

## **Discoveries of the Census of Marine Life—Making Ocean Life Count**

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Source: Arctic, Antarctic, and Alpine Research, 43(3) : 490-491

Published By: Institute of Arctic and Alpine Research (INSTAAR),  
University of Colorado

URL: <https://doi.org/10.1657/1938-4246-43.3.490>

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## Book Reviews

DISCOVERIES OF THE CENSUS OF MARINE LIFE—MAKING OCEAN LIFE COUNT. By Paul V. R. Snelgrove. Cambridge, New York: Cambridge University Press, 2010. 270 pp. \$45.00 (softcover). ISBN: 978-0-521-16512-9

The Census of Marine Life supported by the Alfred Sloan Foundation is based on 17 different international projects that over a period of 10 years mobilized more than 2700 researchers plus research expeditions and added more than a thousand new species to science. The founders of the Census of Marine Life formed a community of researchers with different research interests and objectives and an interdisciplinary approach. They focused on the use of new technology in order to investigate varying aspects of the ocean and thus increase knowledge concerning the diversity, distribution, and abundance of marine life in all the oceanic environments of the world.

The book reflecting this work, DISCOVERIES OF THE CENSUS OF MARINE LIFE—MAKING OCEAN LIFE COUNT, is very well written for a broad audience and it includes all relevant new scientific references after each chapter. It includes the whole ecosystem from microbes to whales. The size of marine organisms ranges a hundred million million million fold from drifting bacteria through blue whales, from the smallest to the largest organisms, from the shortest- to the longest-lived, and from the slowest to the fastest. THE CENSUS OF MARINE LIFE encompasses virtually all new technological methods regarding the study of ocean and marine life, and includes all the examples of records of animal life such as a 200-year-old rockfish and 400-year-old clam. Further examples include sail fish that can swim 110 kilometers per hour, Atlantic blue tuna that migrate over 5800 kilometers; sooty shearwaters that migrate over a distance of 64,000 kilometers; and humpback whales that migrate 8400 kilometers. THE CENSUS OF MARINE LIFE has a wide selection of color photographs of marine life including, for example, spectacular new species such as a crab so unusual that it warranted a whole new family (Kiwaidae). Others include a blind lobster which was discovered at a depth of 300 meters in the Phillipine Sea, and a new species of octopus at a depth of 250–600 meters near the Antarctic Peninsula.

The overall goal of the CENSUS was to understand the diversity, distribution and abundance of marine organisms across all the oceans and include all species and ocean habitats. It involved thousands of experts from more than 80 nations, and was organized in 17 interlinked projects. The book is organized in three parts: Part I: the Unknown: Why a Census?; Part II: the Known: What Has the Census Learned?; and Part III: from Unknown to Unknowable.

The ocean encompasses more than 99% of the Earth's biosphere, and it is therefore necessary to continually use new tools to study the different species. For many species it is still not known where they go, how they go, or why they go where they do. The International Census of Marine Microbes (ICoMM) collected more than 1200 samples, representing 583 bacterial, 120 archaeal, and 59 eukaryotic data sets and more than 25 million sequences. ICoMM found the most abundant type of life on Earth to be a group of Alphaproteobacteria, which cycle carbon, nitrogen, and

