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The Census of Marine Life: A Global Partnership for Sustainable Development

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Abstract discussions of partnerships sustain only intellectuals and bureaucrats. Here I offer one specific example of a major new initiative that may help sustain life in the oceans and human benefits from the ocean. The initiative is a research program called the Census of Marine Life (CoML, www.coml.org). The purpose of the Census is to assess and explain the diversity, distribution, and abundance of marine organisms throughout the world's oceans.

An international program involving experts from a variety of fields, the Census will culminate in 2010 with a report on the state of life in the world's oceans. Along the way, the Census will test and develop prototypes of global ocean observing systems for marine life. The program should work in the same way as the atmospheric research programs of the 1970s, which laid the observational foundation for our modern weather forecasting. In the 1970s weather satellites were first launched and maintained as part of experimental programs; a decade later they become routinely operational.

Why conduct a Census of Marine Life now? Several reasons make the program timely, indeed urgent. One is the United Nations Convention on

Biological Diversity, which requires signatories to collect information on living resources. In fact, no nation has reliable baseline information on its living marine resources. Meanwhile, many nations are interested in creating more marine protected areas and marine parks in their exclusive economic zones and also in the open oceans. Better information is needed to fashion the management that will sustain fisheries, reverse losses of habitat, reduce pollution, and respond to global climate change. Indeed, one way to mitigate global climate change might be to increase the absorption of carbon in the oceans by fertilizing the ocean surface with iron and other elements. Some object that the carbon capture and sequestration may change life in the oceans, but, lacking baseline descriptions of life in the regions that might be fertilized, we would not be able to say what has changed and by how much.

What is the current state of knowledge of ocean life? Estimates of the number of species span from one to 10 million. Narrowing this range is one goal of the census. With regard to distribution and abundance, information on status and trends is basically limited to the 200 or so commercially important species including tuna, salmon, and scallops, and a few charismatic megafauna such as some species of whales. The abundance estimates derive mostly from catch statistics, usually reported by fishers themselves. Most are for near-shore areas.

In fact, 95% of the oceans are largely unexplored biologically. In late 2001 scientists associated with the Census reported the discovery of a new kind of deep sea squid, with a body reaching as long as 23 feet. Vast squid populations may be swimming 1000–2000 thousand meters beneath the surface in large areas of waters. Moreover, no synoptic surveys synchronously reporting all (or most) species and their biomass in a column of water from the surface to the bottom and into the sediments have ever been undertaken. One year, surveyors may voyage out and look at the mackerel and herring near the surface; another year, they may look at the cod and haddock near the bottom.

No region has yet been covered by what we might proudly call an ‘eco-system survey’.

Feasibility studies for the Census of Marine Life began in 1997. The studies involved potential users, including resource managers, fishers, and environmentalists, as well as funding agencies of various kinds including national environment agencies, private corporations concerned with marine resources, and philanthropic foundations. The scientific community of course had to assess whether it could do the job.

In fact, a major reason for a Census now is new technologies available at moderate cost. Until recently, it was impossible to "see" much ocean life. But every fish is a submarine, and technologies for detecting big mechanical submarines have zoomed forward, in part because of the Cold War. Acoustics can show a small biological submarine (a fish) 100 km away. Optical sensors and cameras have also vastly improved.

And tags have become much smaller and lighter, so that many more animals can carry them much longer without having their behaviors disturbed. Animals brilliantly sample their environments. A group of CoML scientists are preparing to tag about 10 different species – a total about 5000 animals – and follow them around the North Pacific for one to two years. They will infer from the behavior of the animals what must live in the oceans in order for the animals to behave as they do.

Like the animals, new vehicles, mostly unmanned, can now explore environments that were earlier hard to reach and survey. Molecular and genetic techniques speed and solidify species identification. Crucially, management, communication, and analysis of data have improved.

Thus equipped with technology, the Census addresses three major questions—(i) What did live in oceans? (ii) What does live in the oceans? (iii) What will live in the oceans? Four major component programs address these three questions.

First, any census has more value if historical benchmarks exist for comparison. So, researchers of the Census constructing the history of marine animal populations since human predation became important, roughly the last 500 years. This program component is called 'History of Marine Populations'.

The largest part of the Census involves going out and looking at what now lives, in new field projects. Some 30 are envisioned, sampling important kinds of biota and various regions using a range of technologies. Initial projects range from fresh attempts to learn about the abundance and distribution of salmon in the open ocean to exploration of life on and above the undersea mountain range that extends up and down the North Atlantic from the Azores Islands to Iceland.

