Census of Marine Life 2020
Life in a Changing Ocean
Looking forward from the 2010 baseline

In October 2010, the Census of Marine life will deliver the first global census of marine life. This census resulted from the efforts of 2000 participants from 89 countries, with an investment of some $650M over the last decade. This effort compiled and distributed information about ocean biodiversity, identified knowledge and gaps, and developed new technologies for closing those gaps. The fundamental questions that will be answered in October include: what lived in the ocean, what currently lives in the ocean and what might live in the ocean? The first Census of Marine Life (Census 2010) was composed of 14 field projects, and three supporting projects – one that examined the History of Marine Animal Populations (HMAP), another that aimed at predicting the Future of Marine Animal Populations (FMAP), and a third which was a repository of data collected by all Census-related research, the Ocean Biogeographic Information System (OBIS).

An international program of this scope that studied everything from microbes to whales across all ocean realms on a global scale is unprecedented and its final results will significantly contribute to driving science-based policy. In ten short years, we trained a new cadre of interdisciplinary researchers, and took full advantage of available technology to help achieve our goals, and when it wasn’t available, figured out how to ether modify or create new tools that allowed us to acquire, assimilate and visualize data that were not available a mere decade ago. We can now census and observe marine organisms in virtually every habitat, in every ocean realm from the Arctic to the Antarctic, from the deep sea to the nearshore. In addition to developing new tools, technologies and approaches to study marine life, we have standardized protocols so that the work carried out in one location could be compared to the next and to allow for this work to continue in the future. We now know how to track a tuna across the Pacific and follow a salmon fry as it moves along the continental shelf. We now have the know-how and ability to track enormous fish populations or shoals over a 10,000-square-kilometer area. And we now have a better idea of what organisms live on top of seamounts, along the mid-Atlantic Ridge, and associated with the deep-sea hydrothermal vents and seeps. We have identified DNA sequences that can be used to create barcodes to aid in the quick identification of marine organisms to the species level. We have found species long believed to be extinct and formally described over 1200 new marine species, with thousands more waiting for identification. All of the information collected over the past decade --from DNA barcodes to the distribution and identification of marine organisms and where and how they move – have been recorded and assimilated into the Census database, OBIS. As a result of this decade of research, we know more about marine life than any of us could have imagined. It truly has been a decade of discovery that prompted both surprises, and questions for as we learned more, we realized how little we really knew and how much more there was to learn about the diversity, distribution, and abundance of marine life in the global ocean.
While we have confirmed some hypotheses about the distribution and abundance of marine life, our surprises were many. For example, Census researchers discovered giant mats of microbial organisms, which represent the planet’s largest biomass ecosystem, found the “Jurassic shrimp” alive and well on an underwater peak in the Coral Sea that was believed to have become extinct some 50 million years ago, discovered the world’s largest known cold seep: over 180,000 square meters, recorded a 40,000 mile annual migration of sooty shearwaters that allows them to cover the entire Pacific Ocean basin in an endless summer. To date, Census scientists have produced more than 2,400 scientific papers, 10 books, with three more in the hopper, and numerous dissertations. Scientific products resulting from Census research will continue to be produced well past its official end date of December 31, 2010.

While the data produced by the Census over the last 10 years has been considerable, a great need for such data exists now and will continue into the future. What the Census has done is to establish a baseline from which future changes in marine life can be measured. It has also trained a whole new generation of researchers, who have learned to work together across disciplines, languages, and cultures, subsequently increasing our intellectual capacity and expanding our scientific view. The first Census also conducted taxonomy and genetics well, blending traditional taxonomy with modern molecular tools. Such collective advances stimulated in technologies, analytical approaches, data assimilation, visualization techniques and synthesis will help accelerate marine biodiversity research well into the next decade. The foundation laid by the first Census of Marine Life will make it possible to undertake an unprecedented examination of the marine environment in an integrated and dynamic way well into the 21st century, and tackle the pressing issue of ecosystem function.

