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BOOK REVIEWS

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World Atlas of Coral Reefs. 2001. Mark D. Spalding, Corinna Ravilious, and Edmund P. Green, University of California Press, Berkeley, California. 424 pages. Web address: <http://www.ucpress.edu>. Mailing address: The University of California Press, % California/Princeton Fulfillment Services, Inc., 1445 Lower Ferry Road, Ewing, New Jersey 08618. Cloth-bound, ISBN 0-520-23255-0. US\$45.00, £29.95.

In 1988 the United Nations Environment Programme (UNEP) and the International Union for the Conservation of Nature and Natural Resources (IUCN) published a three-volume set titled *Coral Reefs of the World*. Edited by Susan Wells, these books described the status of coral reefs on a country-by-country basis. Included for each “reef-bearing” nation were discussions of fisheries and other reef-based resources, the types of disturbances and stresses impinging on the reefs, the status of protective legislation and management, recommendations for further action, and a bibliography. For example, Belize, which boasts the second largest barrier reef system in the world (after the Great Barrier Reef), received a 14-page section containing detailed treatments of established and proposed marine protected areas (MPAs).

A great deal has happened to coral reefs since 1988, and unfortunately almost none of it has been good. While there has been progress in protective legislation and in the establishment and enforcement of MPAs in the United States and elsewhere, reefs have been degrading at a rapid rate. The worldwide bleaching event of 1997–98, related to high sea temperatures from the El Niño—Southern Oscillation and possibly augmented by global warming, devastated coral populations from the Seychelles to the western Pacific to Belize. Although some coral populations are recovering rapidly, thanks to heavy larval recruitment, the prospects for reefs in general are dire because other natural and anthropogenic assaults continue unabated.

Now Mark Spalding and colleagues have given us their *World Atlas of Coral Reefs*. This beautiful volume, prepared under the auspices of UNEP’s World Conservation Monitoring Centre, is a worthy successor to *Coral Reefs of the World*, although it is an atlas and not a *treatise*,

as the title states. Introductory chapters in Part I discuss what coral reefs are and the different types of reefs (Chapter 1); why reefs are important to us, the threats they face, and what is being done about it (Chapter 2); and how reefs are mapped (Chapter 3). We learn that the total area occupied by coral reefs around the world is approximately 284,000 km² or only about 1% of the area of continental shelf in the global ocean. About 60% of these reefs are under threat worldwide, and reefs of the Caribbean basin follow this global average almost exactly. Similar statistics can be found in Clive Wilkinson’s *Status of Coral Reefs of the World: 2000*, published by the Australian Institute of Marine Science.

The rest of the book’s parts and their constituent chapters are grouped hierarchically by region, with the chapters containing sections on individual countries or reef systems. Each section has a full-page color map, a photograph from the Space Shuttle, and tables of data. There is a table containing general statistics about the economy and human population of each country as well as information on the nation’s reef resources. Another table in each section lists protected reef areas and their sizes. There are also lovely underwater photographs in these sections, although many of them appear to be for decorative or generally didactic purposes rather than to make specific points about the localities under discussion.

The text in each section is necessarily shorter than the corresponding discussion in Wells’ three-volume set. The section on Belize, for example, is only four pages long, including a photograph of a tourist strolling across an intertidal seagrass flat, an underwater shot of a sponge, the full-page map, and the image from space. This leaves little room to discuss the complexities of reef dynamics in Belize, but then again that is not the purpose of this book. The tabular material tells us that the areas listed in 1988 as planned MPAs are now protected, which is heartening.

Of more parochial interest to readers of *Gulf of Mexico Science*, the Flower Garden Banks receive about as much coverage as the entire Florida Reef Tract. Again there is not much verbal description accompanying the maps and tables. Inevitably, the subtleties are lost in geographic treatments of this sort, but the main point comes through in unemotional language and blazing color: reefs are in peril and with

them the large proportion of the world's human population that is dependent on those reefs for survival.

