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The future of marine biodiversity: The Known Unknown and Unknowable

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**Marine Biodiversity: Past, Present, Future
The Known, Unknown and Unknowable**

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**Conference Report
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This final report covers the third conference hosted by the Center for Marine Biodiversity and Conservation (CMBC) and supported by the Alfred P. Sloan Foundation's Known, Unknown, Unknowable (KUU) Program. Our shared goal is to explore the structure and limits to knowledge of marine ecosystems and the implications of the state of our knowledge to research, policy and society at large.

The Future of Marine Biodiversity: The Known, Unknown and Unknowable

The third CMBC-KUU conference, "The Future of Marine Biodiversity: The Known, Unknown and Unknowable" was held 21-25 April 2005 at Scripps Institution of Oceanography in partnership with the Southwest Fisheries Science Center (SWFSC), NOAA-Fisheries. The purpose of the conference was to explore two main aspects of marine biodiversity in the near (2020) future: (a) projections on anthropogenic drivers (population growth, consumption, modification of the environment, etc.) and (b) projections on impacts on marine biodiversity (commercial and ecological extinctions, range shifts, invasions, coral bleaching and dead zones, etc). The conference was comprised of a symposium open to the scientific community and an invitation only workshop to explore the above questions within the KUU framework. A major contributor to the success of the conference was the diversity of nearly 300 participants at the symposium and 100 at the workshop (please see attached lists of participants). Participants represented an international mix of producers and consumers of knowledge. Seventy percent of the participants were social and natural scientists from academia and governmental research agencies, and 30% were professionals from intergovernmental, governmental and non-governmental organizations, the private sector, the media, environmental education organizations, funding organizations, and concerned citizens.

The public symposium was held on Earth Day and featured eight plenary speakers, a point-counter point on projections of human population growth and the value of predictions, followed by open discussion (please see attached symposium agenda). We encouraged speakers to be provocative, to emphasize the KUU's and to set aside half the time for free-wheeling discussion. The two and a half day workshop was held over the weekend and consisted of four sessions (please see attached agenda). On Saturday, the topic was the KUU's of human drivers (morning) and interactions and synergies among drivers (afternoon). On Sunday, the topic was the KUU's of impacts on biodiversity (morning) and how knowledge and change in human behavior and policy affects biodiversity (afternoon). On Monday, we met in plenary. Each of the working groups summarized their results and there was open discussion. All working groups included a senior "outside" leader, a senior SIO/SWFSC leader, and graduate student/s or post doc organizer, 6-8 invited participants, and a handful of guests or "floaters". Each day of the workshop opened with a plenary address and closed with all the groups getting together once again to synthesize and make dinner arrangements. On Sunday evening, we hosted a reception at the Birch Aquarium on consumer choice and seafood of the future which was organized by David Field, a

postdoctoral student at SWFSC, with help from many SIO graduate students. At the Birch Aquarium event, filmmaker Randy Olson, discussed the issues he has faced in bringing the “Shifting baselines” concept to the public’s awareness via film.

Several themes emerged from the conference.

- 1) Joseph Chamie (UN), opened the conference with predictions of global population growth which will eventually slow to 7 billion by 2020 and level off around 9 billion by 2050. Coastal regions will face increasing urbanization and growth because population growth will be enhanced by migration, both immigration and internal migration within nations. The impact of population on coastal areas will depend highly on patterns of per capita consumption rates. If urbanization increases per capita consumption, coastal areas will face disproportionately high impact rates. However, if urbanization can consolidate impact, encourage regulation, and result in a more organized populace, per capita consumption rates may fall.
- 2) The conservation of marine resources is primarily hindered by a lack of well-defined property rights. Ocean resources will not be sustained unless open access/property rights problems and high discount rates of user groups are mitigated. When no one has the right to exclude users from the harvest of a renewable resource, it will tend to be overexploited. The high discount rate or impatience of users refers to higher valuation of gains today than those in the future. High levels of impatience can lead to rapid depletion of ocean resources even if changes to the marine environment from overexploitation are irreversible.
- 3) Market solutions offer much potential for conservation of marine biodiversity over the next 15 years, but resource managers must allow flexibility when designing such instruments as much is still unknown. Market solutions can help mitigate the open access problem, e.g., New Zealand’s fisheries quota program which has been somewhat successful both in rebuilding stocks and improving returns to the fishing sector. However, it is difficult to predict which ocean resource problems will be successfully mitigated using market instruments. Moreover, it is unclear if market solutions will work in developing or undeveloped nations where private property rights might be new and unfamiliar to user groups. There are biological and technological uncertainties which complicate the implementation of market-based solutions. We cannot predict with any certainty how market solutions will change and be applied over the next 15 years. However, none of these issues are truly unknowable as we will learn as we attempt implementation. The group agreed with Richard Sandor (Chicago Climate Exchange), who advocated that action is recommended now, with the caution that flexibility allows correction as unknowns become known.
- 4) Stressed and degraded systems, especially one suffering synergistic and cumulative impacts, have less resilience and are more susceptible to environmental change, catastrophic events, disease, harmful algal blooms, etc.. Estuaries, in particular, (as illustrated in Heike Lotze’s plenary talk; Dalhousie University) are focal points of anthropogenic change, and will react more unpredictably / idiosyncratically than other ecosystems. The generalized result will be creation of novel species compositions coupled with a loss of habitat diversity and structural complexity. This simplification and homogenization will reduce resilience of the ecosystem. Combined with the new mixes of species, we lose our ability to predict how the ecosystem will function, especially in the face of predicted increased variability.
- 5) Terrestrial inputs influence ocean health. Runoff brings disease to new hosts in the marine environment, and untreated sewage is likely a principal driver for marine diseases. The loss of terrestrial habitats such as mangroves and wetlands can increase disease prevalence because these habitats may also function as important filters preventing the spread of disease pathogens from the land into the ocean. The potential for predictive disease models is limited; emergent diseases are an unknowable. However, predictive disease models could be improved to be more like successful climate change models if we collect more data, improve resolution, collect the right kind of data on the proper scales, and address interactions between trophic levels.

