

# Toward a Census of Marine Life

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hat did live in the oceans? What does live in the oceans? What will live in the oceans?

These questions, compelling for society and for science, motivate the effort to mobilize the resources needed to conduct a worldwide Census of Marine Life.

The process began in March of 1997 with a gathering of about twenty of the world's leading ichthyologists in La Jolla, California, to assess what is known and unknown about the diversity of marine fishes. The experts gathered there, as described by William Nierenberg in this issue of *Oceanography*, concluded that the age of discovery is not over. Indeed, the voyages of discovery open to Darwin, Captain Cook, and the explorers of Linnaeus' century are very much open to the voyagers of 2000 and beyond.

In the time since that La Jolla meeting, the Alfred P. Sloan Foundation has been privileged to assist the oceanographic community in its efforts to explore the feasibility and goals of a Census of Marine Life. The main vehicle has been a series of workshops, each concisely summarized here. The spirit of the workshops was to test the limits to knowledge, to ask what is known, what is unknown, and what under favorable circumstances might be knowable within a decade or so.

The explorations encompassed both the fishes and the non-fish nekton. As described by Carolyn Levi et al., opportunities abound to improve our assessments and explanations for the diversity, distribution, and abundance of invertebrate micronekton, cephalopods, marine mammals, and marine reptiles.

A workshop, described by Frederick Grassle, focused on the benthic environment. There we now invent a synoptic picture of tens of millions of square kilometers on the basis of biological surveys covering a few tens of square meters.

The benthic meeting did more than inventory the vast unknown. It envisaged the development of an on-line ocean biogeographical information system (OBIS). OBIS would enable researchers and resource managers, within a few years, to select any area or volume of water on a global map and bring up information as to what has been reported to live there. A 16 September 1999 Broad Agency Announcement from the National Ocean Partnership Program already seeks proposals to make OBIS real, the first practical fruit of the Marine Census.

Technology will populate OBIS with data and observations, and three workshops examined the state of the art of technologies relevant for the Census. As Jules Jaffe shows, acoustic, optical, and molecular biological technologies all demonstrate growing capability to chart distribution and abundance, and collectively they offer the chance to examine quite large volumes of water, different habitats, and the range of marine animals.

As Greg Stone et al. explain, smaller, lighter, and longer-lasting tags that now may be attached to marine animals also offer remarkable new chances to develop synoptic pictures of marine life. To date, no programs have simultaneously tagged several marine species and monitored their movement and behavior relative to each other and to the oceanographic features of a region.

Researchers are just beginning to apply technology to recognize diversity, that is, for the remote identification of species. Up to now, species identification has relied on capture of animals. Every fisher knows that many species skillfully avoid capture, are costly to capture if deep or sheltered, or slip through nets, like jellies. Julia Parrish reports a set of concepts that might dramatically advance the ability to detect, identify, and enumerate marine organisms over a wide range of size and mobility.

The value of new information will rise if it builds on a base of data on the history of marine animal populations. We have studied the history of fishers but have attended little to the history of fishes, to the history of nature itself. John Steele and Mary Schumacher report on a lively workshop that explored the chances to build a history of marine animal populations since human predation became important, about 500 years ago. Combining historical and paleo-ecological research with modeling may go far to fill in this blank spot, and also highlights major puzzles about possible energy flows in both pristine and heavily fished systems.

While most of the workshops focused on a particular aspect of the Census, two took up the grand challenge. As described briefly by David Bradley and elaborated by Alice Alldredge in these pages, the U.S. National Research Council (NRC) debated the fundamental merits of a Census and what questions could justify it. It was the NRC workshop, co-sponsored by the U.S. Office of Naval Research, that urged the structuring of

the program around the three questions of the past, present, and future diversity, distribution, and abundance. The NRC workshop also emphatically shifted the discussion from a "Census of the Fishes," which had been the point of departure of the feasibility studies, to a Census of Marine Life.

The International Council for the Exploration of the Seas (ICES) built on the NRC report in a workshop hosted by the Southampton Oceanography Centre under the leadership of John Shepherd. As Colin Bannister reports, the Southampton meeting took further steps in considering possible priorities and sampling strategies. The Southampton meeting noted, for example, that squid, which have basin-scale patterns of distribution and migration and form critical links in the marine food chain, are just now being included in quantitative ocean studies.


A welcome outcome of the Southampton meeting was a perspective, included in this issue, by John Caddy and F. Carroci on possible frameworks for negotiating cruise tracks for a global survey of marine life. No one yet knows what shape the field programs for the Census may take, should the program proceed. But, it is valuable that knowledgeable experts voluntarily and boldly kick off the discussion.

We are similarly indebted to John McGowan, one of the leading figures in marine biogeography for many decades, for sharing his perspective on the Census. His vision of a biological version of the World Ocean Circulation Experiment centers attention on the chance to advance understanding of the large-scale pattern of the distribution of marine species. McGowan also notes, as have many during the past three years, the need to assure a sufficient group of marine taxonomists to make sense of what we may see.

The Census of Marine Life can proceed only with broad social support. Michelle Duval reports on discussions organized by the Environmental Defense Fund that addressed what societal goals for the Census might make it compelling for environmentalists. She also discusses the need to minimize direct impacts of testing

and sampling on sensitive ecosystems and on individual organisms. Similarly, Thor Lassen shares some of the perspectives of commercial fishers, who also bring much information to the table, as well as their vessels as potential observational platforms. Both Duval and Lassen emphasize the need for forms of governance and guidance for the Census that engender continuing participation and support from the range of constituencies concerned with the oceans.

As must be clear, the development of the Marine Census until now has sought to stimulate creativity, to raise possibilities, and to test boundaries. During the next one to two years, the Census must move from brainstorming to practical plans and priorities. To accomplish this transition, and to begin to form a durable institutional basis for the program, the Consortium for Oceanographic Research and Education (CORE) in Washington, DC has formed an international steering committee for the Census, chaired by Frederick Grassle. The CORE committee will use a variety of processes to engage the community in the preparation of a report outlining what might actually go on during the possible 8-10 year life of the Census of Marine Life. CORE's web page for the Census will share current information as well as provide background, including more detail on the workshops described here (<http://core.cast.msstate.edu/censhome.html>).

The Alfred P. Sloan Foundation is grateful to the more than 300 scientists and other experts from around the world who have participated in the feasibility studies so far. We are also grateful to the institutions with which they are associated, including the range of oceanographic research institutions, museums and aquariums, governmental and intergovernmental agencies, non-governmental organizations, and private companies. We think the numerous creative ideas in the pages of this issue of *Oceanography*, and the enormous potential social and scientific value of their realization, merit the alliance of individuals and institutions that can make the Census of Marine Life happen. 

## COMMENTS and SUGGESTIONS

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