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Oceanographic Processes of Coral Reefs: Physical and Biological Links in the Great Barrier Reef. 2000. Eric Wolanski (editor), CRC Press, Boca Raton, Florida. 356 pages. Web address: www.crcpress.com. E-mail orders: orders@crcpress.com. Mailing address: CRC Press, 2000 N.W. Corporate Boulevard, Boca Raton, Florida 33431-9868. Hardcover, acid-free paper, ISBN 0-8493-0833-X, US\$99.95, £66.99, CD-ROM included.

Marine ecologists are increasingly turning to oceanography in their efforts to understand the structure and function of benthic systems. Coral reef ecology, in particular, has reached the point at which community-level studies are falling short in their explanatory power. The most obvious area of oceanographic interest is larval supply: are coral and fish populations self-renewing or are juveniles supplied from upstream sources? At which oceanographic scales is the larval supply enhanced and at which scales is it reduced? Is the plankton really a larval soup of unpredictable composition at the scale of the reef? A good example is near and dear to those of us working in the Gulf of Mexico: what is the source and the transportation of the planula larvae that grow into coral colonies on the Flower Garden Banks? As another example, solitons, or internal waves, could be the primary source of cold, nutrient-laden water to Florida's reefs, further complicating the acrimonious debate over top-down vs bottom-up control of community structure. Circulation patterns and other physical phenomena have interest beyond the merely academic, however; the design of marine protected areas and their ultimate success depend on understanding how benthic–pelagic coupling determines the population densities of target reef species under different circumstances.

Wolanski's edited volume is about the nexus of physics and biology on the Great Barrier Reef (GBR). Given that the policy decisions affecting the GBR are currently based primarily on economic cost–benefit analyses of a rather shortsighted nature (Baker, Chapter 1), the point of the book is “to demonstrate the relevance of science, and the need for science in

planning the future of the GBR” (Wolanski, Chapter 2). The book aims at promoting the oceanographic approach that has until now been underappreciated.

Chapters 3 through 11 are devoted to the influence of coastal processes, specifically the detrimental effects of increased runoff caused by the clearing of native vegetation. Chapters 5 (Wolanski et al.) and 6 (Duke and Wolanski) deal with the increased turbidity and other effects that result from the removal of mangroves in “land reclamation” projects. Removing mangroves will wreck a variety of ecosystems, including coral reefs, to the detriment of mangrove-associated commercial fisheries. Chapter 9 (Fabricius and De'ath) examines the effects of turbidity on the diversity of soft corals. Chapter 7 (Fortes) reviews how increased sedimentation affects seagrasses, mangroves, and coral reefs, and Chapter 11 (Capo and Kelley) is about the connectivity of ecosystems from the shore across the shelf and into the open ocean.

Increased runoff is not the only perturbation affecting coral reefs. Chapter 8 (McCook et al.) explores the interaction of nutrient loading with disturbances such as cyclones and outbreaks of the crown-of-thorns starfish. Among other conclusions, this modeling exercise drives home the point that coral mortality is a key requirement for increased algal cover under eutrophic conditions.

The remaining chapters cover topics ranging from how physical oceanography affects the distribution of larval fish (Carleton et al., Chapter 13) to the projected effects of climate change (Lough, Chapter 17). There are also chapters on fisheries as they relate to physical processes. Arranging the chapters by subject into sections would have made the book a bit more cohesive, but this is a very minor criticism.

Chapter 19 (Dutton et al.) uses the environmental mess in Indonesia as a cautionary tale of what should not be done on the GBR. Chapter 20 (Talbot) concludes the book with a warning of what could happen to the GBR if it is not handled with care. These last two chapters have important things to say about the threats to and management of coral reefs. They are based more on common sense and a basic knowledge of natural science than on the novel and intricate oceanographic insights developed in the foregoing chapters.

