

Census of Marine Life Annual Report to SCOR

June 2007

The Census of Marine Life (CoML) was formally established in 2000 and became an Affiliated Program of SCOR in 2002. In 2010, this international research program will release its first report on the status of knowledge of marine biodiversity. In 2007, we are keenly aware of this approaching deadline and have begun implementing plans for integration, synthesis and visualization of marine biodiversity information, as well as the management needs to achieve them. This information is actively being collected by our 14 Ocean Realm Field Projects and three cross-cutting initiatives in historical studies (HMAP – History of Marine Animal Populations), modeling and prediction (FMAP – Future of Marine Animal Populations), and data management and accessibility (OBIS – Ocean Biogeographic Information System). The following report provides an update on the program's status and plans in 2007.

Scientific Accomplishments

All of CoML's global-scale Realm Projects are currently working in the field and analyzing data. This year is a particularly big year for our projects in the Arctic (ArcOD) and Antarctic (CAML), as March marked the beginning of the International Polar Year and the major phase of CoML's polar research at sea. In the past year, HMAP and FMAP have also revealed some new and exciting insights in to changes in marine biodiversity over time and the importance of biodiversity in marine ecosystems. Some highlights from CoML expeditions and research analyses include the following.

Species discoveries

The CoML Corals project (CReefs) explored the Northwestern Hawaiian Islands (NWHI) French Frigate Shoals, one of the healthiest and least disturbed atolls in the world, lying within the recently established NWHI National Marine Monument. Discoveries included 100 potential new species of crabs, corals, sea cucumbers, sea quirts, worms, sea stars, snails, and clams. For some species collected, while not unknown to science, this was the first time they were recorded in the French Frigate Shoals.

The SANTO 2006 Survey, which provides a deep reefs component to CReefs, documented the fauna and flora of the South Pacific island Espiritu Santo in Vanuatu. Philippe Bouchet and Bertrand Richer de Forges led the marine biodiversity component, which involved 97 scientists, students, support staff and volunteers, from 18 countries. The number of species inventoried was remarkable, including 1,100 species of decapod crustaceans (crabs, shrimps and hermit crabs) and around 4,000 species of molluscs. Hundreds of new species - possibly over a thousand - were discovered.

Charles Griffiths, scientist from the Near-Shore project (NaGISA) and chair of CoML's African Committee, and colleagues discovered and identified a new and impressively large species of rock lobster from the Madagascar Ridge. The lobster, *Palinurus barbarae*, is 50 cm long and already attracting the interests of commercial fishers in international waters.

Researchers Yousria Soliman and Mary Wicksten from the Continental Margins project (COMARGE) described a new species of amphipod, *Ampelisca mississippiana*, which inhabits the head of the Mississippi canyon around 460m depth in the deep Gulf of Mexico. Although small (less than 6 mm in length), these tubiculous crustaceans carpet the seabed, with densities up to 12,000 individuals per square meter. Based on its abundance and the stabilizing effects of the tube mats on sediments, this amphipod is likely of great ecological importance.

New insights into marine animal distribution and diversity

The Antarctic project (CAML) explored the biological diversity of an oceanic region alongside the Antarctic Peninsula, where the Larsen A and B ice shelves collapsed 12 and five years ago, respectively. Fast-growing sea squirts observed at Larsen A site may be an indication of a first step towards a biodiversity change after the collapse. Among their other findings were 15 potential new amphipod species, including one of the largest ever collected, four presumed new species of cnidarians, and deep-sea species (sea cucumbers and stalked feather stars) at unusually shallow depths.

Researchers from the CoML Abyssal Plains project (CeDAMar) also sailed to Antarctica to collect deep biological samples from the Weddell Sea. They focused on cataloging the overall biodiversity and studying connections between organisms found in shallow and the much deeper waters. Looking at evolutionary adaptations, such as the absence of eyes in deep water organisms, they believe some species moved from the deep ocean to the much shallower shelf. The Southern Ocean has changed little in the past 40 million years, giving these organisms ample time to evolve. Another exciting discovery was the existence of nearly identical species of foraminifera in the Weddell Sea and the Arctic Ocean, strengthening the awareness of the significant link between the Southern Ocean and other oceans, including the Atlantic.

Scientists from the Top Predators project (TOPP) made a scientific breakthrough as they tracked the sooty shearwater in its journey of more than 40,000 miles in 200 days – the longest animal migration distance ever electronically recorded. The tags, small enough to fit on these little sea birds, revealed that the sooty shearwater flew in a giant figure eight pattern, traveled 40,000 miles annually in search of food, and crossed the equator twice and covered the entire Pacific Ocean.