sulfur, and represent half of the microbial abundance and 25% of microbial biomass. The blue-green bacteria live in sublit waters at concentrations of up to 100,000 to 1,000,000 individuals per milliliter of seawater. Their photosynthesis produces perhaps half the primary production in the ocean. The Census of Marine Zooplankton (CMarZ) focused on zooplankton that live all of their lives in the water column. Zooplankton encompass about 7000 species in 15 phyla. CMarZ is the first global-scale synthesis of marine zooplankton. CMarZ filtered millions of cubic liters of water at more than 12,000 locations and 89 new species were found. These include new jellyfish from Norway, the Gulf of Maine, and the deep ocean, and at least 15 new species of crustaceans. POST, The Pacific Ocean Shelf Tracking Project, inserted small radio tags into thousands of individuals of fish and squid species. POST tagged 4000 hatchery salmon and tracked them through rivers into the ocean. Five juveniles were detected 2500 kilometers away. Tagging of Pacific Predators (TOPP) tagged and tracked large animals that swim far in the ocean, and the seabirds that fly above them. TOPP tagged mostly in the Pacific and included whales, tuna, sharks, squid, seals, sea lions, turtles, and seabirds. White sharks migrated from coastal California to a meeting place the CENSUS dubbed the “white shark café.” Visiting the café off the coast of Hawaii, and traveling back, demonstrated strong and persistent homing behavior. Pacific bluefin tuna and loggerhead turtles mostly swim west to east, breeding in the western Pacific and then migrating as juveniles to the central California coast to feed. After spawning, tuna migrate into the South Pacific, encompassing the largest known home range among marine species. The animal with the longest migrations is the sooty shearwater, which travels the Pacific from the Antarctic to Alaska.

The CENSUS dedicated five of their field projects to the deep ocean, and almost every new sample from the deep sea was found to have a new species in it. The CENSUS focused on continental slopes (COMARGE), chemosynthetic environments (ChEss), seamounts (CenSeam), the Mid-Atlantic Ridge (MAR-ECO), and the abyssal plains (CeDAMar). COMARGE found an intermediate food supply corresponded with peak diversity over depth. ChEss discovered vents in the Pacific and in the Indian ocean as well as new seep sites. MAR-ECO found abundant copepods in the upper 100 meters, euphausiid peaks in the upper 200 meters, and decapod peaks at 200–700 meters. CeDAMar found a characteristic fauna in the Pacific with many foraminifera and nematodes.

CENSUS established a new discipline of environmental history, the Census History of Marine Animal Populations (HMAP). HMAP asked how the diversity, distribution, and abundance of marine life in Planet Ocean had changed over thousands of years. They worked together with the Future of Marine Animal Populations (FMAP), which focused on recent changes in ocean life. HMAP used data drawn from ships' logs, surveyors' and pirates' diaries, as well as tax records, and even medieval cookbooks and restaurant menus to look back in time at how humans have changed the ocean. Where HMAP ends, FMAP picks up and carries the story of the ocean forward. Since human exploitation of the ocean began, the weight or biomass of 256 species of large marine mammals, birds, reptiles, and fishes

DOI: 10.1657/1938-4246-43.3.490

declined 89% and individual species declined by 11–100%. The total weight of large predatory fish has fallen to 10% of pre-industrial fishing levels. HMAP reconstructed abundance and distribution of whales from ships' logs. Using genetic diversity and mutation rates to estimate past population sizes in whales, researchers found that Pacific gray whales were three to five times more abundant before whaling than they are now.

The CENSUS included the results from more than 500 research expeditions, and countless nearshore samplings, and discovered thousands of new species from all the regions that were explored. This added greatly to knowledge of the diversity of new species, their distribution around Planet Ocean, and their abundance. CENSUS showed a new way of conducting science with a global network of 2700 scientists. Thus, for example, TOPP tagging data on black-footed albatrosses was used by the U.S. Fish and Wildlife Service during international deliberations on conservation. The establishment of an MPA (Marine Protection Act) to protect loggerhead turtles was spurred by TOPP findings, and the discovery of leatherback turtle migration has contributed to a resolution by the International Union for Conservation of Nature (IUCN). CenSeam contributed to the Food and Agriculture Organization of the United Nations (FAO) efforts to develop guidelines for sustainable management of seamount ecosystems and their fisheries.

DISCOVERIES OF THE CENSUS OF MARINE LIFE—MAKING OCEAN LIFE COUNT is a fascinating and highly detailed contribution to both general knowledge as well as very specific information concerning the oceans and marine life. It also gives detailed information on a variety of the appropriate research methodologies. It details what is currently known, what is new, and what changes may be expected in the future. In short, it is an excellent reference work for anyone interested in the oceans of the world and the myriad species that live in them, and it provides a global scale context for every marine ecologic niche, from the equator to the poles.

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