To capitalize on the significant advances and intellectual infrastructure that has been developed by the first Census of Marine Life, we are developing Census of Marine Life 2020: Life in a Changing Ocean, in short Census 2020. We will capitalize on what was learned, try to fill in the gaps of what was not covered, and adopt new aspects where more research is needed and exploration done. For example, while the first Census provided insights into a wide variety of habitats, these studies were often separated in space and time. In Census 2020, we will use the tools developed during the first Census and apply them in an integrated manner, providing a seamless transition from the benthos through the water column to the intertidal. In essence, we propose the implementation of an “ecoscope” that will allow us to study organisms from microbes to megafauna in an integrated way. Imagine what might be learned when the intellectual infrastructure, lessons learned and technologies developed under Census 2010 are applied to the eoscope. The result may be a seamless transition from the benthos through the water column to the intertidal across a range of species from bacteria to whales, incorporating measurements of the movement patterns of top predators, coupled with the abundance of zooplankton, the associated ocean physics, and the benthic organisms dependent on nutrients raining down from the surface. We will begin to get a more complete picture of marine life and how aspects of its physical environment help shape and control it. Census 2020’s eoscope will be focused on a number of regions where existing infrastructure is in place or at locations that are representative of critical marine habitats. In Census 2020, we will go beyond a one-time snapshot of biodiversity of an isolated marine habitat, and replace it with a dynamic view into the processes that maintain biodiversity. We will fully utilize new technologies that are making it possible to study the ocean in an unprecedented
manner, increasingly making the ocean transparent. One way to visualize where we are headed is that Census 2010 was a photograph and Census 2020 will be a movie.

We can now make predictions based on what we was learned during the first Census and go further to ask whether this new biogeography of the ocean is indeed correct? In essence, this first decade of coordinated research will provide guidance for informed exploration so we can be smart about where and what we sample. We can make predictions and test hypotheses about what should be where and why. We can then test whether our predictions and models are correct. Further synthesis of the data acquired during the first Census will be necessary, but in Census 2020 these data will be used to fill data gaps, develop models and hypotheses, which will be tested during the Census 2020 decade (2010-2020). Using the previous Census efforts as a baseline, we will look at linkages across habitats and organisms and develop hypothesis about marine biodiversity that can facilitate an experimental approach. A large-scale integrated study as proposed for Census 2020 would allow experiments to be carried out at a global level. For example, there is considerable concern about how the increase in underwater noise, produced by human activities (naval sonar, oil and gas development, shipping traffic, air transportation etc), is affecting marine life. In Census 2020, we could synchronize efforts across ocean realms or across ocean basins to carry out an “International Quiet Ocean Experiment” to actually measure the effects of noise on marine life. For such an effort we would organize a short period— say four hours or so— where all or a significant proportion of human generated ocean noise could be turned off. During the ensuing quiet, we could observe changes in animal behavior across a range of organisms and habitats in an unprecedented way. In the same manner, we could examine the effects of nighttime illumination in the ocean and its effects on marine organisms.

A conceptual framework for the first Census focused on the known, unknown, and unknowable Census 2020 will focus on the unknown from the perspective of the unexplored and the unexplained. Answering questions about what is unexplained will lead to a better understanding of how marine biodiversity is maintained and how it can be protected. While the first Census focused on what lives in the global ocean, there is an increased awareness that as we study and describe new species, marine habitats continue to degrade along with their associated biodiversity. More importantly, the exceptional increase in the rate of discovery of species made possible by the first Census has been accompanied by an alarming increase in the extinction of marine organisms. Over the past ten years, we have witnessed the extinction of the Baiji or Yangtze River Dolphin and predictions are that the Vaquita, Northern right whale and Mediterranean monk seal will be extinct by the middle of this century.

Fundamental to any understanding of human impacts on marine life is an understanding of what was there prior to human influence. Prior to the first Census our understanding of seamounts, the deep sea, the benthos, and the movement patterns of large pelagic organisms was minimal. Knowledge has been increased in all of these areas over the last decade and Census 2020 is uniquely poised to make connections to societal issues and their effects on global marine life thanks to the baseline provided by the first Census of Marine Life. We will also integrate the historical and future-oriented work of the first Census, which has provided a baseline of information that in some cases goes back hundreds of years, as
well as predictions about the future of our changing ocean. These investigations have provided needed data and a starting point to allow us to assess what we need to know and what questions need to be asked to understand what aspects of, and how, the ocean is changing. A baseline understanding, and approaches and tools to monitor marine biodiversity, developed under the first Census are essential to any effort to document—let alone—understand marine life responses due to climate change, ocean acidification, and other human impacts affecting the global ocean. The first Census initiative also is and will continue to provide data essential for marine spatial planning.