A CD-ROM packaged with the book contains all the figures. This means that the reader must be at a computer to access the figures, which

are indexed by “thumbnail” reproductions at the end of each chapter. The inconvenience of not having printed figures is far outweighed by the huge savings in space and cost for color illustrations and by the additional advantage that animations of many of the physical processes are included.

Oceanographic Processes of Coral Reefs should remind us that physical oceanography and reef ecology are intimately connected in the Caribbean as well. The Caribbean is approximately the same size as the GBR, making the world’s second largest barrier reef, in Belize, far smaller. Reef habitats in Belize are closer to shore and are exposed to terrestrial influences to an even greater degree than are the analogous habitats on the GBR. Citrus and shrimp farming are ever-increasing threats to the Belizean Barrier Reef, and the rivers of Belize have become muddier over the past two decades. The issues are bound to be similar to those raised for the GBR in this book. Perhaps it is naive to hope, as Wolanski does, that this technical volume will introduce sound science into the political arena, but it certainly would be nice if rational thought prevailed over profiteering once in a while.

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The Everglades, Florida Bay, and Coral Reefs of the Florida Keys: An Ecosystem Sourcebook. 2002. James W. Porter and Karen G. Porter (editors), CRC Press, Boca Raton, Florida. 1,000 p. Web address: www.crcpress.com. E-mail orders: orders@crcpress.com. Mailing address: CRC Press, 2000 N.W. Corporate Boulevard, Boca Raton, Florida 33431-9868. Hardcover, acid-free paper, ISBN 0-8493-2026-7. US\$199.95.

The Everglades, Florida Bay, and the Florida Reef Tract are the most important aquatic ecosystems in Florida. This edited volume, the outgrowth of a symposium held in 1999, is about their interconnections. Many scientists and managers in Florida blame the degradation of coral reefs in the Florida Keys on poor-quality water flowing out of the Bay (and possibly from Florida’s west coast) onto the Reef Tract; problems in the Bay are generally blamed on water management in the Everglades and its watershed; and of course the ultimate causes of water diversion, pollution, and nutrient loading are human activities on land. This book takes

a position at the outset: water quality is the single most important cause of environmental degradation in the Everglades, in Florida Bay, and on the reefs of the Florida Keys.

There is solid science to back up portions of this thesis. Chapter 8 (DeAngelis et al.) is a modeling study of the Everglades that evaluates the implications of proposed restoration plans for key elements of the biota, Chapter 11 (Lee et al.) reviews the physical oceanography of the coastal ecosystems of South Florida, and Chapter 14 (Nelsen et al.) presents data from sediment cores demonstrating the input of terrigenous materials to Florida’s coastal ecosystems. These are just three examples of what is good and valuable about this book; there are many other excellent papers on topics ranging from recent changes in seagrass distribution to remote sensing of algal blooms to the potential impact of the Everglades on the accumulation of greenhouse gases. In the chapters on coral reefs, however, the tone often becomes one of advocacy rather than of balanced presentation.

Water quality explains some important things about the Florida Reef Tract. In geological terms, reef development is greater seaward of the Keys than seaward of the tidal passes between them. The reason is that the Keys blocked seaward reefs from inimical waters flowing out of the Bay when the Florida Platform was last flooded, beginning about 6,000 yr ago in the Holocene Transgression. One would expect an analogous effect today: coral assemblages should be healthier where the Keys block the flow from Florida Bay. In reality, essentially all reef communities of the Keys—even those blocked from Florida Bay—are in decline, a point driven home in Chapter 29 (Tougas and Porter) on coral recruitment. Using data on the growth rates and physiological functions of experimentally transplanted corals, Cook et al. show in Chapter 28 that nutrient effects did not, in fact, differ with exposure to Florida Bay water. The association between exposure to Bay water and aspergillosis, a fungal disease of sea fans, was likewise equivocal (Chapter 30, Kim and Harvell).

Perhaps all reef areas of the Keys, not just those seaward of the tidal passes, are being exposed to poor-quality water. This possibility is raised in Chapter 22, in which Boyer and Jones present data showing that the nutrient levels are not appreciably lower seaward of islands than offshore of passes. Chapters 25 and 26 point to nutrient delivery via groundwater flow, which would obviate the protection afforded by islands against runoff.

