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employs technological advances new to marine science, such as ceramic spheres to provide buoyancy at pressures close to 16,000 pounds per square inch and a micro-fiber-optic cable the width of a human hair that can transmit multiple video streams along with vehicle sensor and navigation data to scientists aboard ship through a 20-km-long tether. While testing the vehicle's sampling capability, we discovered the anthropogenic legacy of mounds of spent munitions and gunpowder-filled tubes at 500-m depth. Coincident with this find in the Pacific was the discovery of massive damage caused by fisheries trawling on the Corner Rise seamounts in the North Atlantic. These recent experiences made only too real Koslow's major points: that deep-sea science has a storied history and a legacy of exploration that extends to the current day and that the deep sea remains largely unexplored, although even the most far reaches are not only explorable by humans but have already been negatively impacted by us. He reminds us that we also have the power to steward the future health and use of the deep sea.

The Silent Deep is a unique and wonderful companion to the few other deep-sea textbooks that exist, such as Gage and Tyler's *Deep-Sea Biology: A Natural History of Organisms at the Deep Sea Floor* (1991, Cambridge University Press). However, I know of no other volume of work that so readily describes human impacts on the deep ocean, including the rapid spread and damage of trawling, the buildup of humanity's toxic pollutants in deepwater life forms, the potential consequences of climate change and ocean acidification, and the future mining of seabed minerals and methane hydrates for hydrocarbons. The public needs to know what is at stake. From a single cigarette butt to megatons of radioactive waste, we have and will continue to impact the deep ocean.

I highly recommend this book for anyone with an interest in deep-sea ecosystems—and the future of our planet.

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Enumerating the Sea's Dwindling Bounty

A Review of *World Ocean Census: A Global Survey of Marine Life*

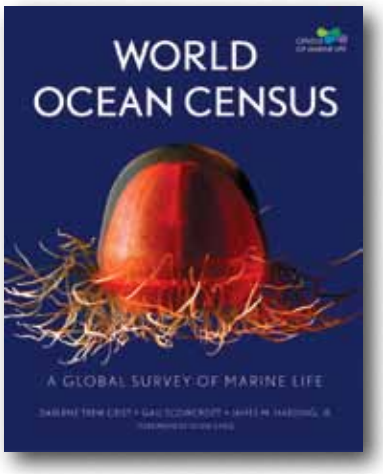
By Darlene Trew Crist, Gail Scowcroft, and James Harding, Jr., Firefly Books, 2009, ISBN 978-1-554-074341, Hardcover, 256 pages, $40 US

REVIEWED BY CHARLES H. GREENE

During the first decade of the new millennium, a revolutionary approach to studying life in the sea was launched—The Census of Marine Life. Assembling over 2000 ocean scientists from 82 nations, the Census set out to answer three fundamental questions:

- What once lived in the global ocean?
- What is living there now?
- What will live there in the future?

In addressing the above questions, the Census evolved into an unusual mixture of nineteenth-, twentieth-, and twenty-first-century ocean science. Like the *Challenger* expedition of the mid-nineteenth century, the Census placed a strong emphasis on ocean exploration and cataloguing marine biodiversity. At the same time, it pioneered entirely new technologies to study the distribution, abundance, and genetic structure of marine populations as well as the behaviors of individual animals in the wild. It is not an exaggeration to state that over the past decade, the Census has played a fundamental role in transforming the study of life in the sea.



So, what has enabled the Census to play such a transformative role in marine biological research? During a decade in which federal support for such research was modest at best, the Sloan Foundation was able to use its own resources to leverage a large commitment of funding for the Census from

other private sources. Historically, when funding for marine biological research is adequate, scientific creativity and innovation can flourish. In contrast, when funding is scarce, the review process becomes more combative, the proposals become more conservative, and the odds are stacked heavily against truly innovative science. Certainly, the decade-long infusion of over half a billion dollars into marine biological research set the stage for the Census' success.

However, funding alone cannot ensure success. Projects had to be vetted in some sort of review process, and if creativity and innovation were to emerge, risks had to be taken. Did the Census only support the best scientific projects available? Probably not, and it is fair to guess that some would never have survived the peer-review process at traditional funding agencies like the National Science Foundation. Nevertheless, the Census did select themes and support projects that can only be described as game changers. The Future of Marine Animal Populations (FMAP) project was perhaps the most controversial and successful. By supporting conservation-oriented marine ecologists to look into the history of recent fishing practices and project future trends, the Census stirred up a hornet's nest of controversy with fisheries biologists and managers. Remarkably, rather than spinning out of control, this controversy eventually brought both sides to the table and a consensus perspective emerged by the end of the decade (Worm et al., 2009).