Loren McClenachan, Jeremy Jackson, and Marah Newman, researchers from the HMAP project, employed 163 historical sources to map the loss of nesting sites and the long-term decline in populations of green and hawksbill turtles in the Caribbean over the last 1000 years. They reported that 20% of historic nesting sites are completely gone, and another 50% support only remnant nesting populations. Modern populations of green and hawksbill turtles in the Caribbean have declined over 99.5% from numbers once described as “infinite,” which has had a significant negative impact on sea grass beds and coral reefs. While populations of nesting green and hawksbill turtles have risen on protected beaches over the past 30 years, those results are still sobering when compared to historic levels of abundance and distribution.

FMAP scientists reported that the loss of large sharks in the oceans, due to overfishing, is impacting bay scallops and other shellfish. The removal of the largest predatory sharks (bull, great white, dusky, and hammerhead) along the US Atlantic coast has led to an explosion of their ray, skate and small shark prey species that, in turn, have preyed on scallops and have wiped them out.

Novel technologies and approaches

The Marine Microbes project (ICoMM) demonstrated a revolutionary DNA technique called “454 tag sequencing” and found that marine microbial diversity may be 10 to 100 times more than expected and that the vast majority of species are previously unknown, low-abundance organisms theorized to play an important role in the marine environment as part of a “rare biosphere.” The ICoMM team discovered more than 20,000 kinds of bacteria in a single liter of seawater when they expected to find just 1,000 to 3,000. This discovery is important because microorganisms are vital to our survival, and these rare ones have as yet unknown roles in the ecosystem and can be significantly impacted by global change. The “454 tag sequencing” requires only small snippets of genetic code to identify an organism. ICoMM is now inviting proposals from the microbial oceanographic community to further demonstrate tag sequencing of samples from diverse marine habitats and biogeographic provinces of the world’s oceans.

On Georges Bank, Nick Makris of the Gulf of Maine Area program (GoMA) tested his Ocean Acoustic Waveguide Remote Sensing (OAWRS) technology, which can track movements of fish schools at a continental shelf scale. The technology imaged an area over 100 km in diameter, where a school of herring, possibly consisting of 10 billion individual fish, was observed.

The Ocean Tracking Network, a Canadian project led by CoML Senior Scientist Ron O’Dor, received funding to globalize the tagging and tracking technologies developed in the Pacific by CoML’s Top Predators (TOPP) and Shelf Tracking (POST). The OTN will serve as a legacy project of CoML after 2010, giving scientists and resource managers a highly detailed picture of marine conditions and the migrations of fish and ocean animals throughout the world.

Contributions to the community

The Ocean Biogeographic Information System (OBIS) is currently serving over 13 million data records covering 81,000 species from 210 databases. Many of the newly added data sets were contributed by the network of Regional OBIS Nodes and cover the understudied southern oceans, particularly the waters around Africa, Australia, Antarctica, and South America.

The Shelf Tracking (POST) project studied whether salmon that have struggled to reach the river mouths through many dams might be less likely to survive in the open ocean than those that swam a free-flowing river on their journey to the ocean. Findings indicated that survival of stocks was not impacted by dams.

The Seamounts project (CenSeam) produced a report on “Seamounts, deep-sea corals, and fisheries: vulnerability of deep-sea corals to fishing on seamounts beyond areas of national jurisdiction,” which was published by the UN Environment Programme’s World Conservation

Monitoring Centre. The Executive Summary was distributed in New York on in October 2006 to the negotiators involved in the first round of the UN General Assembly's fisheries resolution negotiations. CenSeam has also published protocols for collection of deep-sea corals. These protocols were peer-reviewed and prepared as a NOAA Technical Memorandum by the U.S. National Oceanic and Atmospheric Administration's (NOAA's) Office of Habitat Conservation.

Led by Boris Worm, FMAP researchers published a study that found current trends in overfishing and pollution project collapse of all currently fished seafoods before 2050. The real impacts of species loss, however, were shown to go beyond declines in seafood. Human health risks emerge, as depleted coastal ecosystems are vulnerable to invasive species, disease outbreaks and noxious algal blooms, which create human health risks and negative impacts on human economy dependent on healthy oceans. The positive side was that the data showed ocean ecosystems to hold great ability to rebound, but change needs to happen soon.