Despite the rigorous scientific work de-

scribed in some of the chapters, hard evidence linking nutrient loading to reef degradation remains elusive. This, unfortunately, is the point at which the book's scientific value gets watered down, so to speak. Assertions in Chapter 23 (Lapointe et al.) to the contrary, an association in time between increased nutrient input and the various ills of Florida's reefs does not prove that there is a causal connection.

Chapter 27 (Porter et al.) reports the results of a reef-monitoring program throughout the Keys, which ran from 1996 to 2000 and encompassed 160 stations. Despite the large data set, it is difficult to interpret claims that coral cover and species richness declined at a large percentage of the stations. Coral cover exhibited "no significant change" at a slim majority of the stations, and almost as many stations showed a "significant decrease" in cover. The problem is that the stations were established in groups of four per site, and many reefs had four shallow and four deep stations. With this design, calculating the percentage of stations with declining coral cover constitutes pseudo-replication at the hierarchical level of the Reef Tract. This problem aside, there is not enough information given on the statistical analysis to enable the reader to determine whether (1) coral cover changed significantly overall, or (2) any interactions between factors were significant.

Furthermore, the area of each station, 44 m², was too small to evaluate accurately the species richness of corals. Rarefaction analysis by other investigators has shown that an area encompassing all four stations in a set would be required for the relationship between species richness and area surveyed to reach its asymptote. This means that monitoring larger areas could have shown that most species are found in most areas, with little change from year to year. In the list of conclusions, therefore, "A significant loss of coral species occurred in the Florida Keys National Marine Sanctuary," does not follow from the fact that "between 1996 and 2000, 67% of 160 stations lost [coral] species." The confusion of hierarchical levels in Chapter 27 makes it impossible to tell if we should be especially alarmed or not.

The final section, tenuously connected to the rest of the book, is about the reef system at Negril, on the west coast of Jamaica. According to Jim Porter's introductory chapter "... this section puts to rest an academic debate

about whether nutrient enrichment or sea urchin dieoff [i.e., declining herbivory] has caused coral reef decline in this area of Jamaica: while sea urchin dieoff may be a proximate cause, nutrient addition is the ultimate cause." In reality, the two chapters on Negril do not end the argument at all. There is an enormous body of work demonstrating the importance of declining herbivory in mediating the transition from coral to macroalgal dominance on reefs worldwide, including areas with little or no nutrient input. Population densities of sea urchins are now increasing along the north coast of Jamaica, causing macroalgae to decline and coral recruitment and cover to increase in fore-reef environments. This return to an earlier community composition is occurring despite the supposedly continuing or increasing delivery of nutrients to those fore-reef habitats. Chapter 34 (Porter et al.) is actually quite realistic in providing circumstantial evidence for both bottom-up effects of nutrients and top-down effects of herbivory.

All arguments aside, it would be silly to deny the potential impact of deteriorating water quality on the function of Florida's coral reefs. It is equally clear, however, that even though water quality is a relatively tractable problem, it is not the only problem. Some chapters emphasize the need for a balanced view of multiple causes at multiple scales, but alternative and complementary views receive short shrift in the treatment of coral reefs. Nutrients and herbivory may both be involved in macroalgal dominance on some reefs, but the real "ultimate cause" may be the large quantities of space opened for algal recruitment by regional-scale sources of coral mortality such as disease.

Although some of the chapters blur the distinction between fact and opinion, portions of this volume will be a valuable resource for scientists, managers, and policymakers. Regardless of the outcome of the debate over water quality as it affects Florida's reefs, the degradation of aquatic ecosystems in general is ultimately the result of an expanding human population. The emerging picture, therefore, is rather bleak. One must certainly agree with the editors and authors that now is the time to address water quality and other anthropogenic insults to the environment.

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