Obviously, not all of the Census projects will conclude as gracefully and on such a high note as the FMAP project. Nevertheless, as the Census draws to a conclusion, it is an appropriate time to assess its accomplishments. *World Ocean Census: A Global Survey of Marine Life* is the first attempt to present these accomplishments in a format that is accessible to a broad audience. With its striking photography and high production standards, the book unfolds as a visual celebration of the Census. Marine biodiversity and the excitement of ocean exploration come alive as the reader thumbs through the pages and marvels at images collected from Census projects throughout the world ocean. As a coffee-table book, *World Ocean Census* succeeds admirably.

The text of *World Ocean Census* is not consistently up to the standards of its photography. Like the Census itself, the book is organized into three sections focusing on the past, present, and future of life in the sea. Unfortunately, coverage of these topics is uneven, and the quality of the narrative varies considerably from chapter to chapter. The narrative is at its best when it brings to life the personalities of the scientists participating in the Census. I particularly enjoyed Chapter 4 on "Animals as Ocean Observers" and Chapter 8 on "Unraveling the Mysteries of New Life-Forms." Chapter 4 captures the excitement of scientists conducting animal tracking studies and the challenges they face in tagging animals in some of the world's most extreme environments. Chapter 8 is equally engaging, letting the reader share in the thrill of discovery as Census scientists describe the excitement of finding new species.

The narrative hits its low points when it gets caught up in cataloguing technology rather than biodiversity. For example, Chapter 3 on "Expanding the Use of Technology" was very disappointing. Normally, this topic would be of special interest to me. However, I found the descriptions of a wide variety of technologies in this chapter to be superficial and occasionally misleading. The development and use of state-of-the-art technology has been critical to the success of the Census; nevertheless, I would recommend skipping over this chapter and reading the much more enjoyable Chapter 4. Perhaps an appendix describing the technology in greater detail would have satisfied the more technologically inclined reader without disrupting the flow of the narrative.

Among its many themes, the most memorable message of *World Ocean Census* is that we must explore the ocean and understand it biodiversity before it is too late. This theme is expressed most eloquently in the book's foreword by Sylvia Earle:

> *The importance of the Census is made urgent because at the same time that more is being learned about the diversity of life in the sea…more is being lost.*

However, this statement is not meant to imply that we are simply in a race against the clock to catalogue marine biodiversity before it disappears. Rather, the critical point is that only after we achieve a better appreciation of marine biodiversity can we fully comprehend and address the threats that humanity poses to the ocean environment and its inhabitants. There are several occasions early in the narrative when this message is communicated in a subtle manner. One example is Chapter 5 on "Disappearing Ice Oceans." This chapter has a chilling effect, leaving the reader with haunting images of spectacularly colorful animals living in polar environments that are

gradually disappearing due to some of the most dramatic, climate-induced changes on the planet.

In the final section of the book—"What Will Live in the Ocean?"—all subtlety is cast aside, and the authors forcefully draw attention to the impacts humans are having on marine populations. Chapter 9 on "Forecasting the Future" highlights the threat of extinction from overfishing faced by many large animal populations in the ocean. In addition to the species targeted by fisheries, numerous fish, sea turtle, and marine mammal populations are being driven toward extinction by their incidental capture or entanglement in fishing gear. Despite its overall sobering theme, the chapter ends on an optimistic note, describing how a change in lobster fishing practices can benefit both lobsterman and North Atlantic right whales.

The book's final chapter, "The Path Forward," continues the litany of human threats to the ocean and its inhabitants. Ocean acidification, anoxic dead zones, and the *jellification* of marine ecosystems are each given their due. One can only hope that lay readers fascinated by the book's earlier focus on marine biodiversity do not become too discouraged reading about how humans are decimating that biodiversity. Like the previous chapter, this one also ends on an optimistic note—concluding that the Census has made a difference and will help humans become better stewards of their ocean planet.

It is worth noting that *World Ocean Census* was written prior to the Census' completion this year. Therefore, we can anticipate more comprehensive treatments of its scientific findings after the project's synthesis phase is completed. However, beyond its scientific findings, the Census has other stories that still need to be told. Any endeavor of this size, involving so many people passionate about what they are doing, will lead to compelling stories with elements of comedy and tragedy, failure and triumph. One example emerged during the *Ocean Futures* project. At the height of the controversy this project stirred up, its leader Ransom Myers developed a brain tumor and passed away after only a few months. His death left his young protégé, Boris Worm, in the crosshairs of the opposition critical of the project's findings and conclusions. Fortunately, this episode, touched by tragedy, ended in triumph as Worm worked with the opposition to mediate their differences and achieve a critical consensus. Stories from the Census like this one, which convey some of the human drama associated with studying life in the sea, may help capture the public's imagination and hopefully raise its awareness in time to make a difference. *World Ocean Census* is a start in the right direction, but there are still many stories left to tell.

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