of the catch in the food web is a useless index of ecosystem health.

This is not to say that fishing does not reduce abundance. In some places, overfishing has dramatically changed ecosystems and eliminated most of the fish — sometimes starting with the large fish. But as Branch showed for the Gulf of Thailand, where more than 90 percent of all the fish are gone, the food web index has been increasing, not declining. This is because the fisheries there began on shellfish and other invertebrates and then moved on to the fish and then the top predators.

Ray Hilborn

Branch said, "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."

***'Many have built their understanding of fishing around this concept, and it won't die quickly. There is an ongoing battle. On one side are scientists, managers, fishermen, and some NGOs trying to identify fisheries problems and solve them.'***

If we are going to identify ecosystems that are in trouble, we are wasting our time looking at where the catch comes from in the food web. We need to look specifically at the abundance of the species in the ecosystem.

All of the key elements of "fishing down food webs" have collapsed under careful analysis:

- Fish high on the food web are no more valuable than those low on the food web.
- Fisheries do not begin high on the food web.
- The food web index is not a useful measure of the status of an ecosystem.
- The food web index itself is increasing worldwide, not declining.
- When we look at trends in abundance, large fish are not declining.

Solving problems of overfishing is like medical diagnosis: We need to identify the problem and the cause; then we can find the solution.

Essington, Sethi, and Branch and their co-authors have shown that, as a diagnostic tool, the food web index is not useful, and we need to rely instead on trends in the abundance of target species.

Pauly remains unconvinced by these critiques, and when interviewed about the Branch article replied, "This paper is a hatchet job, and it's a bad hatchet job."

Many have built their understanding of fishing around this concept, and it won't die quickly. There is an ongoing battle. On one side are scientists, managers, fishermen, and some NGOs trying to identify fisheries problems and solve them.

On the other are those like Sylvia Earle, a National Geographic explorer-in-residence, who simply want to stop fishing. Those people have just lost one of their most cherished arguments. ⚓

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