

MARINE CONSERVATION

Science, Policy, and Management



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Illustrations by Robert L. Smith, Jr.



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The land-sea coastal realm from the tropics to polar regions, where the majority of marine conservation issues lie. See Chapters 2 and 4 for physical and biological/ecological characterization. Illustration © Robert L. Smith, Jr.

Cover image: created in Photoshop by Robert L. Smith, Jr., from separate pictures of the walrus and the ice floe, Bering Sea. Photographs © Ray & McCormick-Ray.

MARINE CONSERVATION

SCIENCE, POLICY, AND MANAGEMENT

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Preface

We are at a time in history when science allows us better to understand our global environment, and when human societies are beginning to recognize the urgency of marine conservation and the need for sustainable use of marine resources. As John A. Moore (1993) has put it: “We have reached a point in history when biological knowledge is the *sine qua non* for a viable human future ... A critical subset of society will have to understand the nature of life, the interaction of living creatures with their environment, and the strengths and limitations of the data and procedures of science itself. The acquisition of biological knowledge, so long a luxury except for those concerned with agriculture and the health sciences, has now become a necessity for all.”

During the past century, humans have acquired the ability to intrude, exploit, and better understand the last, previously unexplored portion of Earth—the contiguous global oceans. The rates and magnitude of change brought on by the Marine Revolution (Ray, 1970) followed 5–10,000 years of the Agricultural Revolution and two centuries of the Industrial Revolution, with dangers of repeating errors of the past. Observation of the quickening pace of change and the way that humans behave and manage themselves, and increasing knowledge of the way marine ecosystems function have made apparent major ecosystem instabilities and management incongruences. Approaches deemed feasible when marine conservation was emerging only a half-century ago no longer fulfill needs of the 21st century. That the world has become “hot, flat, and crowded” (Friedman, 2008) makes clear the need for new marine conservation approaches.

Our previous book, *Coastal-Marine Conservation: Science and Policy* (Blackwell Science, 2004) called attention to the fundamental role natural history and ecosystem-based science play in conservation policy and management planning. That is, conservation must be informed by the natural histories of organisms *together with* the hierarchy of scale-related linkages and ecosystem processes. This book continues that focus on a whole-systems approach to marine conservation, taking account of major advances in marine ecosystem understanding to guide marine conservation practice. Our objective is to expose students and other readers to the broad range of overlapping issues ([Chapter 2](#)) in the context of present conservation mechanisms that have been devised to achieve marine conservation goals ([Chapter 3](#)). Achieving these goals depends on understanding basic marine ecosystem science ([Chapter 4](#)) and the natural histories of marine organisms ([Chapter 5](#)), that is, how organisms make a living in dynamic and often stressful environments. In that process, we call attention to emergent and unexpected properties that are changing coastal and marine systems—climate change, ocean acidification, dead zones, and loss of biodiversity—that challenge the resilience of coast-ocean systems, hence also governance and human well-being. We present seven “real-world” case studies that exemplify coastal and marine conservation in action, each presenting a central issue or issues in the context of its biogeographic and social setting. Each combines theoretical (“pure”) and applied science, and each concludes with challenges to governance that are not yet fully resolved.

A final synthesis chapter looks to the future, to transition coastal and marine conservation from the *being* of traditional, fragmented, protection, and management to the *becoming* of ecosystem-based approaches, intertwined in a social-ecological system, that propel marine biodiversity and

society into the future. Overall, this book is an attempt to provide a framework for thoughtful, critical thinking in order to incite innovation in the new Anthropocene Era of the 21st century.

References, scientific terms, Latin names, and units. This book provides readers with a window into a massive literature on conservation science, policy, and management as a context for understanding the present state of knowledge of marine ecosystems, their life, and their current conservation and management. The language of science is enormous and similar terms often have different, even contradictory, meanings among disciplines. We have attempted to explain these terms by defining some of them in the text. We do not include a glossary, as definitions can be accessed in science dictionaries or through search engines on the Internet. We use the International System of Units (SI units) and metric measurements (e.g., m = meters, mt = tonnes, km = kilometers, nmi = nautical miles, etc.) throughout the text.

Species are referred to by their vernacular (“common”) names (blue crab, herring, porpoise, etc.) with Latin names for proper identification. Care must be taken with vernacular names because for the great majority of species these names are not standardized (mammals, birds, and some fishes are notable exceptions). For example, “cod” is a common name for a valuable Atlantic fish of the cod family (Gadidae), but “cod” in Australia refers to groupers of the sea bass family (Serranidae), and for some species of the Southern Ocean “cod” refers to ice fishes of the family Nototheniidae; similarly, “rockfish” may refer to a number of fishes from a half dozen families of fishes; and, the “Dover sole” of the north eastern Pacific is not the highly valued Dover sole of the eastern Atlantic. Therefore, scientific names are essential for identification, and are given with

the vernacular the first time the species is mentioned in each chapter, or if far separated.

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About the Companion Website

This book is accompanied by a companion website:

www.wiley.com/go/ray/marineconservation

The website includes:

- Powerpoints of all figures from the book for downloading
- PDFs of tables from the book

CHAPTER 1

In Pursuit of Marine Conservation

There is a tide in the affairs of men
Which, when taken at the flood, leads on to fortune ...
On such a full sea are we now afloat;
And we must take the current when it serves
Or lose our ventures.

William Shakespeare *Julius Caesar*

Open-ocean systems may seem not to be so disturbed at their surface, but signs of ecological disruption are apparent. The lone walrus on our cover is a metaphor for Planet Earth's fragmented habitats, disrupted ecosystems, and diminished biodiversity. As oceans change, tropical reefs die, polar regions lose sea ice, and marine life that we hardly know is increasingly becoming vulnerable to extinction. Nowhere is this change more apparent than in the land-sea coastal realm (Frontispiece), where the majority of humanity lives, ecosystems are most productive, and biodiversity is greatest.

During the rise of human civilizations, societies have inherited the economics of resource exploitation from an ocean perceived as “limitless.” Fisheries, shipping, and coastal settlement as old as civilization, have increasingly expanded to force conservation into defense of species and spaces. And as the ecosystems upon which species depend have changed, scientists have become increasingly involved. Modern science, which had moved from studies in natural history to environmental modeling and statistics to

better understand marine systems, is returning to natural history, recognizing that it forms the basis for environmental and evolutionary science itself ([Box 1.1](#)). The advancing state of knowledge and the increasing need for sustainable ecosystems are forcing marine conservation science to become more proactive and to expand its scope to encompass whole regional seas. Recognition of depleted fisheries, coastal catastrophes, and consequences of natural events tied to human activities have led to new ways of thinking about how marine conservation may modify society's relentless pursuit of ocean wealth.