GLOBEC Founder Looks Back, Ahead

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The Global Ocean Ecosystem Dynamics program, which changed the way ocean science is done, has just wrapped up a decade of research, and founding chair Brian Rothschild is looking back on the program's accomplishments and the way forward.

When Copernicus unveiled the theory that supplanted the earth-centered view of the universe, it ushered in what historians of science call a "paradigm shift." That is, the new theory didn't simply add to knowledge, it changed the frame-work through which scientists view knowledge. It transformed not only what new knowledge would be discovered, but also the knowledge that was already on the books.

That, says SMAST Professor Brian Rothschild, is what the Global Ocean Ecosystem Dynamics program did for marine science.

"GLOBEC moved us from observational ecology into an era of attempting to understand the effects of ocean physics on population dynamics, and the ecology of the plankton and fish."

Before GLOBEC, Rothschild says, "biological, physical, and chemical oceanographers weren't talking to one another. GLOBEC brought together physical oceanography and biological oceanography, and to some degree, chemical oceanography."

"It's easy to create new knowledge when you put different disciplines together. It's like a spark.“

A decade-long (1999-2009) program of worldwide research, GLOBEC's reach would be difficult to overstate. Thirty countries participated at a national, multinational or regional level in all of the world's major ocean basins. Some 3000 refereed publications were produced, including more than 30 special issues of journals dedicated to GLOBEC studies. And data are still being analyzed, papers written.

The work was unified by an international coordinating structure and a shared vision: namely, the criticality of incorporating physical forces into our understanding of ecosystems. That is, a system of mutually interacting marine organisms is driven by climate.

We tend to think of climate as the long-term behavior of the atmosphere, but that's because we live on land. Climate scientists study the ocean-atmosphere system because the interactions between the two are profound and continuous.

An analogy is a propos here. We know that human activities affect climate, but we don't know how much. And that uncertainty leaves room for both climate-change alarmists and deniers. Similarly, we know that fishing affects fish populations, but we don't know how other forces may be intervening to exacerbate or mask the effects of fishing. That uncertainty is a handicap for management.

The ultimate goal of the research, says Rothschild, is a "biophysical theory of the ocean. One early step on the way to that goal is to understand trophodynamics, population dynamics, ecosystem dynamics of plankton. GLOBEC has made some progress in that direction."

"Some of us like to say, 'If you have to hold the fish in your hand to understand it, you're not going to learn very much.'"

While GLOBEC was going on internationally, Brian was spearheading the development of a research center and then graduate program in marine sciences at the University of Massachusetts Dartmouth. Not surprisingly, that academic program has an interdisciplinary focus. For example, the Department of Fisheries Oceanography includes not only biologists, but also physicists and modelers. To fulfill degree requirements, students must take courses in marine disciplines other than their major. Today, this is still "a bit unusual," says Rothschild, "but it's getting more commonplace in major oceanographic centers around the world. University's are turning out more interdisciplinary young marine scientists, in large part because of GLOBEC."

But GLOBEC was an idea long before it was a program. And Rothschild traces the idea back perhaps as far as the 1970 meeting on Fish Stocks and Recruitment in Denmark, sponsored by the International Council for the Exploration of the Sea.

"A bunch of us thought that fish recruitment was the next big problem related to survival/mortality of larval fish. We thought that it involved the ecology of larval fish, population dynamics of larvae, the plankton they eat, and the plankton that eat them. Just like a sandwich.“

These ideas were developed at a succession of scientific meetings in the intervening years. Notable along the way was a meeting in Miami in 1982 called Fish Ecology III, attended by scientists from England, the U.S., Canada, and Scotland. The published proceedings of the meeting recommended experimental design criteria for a study of the major forces influencing fisheries.

In 1988, the volume *Toward a Theory on Biological-Physical Interactions in the World Ocean*, edited by Rothschild, was published. The book was from a 1987 NATO Advanced Research Workshop of the same name, which concluded that "the oceanographic community is at a point in time … where the physical and biological observations of the sea can again be brought into harmony, a challenge that is urgent, and a goal that is achievable.“

That same year Rothschild led the first nominally GLOBEC meeting in Wintergreen, VA. But it would take another eleven years before GLOBEC would be fully realized.

The biggest boost to GLOBEC's status came in 1995, with its acceptance as a core project by the International Geosphere-Biosphere Program. "GLOBEC became more global," Rothschild says. "It was a natural segue into climate."

Finally, in 1999, an International GLOBEC Implementation Plan was approved, and the research was underway.

Ten years later in June 2009, the third and final Open Science Meeting (OSM) for the Global Ocean Ecosystems Dynamics program was held in British Columbia. More than 300 participants from 34 countries attended, and the just-published volume *Marine Ecosystems and Climate Change* was launched, which summarizes the findings of the international program.

Achieving agreement across national borders is always a challenge, but GLOBEC created a global network of scientists outside national organizations, where fisheries ecosystems can be studied free from the self-interests of individual nations. It also demonstrated the general significance of the direct relations between physical dynamics, plankton and pelagic fish populations.

Meanwhile, Rothschild is looking ahead to the next steps.

"We still know more about the population dynamics of fish than plankton," he says. "For fish, we have population estimates, mortality rates, and how they change with time. There's no comparable body of knowledge about plankton."

"We have multi-decadal observations of fish, which is much richer than our observations of plankton. Four years of data on Georges Bank is trivial; we need multi-decadal studies. Only thru such observations can you, for example, study the interaction of climate-scale variability with plankton sequestration of carbon."

"We're in a state of limbo. I've recommended an international institute of ocean ecology to focus on collecting data and developing theory to help understand separation between anthropogenic and natural forcing, particularly with respect to fisheries, pollution, and climate change."

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