**COML 2020 will focus on a series of science questions, including:**

*What components of marine biodiversity are important to community resilience?*

*Does the presence or absence of a group of organisms stabilize or destabilize the composition of marine communities? Are functional groups important?*

*Do changes of individual species result in a sequence of events that causes a chain or cascade that drives the system to a new steady state? How common are trophic cascades?*

*Is there a relationship between connectivity and productivity? Does biodiversity follow through the water column? Or is the water column decoupled?*

*What factors drive the connectivity and interactions between marine organisms?*

*Are there social networks of marine organisms? What factors are responsible for this connectivity or “communication”?*

*What are the major drivers that control or determine the abundance distribution and movement patterns of marine organisms?*

*What are the boundaries and connections of marine organisms and/or habitats?*

**Organizational Structure of Census 2020**

A strong Secretariat is essential for the implementation and success of Census 2020, which seeks to develop an experimental approach to answer common questions across specific habitats, regions, and realms. To this end, we are seeking core support to develop an International Secretariat that would be located in Ocean Leadership Offices in Washington DC. A fundamental component that made the first Census of Marine Life work was the integrating role of its International Secretariat. The Secretariat was the glue that brought its 17 projects and 13 regional and national committees into one unified effort. The Secretariat is essential to maintain and enhance the communication networks that have been established for program management and conveying international discoveries across and between individual programs. Without the Secretariat, the individual projects would have remained isolated research efforts without any synthesis beyond the realms of individual products. In addition, the Secretariat provided support for a well-trained and experienced Education and Outreach program. Its small core staff had expertise with, and access to media, that went far beyond that, which could have
been justified for any individual project. Finally, through funding supplied by the Alfred P. Sloan Foundation, the Secretariat provided funding for the various field projects that supported the essential administrative core functions of these programs, which enabled them to obtain funding from their national programs or other foundations to secure support for their research. In effect, this core support enabled the various projects of the first Census to obtain financial support that went far beyond that provided by the Sloan Foundation—about 75 cents for every dollar provided by the Sloan Foundation.

Many Census of Marine Life projects will continue to provide regular ocean observations of biodiversity and habitat changes beyond 2010. The Nearshore project, for example, has established relatively simple, standardized protocols for repeated, rapid sampling of biodiversity using barcodes and DNA chip technology. Monitoring of coral reef biodiversity will continue using novel environmental gene sequencing for rapid enumeration and a Census-developed sampling device called ARMS for Autonomous Reef Monitoring. Coastal projects can continue monitoring the movements of commercial and conservation species in near real time and link these to changing oceanographic conditions. Such habitat data, collected by sensors on animal platforms, particularly in the Arctic and Southern Oceans, are already being integrated into ocean models and providing a mechanism for “ground truthing” for satellite imagery. Census-like programs are planned and being funded by Canada, India, and South Korea, and many European countries are partnering in similar efforts.

Canada and a series of global partners are also committed to supporting the Ocean Tracking Network spin-off project as part of the Global Ocean Observing System (GOOS) project through 2015. The first Census’ Open Ocean and Deep Sea projects have been, and will continue to be, major scientific data contributors to aid in policy development for seamount fisheries, mining, etc. under the FAO and Law of the Sea Convention, and in the Global Ocean Biodiversity Initiative.

The first Census of Marine Life has made a difference in how marine science is conducted and has made significant advances in what is known about what lives in the global oceans. Census 2020 stands ready to continue this work, capitalizing on what was learned, the techniques and tools developed, but refining its approaches to meet more targeted objectives in order to answer more pressing, and in some instances basic questions, about marine life. The scientists are ready and committed, the network is in place, the viability and workability of the system tested and proven to help realize its mission of defining “Life in a Changing Ocean.”