FMAP researchers also published a study that examined ways to aid the recovery of North Atlantic right whales. Right whales are virtually extinct in Europe, but exist in a small population of about 350 individuals on the east coast of North America. A leading threat to the species is lethal entanglement by fishing gear, primarily from lobster fishing gear. The FMAP team compared the Nova Scotian and Maine lobster fisheries and found that Maine lobstermen could substantially reduce the number of traps, shorten the fishing season by as much as six months and still catch the same amount of lobsters – at lower cost and reduction of risk of right whale entanglements.

Education and Outreach

The Mid-Atlantic Ridge project (MAR-ECO) received the 2006 Descartes Prize for Science Communication in recognition for its “innovative action for science communication.” The award was given in March 2007 at a ceremony at the European Commission in Brussels. MAR-ECO is a shining example of the outreach efforts taken on by the CoML projects.

The Top Predators (TOPP) project teamed up with Yahoo!, Conservation International, the Leatherback Trust and the Costa Rican Ministry of Energy and the Environment for The Great Turtle Race, an outreach effort aimed at raising awareness of the endangered Leatherback turtle. TOPP deployed tags on 11 Leatherback turtles in Costa Rica and tracked them on their journey to the feeding grounds of the Galapagos Islands. The race was followed online by school students and the general public, and was remarked on frequently by Stephen Colbert, who had a turtle named for him, on his television show *The Colbert Report*.

CoML continues to work closely with Galatée Films on production of *Oceans*. The film is currently scheduled for release in May 2009.

Program Governance and Administration

The international CoML Scientific Steering Committee (SSC), the governing body of CoML, includes 16 members from around the world:

Dr. J. Frederick Grassle (*Chair*), Rutgers University, USA

Dr. Victor Ariel Gallardo (*Vice Chair*), University of Concepcion, Chile
Dr. Ian Poiner (*Vice Chair*), Australian Institute for Marine Science, Australia
Dr. Vera Alexander, University of Alaska Fairbanks, USA
Dr. D. James Baker, Science and Management Consultant, USA
Dr. Patricio Bernal, Intergovernmental Oceanographic Commission, France
Dr. Dorairajasingam Chandramohan, National Institute of Oceanography (Retired), India
Dr. David Farmer, University of Rhode Island, USA
Dr. Serge Garcia, Food and Agriculture Organization, Italy
Dr. Carlo Heip, Netherlands Institute of Ecology, The Netherlands
Dr. Poul Holm, Roskilde University, Denmark
Dr. Yoshihisa Shirayama, Kyoto University, Japan
Dr. Myriam Sibuet, Ifremer (Retired), France
Dr. Michael Sinclair, Bedford Institute of Oceanography, Canada
Dr. Song Sun, Institute of Oceanology, China
Dr. Meryl J. Williams, Future Harvest Alliance Office, Malaysia

The program also has ten National and Regional Implementation Committees (NRICs) that are building local programs that address national research priorities. The intention is that, after the first CoML report in 2010, the NRIC programs will contribute regional syntheses of the known, unknown and unknowable about marine biodiversity and continue to promote CoML's proven technologies and approaches to surveying marine biodiversity in research and monitoring programs and ocean and coastal observation systems. National committees are located in Australia, Canada, China, Indonesia (funded 2007), and the United States. Regional committees are located in the Caribbean, Europe, the Indian Ocean, South America, and Sub-Saharan Africa. Though not formal committees at this time, organized activities for CoML are also taking place in Japan and in the Arabian Sea region.

CoML's international Secretariat is located at the Consortium for Oceanographic Research and Education in Washington, DC. In April 2006, it received renewed funding to continue administering the program through March 2008.

We estimate total commitments to the CoML, including ship-time and other contributions, now exceed \$400 million. These funds come from traditional sources, including governments and private organizations, and support scientific research, outreach and education, and project management.

Plans for 2008-2010

The CoML, under the guidance of its SSC, has established and implemented a complete suite of international projects and other planned activities and is guiding them toward reporting their key findings in 2010. By the end of 2007, CoML will have put in place writers, a management team and a plan to achieve global synthesis of CoML-collected marine biodiversity findings that will carry the program through 2010. CoML is also focusing on its legacies and potential for ongoing marine biodiversity science and observations in the next decade.

For the SSC and Secretariat, the work plan for the next few years emphasizes identification of the key questions to be addressed in the 2010 report, information integration and synthesis,

innovative visualizations of findings, and increased participation and partnerships to address societal needs and implement regional programs. While the primary concern of the SSC is the body of work concluding in 2010, it does have an eye to the future and will be calling upon a group of leading scientists from the NRICs and the marine science community in general to consider options for a “Census of Marine Life II.” The SSC is also actively promoting CoML methodologies and technologies to the ocean observing community, namely the Global Ocean Observing System (GOOS) and the Global Earth Observing System of Systems (GEOSS). The broader strategy for post-2010 will involve increased partnerships with a variety of stakeholders and potential user groups that need marine biodiversity information for resource management, conservation, industry practices, and education.

