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Ocean: Reflections on a Century of Exploration

By Wolf H. Berger, with contributions by E.N. Shor, University of California Press, 2009, 519 pages, ISBN 978-0-520-24778-9, Hardcover, \$59.95 US.

REVIEWED BY PETER WADHAMS

I will always remember my first visit to Scripps Institution of Oceanography to see Walter Munk. It was a November lunchtime when I arrived at a sun-drenched Institute of Geophysics and Planetary Physics (IGPP), perched on its cliff overlooking the Pacific Ocean. Walter was sitting in his bathing shorts at the picnic table outside the IGPP entrance. In the background, groups of younger oceanographers passed by carrying surfboards. I had just arrived from a cold, rainy, miserable Cambridge, England, and I gazed at the scene with amazement possibly tinged with censoriousness. Seeing my expression, Walter smiled and said, "You don't have to suffer to do good science!" I would like to suggest this as the official motto of Scripps.

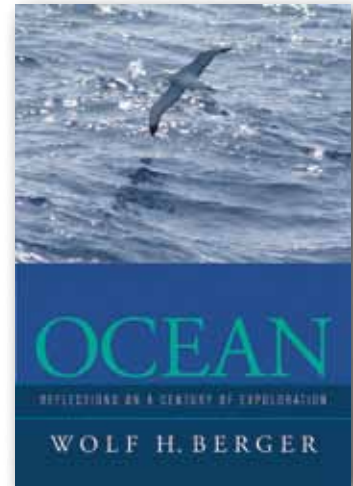
To write a survey of oceanography based mainly on work done by Scripps could be taken as presumptuous, for this is what Wolf Berger has done in his book *Ocean*. But of course it is not, for much of the history of oceanography since 1903 is the history of Scripps. It has always attracted the best oceanographers because it combines a formidable research ethic with a setting in one of the most beautiful places in the world. In fact, one sometimes feels that there are only two types of oceanographers: those who work at Scripps and those who

haven't been able to get a job there. So Berger's bias can be excused.

His survey is set at a fairly elementary level, rather like those introductory textbooks of the 1960s that sit on the bookshelves of older oceanographers, but it says much for the rate of progress of oceanography that it takes him 519 pages to give even a basic account (although I learned much from it). A lot of the growth since those heady 1960s days comes from marine geophysics and marine biology. The revolution in Earth sciences from plate tectonics, the role of geothermal vents, and the discovery of cyanobacteria show how ocean science has massively expanded at both ends of the size scale.

Berger begins with a brief history of oceanography, then he gives "A Portrait of the Ocean Planet," a survey of the ocean and its properties, in 28 pages. Fourteen more chapters then follow on more specialized topics that are treated in the same clear, simple, and entertaining manner. "Life at the Edge of a Fertile Sea" deals with the coastal and intertidal zone, especially of California, giving some recent insights to update the immortal work of Ricketts and Calvin, *Between Pacific Tides*, first published in 1939. "Of Coral Reefs and Atolls" covers the tragic story of damaged and ruined reefs, showing how difficult it now is to find a pristine reef anywhere.

"The Zen of the Beach" ranges widely, from the origin and fate of beaches, drawing on the work of Scripps scientist D.L. Inman, to the sources of swell, drawing on the work of Walter Munk, and the history of sea-level rise.



"Unravelling the Gulf Stream Puzzles" starts with the origin and structure of the Gulf Stream, but goes on to consider the dynamics of ocean current systems in general, paying generous tribute to the work of Henry Stommel of the Woods Hole Oceanographic Institution (WHOI), Scripps' deadly rival, as well as to that of Walter Munk. This warm current flowing north is then contrasted with a cold current running south, in "Sardines and the California Current." This chapter begins with the famous collapse of the sardine fishery but goes on to deal with upwelling processes and El Niño.

"Meadows and Deserts of the Sea" deals with ocean productivity and the food web in the sea. "Of Whales and Sharks and Giant Squid," coauthored with E.N. Shor, is a fascinating account of the largest creatures in the sea. The authors are commendably courageous in giving space to the evidence for sea serpents and other possible giant creatures, referring to the work of Ed Bousfield and Paul LeBlond in analyzing sightings of a creature they named *Cadborosaurus* off Vancouver Island. "The Deep, the Cold, the Dark" deals with life in the unlit depths of the

ocean, from midwater fish with photophores down to the benthos. "Seeing in the Dark" introduces acoustic oceanography, starting with sounds created by fish themselves, and moving on to the deep scattering layer and to seismic refraction and reflection methods for investigating the seabed. Acoustic thermometry of the ocean is described, but the more general technique of ocean acoustic tomography, invented by Walter Munk and Carl Wunsch of MIT, is not. This omits a development important to Scripps (and WHOI), and also a unifying trend in oceanography. Munk has drawn attention to the way in which acoustic oceanography and "normal" physical oceanography developed independently, for different purposes, and with different ways of defining and looking at the physical nature of the ocean. Each has much to learn from the other, and it is time to unify the two views.

"Mountains, Trenches, Sunken Islands" moves into Berger's own territory of marine geophysics. This chapter deals with the exciting history of how seafloor spreading was established as a fact and the scramble to discover the arrangement and mode of operation of the tectonic plates that make up Earth's crust and that are most accessible and dynamic under the ocean.

