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THE ECOLOGY OF FISHING DOWN MARINE WEBS

BY DANIEL PAULY

The phenomenon wherein fisheries increasingly target smaller fish lower down in the food web, called "fishing webs" (FD), and first demonstrated in 1998, is now well documented from a variety of countries and ecosyster why the Convention on Biological Diversity selected the mean trophic level of fisheries catch, renamed "Marin eight indicators for "immediate testing" by its over 180 member countries.

FD was an easy transition for the fishing industry to make: moving on from one depleted stock to another tradi standard operating procedure. And FD does not have a built-in economic break: small fishes and invertebrate levels, have recently experienced steep increases in their market value, so much so that they may be seen as

One aspect of FD that still needs a basic framework, however, is its ecology, or, more precisely, its ecological ecosystems. Essentially, FD is a succession, even if it seems to reverse the usual sequence: it consists of a g organisms, species diversity, and structural diversity, and a gradual replacement of recently evolved, derived g bony fishes) by more primitive groups (invertebrates, notably jellyfishes, and bacteria). This is best seen when phases of the FD process, and by characterizing, for each phase, (1) the main features of the fishes and other (2) pelagic-benthic coupling and its effect on processes in the water column.

Three Phases

The first phase, "pristine," prevailed before humans strongly impacted ocean ecosystems. A few parts of the o areas of the South Pacific, still may be pristine, But for most of the world, pristine abundances must be recove historical accounts and anecdotes, or inferred from archeological data.

A pristine state invariably is characterized by numerous marine mammals and large fish as top predators, the exceeding their present abundance tenfold to hundredfold. Elevated biomass of top predators implies large bi and invertebrates, though not necessarily of those opportunistic groups (shrimps, squids) that now support inc fisheries.

In the pristine environment, benthic life is dominated by an abundant structure-forming and sessile fauna, com deposit feeders, which keep phytoplankton biomass down and prevent resuspension of sediments. As a resul to be free of suspended particles and of nutrients leaching from them, or oligotrophic.

The second phase, "exploited," is the phase we are in currently. It is best characterized by declines, notably d fishes, declining sizes and diversity of fishes in fisheries catches, declining trophic levels of the same (and her and declining benthos.

Initially, these declines are compensated for by cascades effects, manifest in the emergence of new fisheries invertebrates, but these eventually decline as well.

Benthic life is modified: biogenic structures, built over centuries by filter and detritus feeders, are increasingly trawling, and replaced by small errant benthic animals and the benthic (polyp) stages of jellyfishes.

This leads to an increased eutrophication of the water column, owing to the increasing scarcity of the animals cropping the phytoplankton and consuming the marine snow (detritus), which is now resuspended by storms a

The third phase, "fully degraded," will follow on the continuation of present trends-although in some places, e.g Chesapeake Bay, many of the features associated with this third stage have already developed. In the Chesa has eliminated virtually all animals above the size of striped bass, the current top predator, but more importan benthic filter feeders. Indeed, the oysters that until 150 years ago formed giant reefs are reported as having be water of Chesapeake Bay in three days. Their absence (again, a result of fishing) is the ultimate reason why p can have such strong effects, and why harmful algae bloom. This also applies to other water bodies, estuarine rendered less resilient by fishing, and easier for invasive species to overwhelm.

The biological endpoint of ecosystem degradation is the "dead zone," a zone free of oxygen and of multicellula nutrients in the water column and of bacteria, rather than benthic animals, processing the resulting abundance detritus. There are growing numbers of these dead zones throughout the world, from the northern Gulf of Mex Adriatic Sea to the Bohai Sea in China, and there can be no argument that the underlying ecosystems are full

Conclusions

These three phases of fishing down, pristine, exploited, and fully degraded, are schematic; they could be furth more rigorously. Still, even in their present, preliminary form, they provide a coherent framework for many of th ocean ecosystems. Our task is to further develop this framework.

Daniel Pauly received SCB's 2005 Edward T. LaRoe III Memorial Award for his leadership, innovation, and eff the results of his research and their implications for management of fish stocks to fisheries managers and poli

Back to *LOCAL CHAPTERS REPORT* | Up to *Table of Contents* | Ahead to *UPDATES FROM REGIONA WORKING GROUPS*

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