Recognizing the breadth of potential user groups in both government and private realms, the SSC wishes to ensure that the information and insights of CoML will address a variety of needs and issues. It established a working group, led by Paul Snelgrove (Memorial University of Newfoundland), to develop the framework of the 2010 report in consultation with CoML projects and the user community. These recommendations will be presented to the CoML community in November 2007 at its 3rd All Program meeting. The 2010 report will also recommend a plan for future research by identifying remaining knowable gaps in information.

CoML is closely integrated with the Barcode of Life initiative. There is now a marine barcoding initiative, in which CoML scientists are strong participants. The marine barcoding group will meet in Taipei, Taiwan in September 2007, in conjunction with the 2nd International Barcoding Conference.

CoML is also working closely with the recently launched Encyclopedia of Life (www.eol.org), which has the goal to produce species biographies for all known species on the planet. CoML will help ensure pages for all known marine species.

Relationship to other SCOR activities

CoML has ongoing collaboration with the SCOR Panel on New Technologies for Observing Marine Life. This Panel makes recommendations to the CoML projects regarding technologies that are applicable to their research and more broadly communicates the benefits and potential of novel technologies for studying marine life. It has reviewed the suite of CoML field methodologies and has made recommendations of additional technologies and approaches to consider. The Panel met in October 2006 in Japan, in conjunction with meetings of the CoML SSC and near shore biodiversity (NaGISA) project. It will meet again in conjunction with the November 2007 All Program meeting in New Zealand.

In December 2006, CoML participated in the SCOR-organized meeting to build synergy between major international ocean research and observation projects and programs. This was a follow-up meeting to the one held in September 2004, in which CoML also participated. CoML is a supporter of these forums for communication between the large ocean science programs because it reduces redundancy in activities and increases the spirit of and knowledge of opportunities about collaboration, thus making more efficient use of limited resources. CoML endorses efforts to strengthen the community through better data management and interoperability between systems, ocean observing technologies, and the development of a cruise

database. The 2004 SCOR Summit made a recommendation to coordinate activities in the Southern Ocean towards a Southern Ocean Observing System. CoML was well represented at the initial meeting toward coordination, which took place in conjunction with the 2006 SCAR annual meeting. A follow-up SOOS meeting will be held this year.

Odd Aksel Bergstad, Principal Investigator of the Mid-Atlantic Ridge project (MAR-ECO), has been invited to make a presentation and represent CoML at the 2007 SCOR annual meeting in Bergen, Norway. CoML will also participate in the SCOR 50th Anniversary meeting in 2008 and has been keeping abreast of the planning. Several CoML participants are noted as potential speakers, including Hans Verheye and Peter Weibe of the Zooplankton (CMarZ) project.

There is natural cross-over between CoML and SCOR through their vast networks of scientists. CoML shares active personnel with both SCOR-sponsored programs IMBER and GLOBEC. Ann Bucklin, Principal Investigator of the CoML Zooplankton project (CMarZ) and leader of CoML's integrative initiative in DNA barcoding, is a former member of the IMBER SSC. Mike Roman, a former member of the CoML U.S. Committee, is a current member of the IMBER SSC. Dave Karl, of the CoML ICoMM project, and Rory Wilson, of TOPP, are on the joint IMBER-GLOBEC working group for "end-to-end food webs." Ruben Escribano, former chair and current member of the CoML South American regional committee, is a member of the GLOBEC SSC. Additional personnel from CMarZ, TOPP, MAR-ECO, and the Gulf of Maine projects are active in GLOBEC regional and science activities, such as CLIOTOP.

Additionally, many of the individual CoML projects have partnerships with other programs of interest to SCOR. The ChEss project collaborates with InterRidge, a SCOR Affiliated Program, on cruises, workshops and database development. The CoML projects in the Arctic and Antarctic, ArcOD and CAML, respectively, are the lead coordinating projects for marine biology in the International Polar Year. CoML as a whole is seeking greater participation and input into GOOS, particularly through OBIS, POST, TOPP, and the Gulf of Maine project. Jim Baker, a member of the CoML SSC and promoter of U.S. GOOS in his former position as NOAA Administrator, is leading this charge.