Remarkable communities of life – chemosynthetic eco-systems – crop up along the ocean floor with mussels, shrimps, crabs, and worms flourishing at depths of many thousands of meters and almost unimaginable pressures. Explorers first discovered these only in 1977, off the Galapagos Islands. About 25 of the communities – areas usually about the size of a dining room table – have been visited. We don't know whether there are 100 or 10,000 or 1 million of them. Clever exploration strategies by Census of Marine Life researchers can begin to map and explain the population ecology of the vent and seep systems.

Another way to learn about marine animal populations is to put in arrays of listening devices of the kind that navies have developed to hear passing vessels. These devices have cost much but now come in very low-power and

low-cost versions. CoML scientists are experimenting with building coastal curtains extending from the shore out across the shelf for a few kilometers. These could be employed worldwide for getting much better estimates of coastal fish populations, ranging from salmon to striped bass to sturgeon.

To speak about what will live in the oceans involves numerical modeling and simulation. This component program is organized under the rubric of the Future of Marine Animal Populations. Together, the historical, present, and predictive programs of the Census aim systematically to improve and state honestly what is known about life in the oceans, to identify what is unknown but knowable, and also to say what may be unknowable even if scientists had their dreams fulfilled for new measuring gadgets.

The effort requires a state-of-the-art data assimilation framework, and this effort, the ocean bio-geographical information system (OBIS), forms the fourth component of the CoML. The vision is that users or partners of many kinds will be able to click on maps of the oceans on their laptop or desktop anywhere in the world and bring up data on what is reported to live in the ocean zone of interest. Consider squid populations in the Gulf of Maine between the USA and Canada, which collapsed between 1979 and 1982. User interest may be in whales eating the squids. OBIS enables the user to overlay images of the abundance and distribution of whale populations on top of squid populations. Integrating such data throughout the water column has been hard. The shared standards and protocols of OBIS will make it easy, and open big chances for improved understanding of the patterns and processes that govern marine life.

The Census goal is that this next generation information infrastructure for marine biology and resource management will be in place and fully operable by 2010. OBIS is progressing rapidly. A web portal is online, collating several databases of marine animals and offering various tools for species

identification and classification as well as mapping and visualization. With 1-10 million species, we recognize we are at the beginning of something big and important.

Institutional progress is occurring as well. In the late 1990s, about 30 ministers signed an agreement to create the Global Biodiversity Information Facility (GBIF), now operating in Copenhagen, for both terrestrial and marine concerns. OBIS is the main marine affiliate of GBIF. The OBIS international federation has been established with more than 100 partners in 20 countries getting it going.

Education and outreach as well as direct social benefits such as improved fisheries management are also key reasons for the Census. People are interested in the world around them and the ocean is much of it. Census plans include a large outreach component. A consortium of aquariums for the CoML has already been formed. Aquariums and natural history museums receive about 150 million visitors each year and can do much to share what is learned. Obviously, web sites offer tremendous potential in this regard.

On the subject of institutional arrangements, conducting the Census is a complicated endeavor. An international scientific steering committee and a secretariat guide and encourage the program; regional and national implementation committees have been formed. An international funding network is firming up. The program requires alliances among inter-governmental organisations, such as the International Council for Exploration of the Seas (ICES) in the Atlantic and its Pacific counterpart (PICES), and parts of the UN concerned with marine life (the Intergovernmental Oceanographic Commission of UNESCO and the Fisheries Division of the United Nation's Food and Agriculture Organization).

On the non-governmental side, bodies of the International Council for Science such as the Scientific Committee on Oceanographic Research (SCOR) and the International Association for Biological Oceanography (IABO) embody much indispensable expertise. The offshore oil and gas industry gets together through the International Petroleum Industry Environmental Conservation Association and the Oil and Gas Producers' Association. Commercial fishers and seafood processors matter a lot, of course. Environmental groups such as Conservation International are also involved. Partnerships need to abound.

In conclusion, the Census of Marine Life is a chance for us to increase and clarify what is known about life in the oceans, and also to report what is unknown and what is unknowable. The scientists and explorers of the Census will not visit everywhere. But the ancient dream of seeing into the seas is now a real possibility and tests here and now partnerships and mechanisms for sustainable development. If we succeed with the Census, it should be very good for life in the oceans. Failure in the oceans would tangibly demonstrate the shortcomings of our present worldwide arrangements for research and its application, and imply bad news for climate, forests, and other environmental domains. Let's make the needed alliances and partnerships for the Census of Marine Life and thereby exemplify sustainable development.