Oceanography in the Service of Fisheries

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Declines in world fish catch and changes in the biology of pelagic ecosystems can be attributed to the effects of overfishing imposed on top of natural changes in ocean climate. To understand these processes, it is necessary to change the foundation of fisheries management based on the theory of population dynamics to management based on ecosystem knowledge.

In our early work we demonstrated that salmon production could be increased by adding nutrients to a large lake. Thus fish production could be manipulated by changes in primary production at the bottom of the food chain, without employing theories on fish population dynamics. This result led to the formulation of ideas on ecosystem management in marine habitats.

It is now possible to understand some aspects of energy flow in the sea from plankton through to fish by using large marine mesocosms to study in situ biological communities, in conjunction with computer models of experimental and natural marine ecosystems. Several experiments are described showing how the trophic phasing of plants and animals in the plankton community and the effect of nutrient enrichment can lead to marine ecosystems with different properties. In general, results show at least two major pathways of energy flow: the one dominated by small phytoplankton (flagellates) is generally a low-energy, long food chain; the other, dominated by large phytoplankton (diatoms) is higher in energy and generally results in a short food chain leading to fish and mammals. It is postulated that the effect of over-fishing on the high-energy, short food chain can result in the replacement of fish by jellyfish in some areas.

In the future, we must have new methods that can be used for extensive collections of biological data from the sea. These should include greater use of DNA analysis and satellite imagery, and the deployment on commercial vessels of electronic equipment for measuring physical and biological parameters. Time-series changes could then be better diagnosed, and the accumulated ecosystem data used for management decisions.

Fisheries management must recognize that there is no "Natural" state of oceanic systems, but that these systems change over periods from years to many decades. Long-term climate and ecosystem data should be integrated in order to determine the carrying capacity of the oceans, and how this may change due to climate/fishery interactions. This scientific understanding must come before the political and economic decisions that so often dictate fisheries policies.