- 6) There was considerable discussion on whether humans have the capacity to learn from cumulative past experiences. In particular, technology and information transfer from developed countries would allow developing countries to skip or speed through the same destruction the developed countries already have experienced. There was agreement that attempting to transfer knowledge and technology to these countries was a good first step to facilitate “leap frogging” and perhaps alter the process of degradation.
- 7) Inequalities between developed and developing nations will exacerbate all problems – political, economic, and environmental – if left unaddressed.
- 8) An overarching international marine conservation goal was identified by the Institutions working group. Such a plan needs to be based on an ecosystem approach to management and use the precautionary approach. It needs to be integral to social and economic sustainable development and apply across sectors. An overarching marine conservation goal also needs to provide a framework for collaboration among existing mechanisms, establish new mechanisms and approaches, and inspire political will. It was agreed that implementation should take place at the regional level based on ecosystem boundaries, not political boundaries.
- 9) Scientific information is of critical importance in informing societal decisions, yet discussion focused on how information alone does not change things. Future changes in media ownership will continue consolidation but the messages will be increasingly fragmented. Many unknowns will accompany future change in communication technologies to broad band media. For example, will technological changes improve dissemination of quality information or will more misinformation lead to more confused people? Will new independent media become ascendant and create a new major movement of high-quality information? Also noted was that the changes to broad band technologies mean that information transfer is no longer one-way. Increasingly, information is now more interactive, and audiences prefer facilitation to lectures. No one message gets to everyone.
- 10) In the United States, science is under siege and conservation is seen as a liberal issue. To promote future change, conservation must be seen as a human issue, non-partisan and value-crossing.
- 11) A recurrent theme in the workshops was the failure of the research community to make simple but powerful arguments that might stimulate broader awareness and action toward promoting marine conservation. Exacerbating the problem is that at many academic institutions in the United States, scientists are penalized for being “too” involved. Parting messages in Andrew Zolli’s plenary address were quoted often throughout the remainder of the conference, admonishing us to “be storytellers, not informants” and pointing out that scenarios succeed more than predictions and that “people feel you more than they hear you”.

There were strong links throughout the symposium to the FMAP Program of the Census of Marine Life (CoML). These included workshop plenaries by FMAP participants Ransom Myers and Boris Worm. Boris’s workshop plenary, “The value of marine biodiversity” summarized results from the National Center for Ecological Analysis and Synthesis (NCEAS) working group that was formed as an outcome from the first CMBC-KUU conference. Andy Rosenberg, leader of the “Institutions and Governance” working group, combined his management experience and perspective gleaned from FMAP and HMAP participation throughout the discussions in ways that clearly demonstrate the revolution in perspective that has emerged from serious consideration of the past and CoML’s efforts to integrate lessons learned from the past to inform the future. Members of the Scientific Steering Committee (SSC) of the CoML participated in the CMBC conference as well.

We received many written thanks and comments about the meeting almost all of them very positive. Clearly, our greatest accomplishment was bringing together an even more diverse group of participants than in previous years and providing a format that encouraged interaction among futurists, social scientists, natural and physical scientists, experts in the humanities, managers, and the media to listen to

each other and to try to incorporate their different perspectives about the future into a more integrated view of how marine ecosystems are likely to change and the role of people as members of those ecosystems as well as agents of change. Comments included: "Thanks for setting up an amazing conference and workshop. It was incredible to be in a room with four of my idols... not to mention talking and interacting with them like an equal." (Andrew Balendy, Masters of Advanced Studies student, SIO). "I enjoyed the wide breadth of individuals you brought together as well as the information presented. In addition, I suspect that some of the personal connections you essentially mid-wifed will help all of us address future unknowns and unknowables -- an outcome that I have to believe is in line with the intent of Scripps, the Sloan foundation, and the COML." (Conny Arvis, State Department). "The CMBC workshop was absolutely life changing for me. I have never had such an opportunity to interact with such a diverse and rich group of people. I was so deeply informed about the way the world is on so many levels, I will never be the same! (Jill Nephew, SIO graduate student). "Congratulations! You and your colleagues should feel very pleased with the successful completion of your conference. It was very stimulating, with interesting people, challenging issues, and very well executed." (Joseph Chamie, retired, UN). "The conference really opened my eyes to the world of marine ecology. It was such a rewarding experience." (Ryan Williams, undergraduate, Meyerhoff Program, University of Maryland).