The later chapters bring us into newly developed areas of research where much remains undiscovered and much else is controversial. "The Ocean's Memory of the Ice Ages" deals with the impact of the ice ages on ocean structure, and also the role of the ocean in the descent into, and recovery from, the ice ages. In particular, the unsolved question of the origin of the two-stage recovery from the last ice age, via the Younger Dryas reversion, is

dealt with in detail. "Abyssal Memories" takes us further back into climate history through the results of the Deep-Sea Drilling Project, which was originally managed at Scripps in the 1960s before becoming a Texas A&M responsibility in 1985. The final chapter is highly speculative: "Global Warming and the Ocean" traces out the current controversies relating to the mechanisms of present climate change, and the role of the ocean in the greenhouse effect. As has often happened, a pioneering effort from Scripps can be identified in the 1957 paper of Roger Revelle and Hans Suess on carbon dioxide exchange between the atmosphere and the ocean, showing that the ocean was not in fact capable of absorbing all the additional CO₂ pumped out by human action, but must result in a rise in atmospheric levels. This conclusion led to the Mauna Loa observations, and the rest is modern history.

The epilogue deals with the future, and what we can do to halt the warming and pollution of the ocean and the destruction of its ecosystems. It ends with a plea for public education in Earth sciences, but equally a plea for public education toward environmental stewardship, that is, toward a sense of responsibility for the future of the ocean and the planet. "Without participation of a committed public, scientific knowledge will not translate into political action." This is a call for public action from marine scientists.

As shown above, although the book ends up covering most major topics in oceanography, it is not structured in a didactic way, but each chapter goes on from one starting point and seemingly naturally wends its way through a number of connected topics, like

a stream of consciousness artfully designed to look random. This construction makes the book a pleasure to read, as each chapter looks like a self-contained essay. *Ocean* also contains a useful set of appendices.

One of the delights of the book is the lengthy set of gossipy footnotes to each chapter, which expand on the personalities involved in the work and their interactions, and also direct us to a mass of further books and reading. We learn, for instance, in Chapter 7, that Carl Hubbs, a Scripps ichthyologist, used to take his graduate students on field trips in the 1940s, and forced them to spend the evenings and nights sorting fish while allowing them to cook some of the specimens for dinner. Luckily, he prevented them from eating cabezon, which he suspected of being poisonous, and he and chemist Arne Wick then experimented on cabezon specimens, finding that the roe killed rats and guinea pigs while the flesh was harmless. One of Hubbs' voyages was funded by the actor Errol Flynn, who quickly jumped ship to party in Acapulco while the scientists collected specimens, resulting in a movie called "The Cruise of the Zaca." Dipping in again, in Chapter 11 we learn that a fiendishly dangerous electrical sound source for seismic reflection, called the Rayflex Arcer, was operated safely by the Scripps marine technician Harold Sammuli only because his body was found to have an unusually high resistance to electricity. These historical snippets are absolutely fascinating and humanize the process of oceanography—although ocean science has always seemed the most human of the sciences, the one most closely connected to the enthusiasms and foibles

of the scientists who created it.

Elizabeth N. Shor, the historian at Scripps, is co-author of two of the chapters, on giant creatures and underwater acoustics, but makes her presence felt strongly throughout in supplying historical material to the footnotes sections.

There are bound to be a few errors in such a huge book. I only noticed two: Alfred Russel Wallace (who is given due credit for his role in discovering evolution) spelled his middle name with one “l”, not two, and the voyage of the *Fram*

started in 1893, not 1883.

I thoroughly recommend this book, not only to oceanographers of every kind and age, but also to general readers. It is enormously enjoyable and informative.

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Ecosystem-Based Management for the Oceans

Edited by Karen McLeod and Heather Leslie, Island Press, 2009, 392 pages, ISBN 978-1-59726-155-5, Paperback, \$45 US

REVIEWED BY ANDREW FISCHER

By now, there is no mistaking that the oceans are in peril. But, how do we move forward to address the problems and manage our ocean ecosystems for sustainability? How do we create new solutions to resource management challenges that span biological, social, and political disciplines? The compilation *Ecosystem-Based Management for the Oceans*, edited by Karen MacLeod and Heather Leslie, is probably the most comprehensive attempt at addressing these questions.

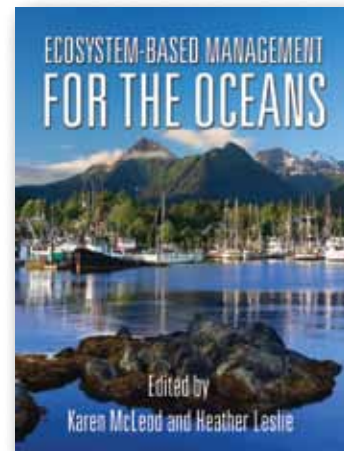
The book is organized into five parts, and each of the 19 chapters is a contribution from a total of more than 40 experts in the fields of marine science and management. Each of the chapters contains black-and-white illustrations

and photographs that support the text, and critical information in each of the chapters is summarized in boxes. The book begins with a foreword by Jane Lubchenco (Administrator, National Oceanic and Atmospheric Administration) and a preface by Anne Guerry (Lead Scientist, National Capital Project’s Marine Initiative) highlighting the interconnectedness and complex relationships among ecology, human interactions, and climate change in the Arctic and Puget Sound ecosystems. They make a compelling case for the urgent need for ecosystem-based management (EBM).

The first part of the volume is titled “Setting the Stage,” and the first two chapters define EBM, provide a guide to the volume, and spell out what resource managers need to implement an EBM approach. Ecosystem-based management is defined as an “integrated approach to management that considers the entire ecosystem, including humans.” The

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basis of this approach is to conserve ecosystems for the long-term delivery of ecosystem services. Another key aspect of the approach espoused by the book is the incorporation of resilience science, or embracing change and how ecosystems respond to myriad human and natural influences. To overcome traditional sector-based management challenges of current ocean management regimes and deliver a robust approach to EBM, Chapter 2 concludes that managers will require, among other things, a comprehensive and clear legal mandate, scientific information that is