Another measure of the developing synergies and interdisciplinary perspectives is evident in links that were established between conference participants. For example, Mercedes Pascual and Andy Dobson, participants in the Ocean and Human Health working group submitted a proposal for an AAAS symposium titled "The Rising Tide of Ocean Plagues". One of the emphases will be on the Land-Sea interface and influences from land on marine diseases, in a broad sense. A number of the speakers were part of the CMBC-KUU conference. In addition, the graduate and post-doctoral student members of that working group will be drafting up a paper for publication based on the progress and insights made by the group. Pete Peterson and Ransom Myers realized in an impromptu conversation that they had been studying two different ends of a single trophic cascade. The fortuitous conversation will lead to a co-authored publication. As mentioned above, another collaboration that emerged from the first CMBC-KUU conference, but that benefited from this year's as well, is the working group on marine ecosystem function at NCEAS organized by Enric Sala and Boris Worm.

Student participation was excellent. Nearly 40 graduate and undergraduate students from SIO, Stanford, UC San Diego, UC Irvine, California State Universities at San Diego, Los Angeles, and Fullerton, University of New Mexico, Boalt School of Law at UC Berkeley, University of Washington School of Law, and the Universidad Autónoma de Baja California attended the conference. All student costs were covered. At the public symposium, we hosted a graduate student poster session and affiliation tables for all students so that they could meet informally with the invited speakers on various subjects such as fisheries, policy, and conservation genetics (topics chosen by SIO graduate students). A select group of SIO graduate students and SIO/SWFSC post docs were also heavily involved in the planning and organizations of the workshop and, as mentioned above, created and produced the sea food presentation materials at the Birch Aquarium event. In addition, this year we hosted 15 undergraduate students from traditionally underrepresented minority groups. Many of these students came from CMBC's partner programs in diversity recruitment – the Meyerhoff program at University of Maryland, NOAA's Environmental Partnership Program, the MSPHD program at South Florida University, and the California State University system. The visiting students were paired up with SIO graduate students and technicians from SWFSC to ensure that they were able to get a peer's view of opportunities in graduate education and to facilitate plans for summer internships.

In retrospect, we successfully addressed the three greatest weaknesses of the previous conferences. We decreased the number of speakers at the symposium and increased the time each was given to speak. This year's plenary speakers were better able to develop their messages than the short panel presentations we held in previous years. We increased the opportunities for conference participants to interact by breaking

up the workshop into small working groups which met alone each morning and in afternoon pairings with other working groups. This experimental format was not entirely successful (on the last afternoon, working groups needed more time alone to summarize their results) but overall participants seemed to enjoy the balance between some structuring and plenty of time for informal interactions. As in past years, there were problems of diversity of participation. We worked hard on this, and while we are pleased at the increasing participation from social scientists and undergraduates, we would have liked to have more participants from the private sector, the political sector, education, and developing countries, and more senior women and minorities, at the workshop. Several invited participants could not attend because of too short notice but this seems inevitable for an annual event. We would like to do web casts of the conference and post it on the CMBC website, but are constrained by the inadequacies of the conference hall – a problem to be alleviated eventually by the new SIO conference center. We were successfully roused to action this year by David Field's comment at last year's conference where he suggested we work with the catering department to have an inspiring "blue" menu. This suggestion led to the event at the Birch Aquarium which was attended by many additional people including CMBC donors, local San Diego fishermen, and local politicians.

Products of the Conference

As mentioned above, a proposal submitted for a symposium at AAAS on "The Rising Tide of Ocean Plagues" and a paper for publication based on the results and insights of the Ocean and Human Health working group will be prepared this summer. Enric Sala and Sarah Mesnick will take the lead on a multi-authored paper for publication which will synthesize the projections made at the conference in order to describe future scenarios of marine biodiversity, as well as solicit additional projections, and will map hotspots of anthropogenic impact on marine biodiversity. All invited workshop participants have been asked to participate and the working group summaries will provide the backbone of the paper. We expect to convene the group leaders to discuss the first draft in Fall 2005.

The PowerPoint symposium presentations and workshop summaries are available on the workshop website: (<http://cmbc.ucsd.edu/about/workshop05.cfm>). This report will be posted on the public website: (<http://cmbc.ucsd.edu>).