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ADEY, W. H., AND K. LOVELAND. 1998. **Dynamic aquaria. Building living ecosystems.** Second edition. Academic Press, San Diego. xx + 498 p. $49.95. ISBN 0-12-043792-9.

Living ecosystem models are widely used in marine ecology studies in northern European countries: Dutch, Norwegian, Danish, British, and French facilities have been or are presently used to study pollution, plankton, and fisheries. In contrast, North American marine researchers make little use of this technique, perhaps because of the perceived failure of the NSF-supported CEPEX project (Controlled Ecosystem Pollution Experiments, or in the last phase, Controlled Ecosystem Population Experiments) in the early 1980s. With one or two exceptions (e.g., the Center for Estuarine and Environmental Studies at Horn Point), use of most surviving or new systems has declined (e.g., MERL—the Marine Ecosystem Research Laboratory at the University of Rhode Island) or they are notably less ambitious (The Academy of Natural Sciences, The South Florida Water Management District). On the other hand, experimental ecosystems are widely used in limnological studies in North America. My guess is that the many incisive experiments done at the Experimental Lakes Area in Canada put microcosm and mesocosm studies in a better light than the marine efforts. For example, ELA experiments demonstrated unequivocally that phosphorus was the key to controlling north temperate freshwater eutrophication problems, and this work led directly to the removal of phosphorus from detergents. Contributing to this success was the fact that an abundance of small streams and lakes permitted a variety of experimental designs to be realistically calibrated.

Although living marine ecosystem models are little used in marine research, they are widely used for display purposes. Examples in this book include models of coral reefs, the Maine coast, Chesapeake Bay, the Florida Everglades, a blackwater pool, and an African pond. Like their research counterparts, these display systems demonstrate the ubiquity of ecological self-organization: if the physics deviate from the wild systems, so will the model systems. This presents a wonderful opportunity to study ecosystem behavior as a function of changing physical conditions experimentally.

A great deal of attention to detail and knowledge is required to make a model ecosystem faithfully represent its wild counterpart. A significant part of the book deals with how to set up and maintain physical and biochemical environments and the biological structure. For example, the most difficult ecosystems to model are coral reefs; the book explains the principles of gas exchange, oxygen, carbon dioxide, pH, alkalinity, and coral calcification that are required to successfully maintain corals. The approach outlined here is fundamentally different from what would be done in a research context. In particular, the authors maintain that model ecosystems must be artificially fed to sustain high biomass, and excessive wastes must be removed with algal scrubbers (this is apparently the key to success). In a coral reef microcosm, if 1 g of dried shrimp is fed to the ecosystem, then more than 1 g of dry algae and other organics must be removed. Allied procedures include sterilization, bacteriological filtration, enhanced denitrification, and foam fractionation. This chapter leads naturally into the use of controlled ecosystems to remove nutrients from domestic, agricultural, and aquaculture waste waters and to ameliorate industrial waste water using algal turf scrubbers. Professional and hobby aquarists, as well as those involved with environmental remediation and restoration, will find all of this information invaluable.

The model ecosystems of most interest to the public are shallow water benthic systems (coral and rocky reefs, emergent marshes, mangroves, and swamps). The recipe for establishing these communities includes consideration of imports and exports at boundaries, developing lists of species and their relative abundances for the wild counterparts being modeled, creating the correct physical or living structures, transferring ecosystem components in blocks, repeating injections of components, introducing small fauna, tentatively adding large fauna, and then watching and culling, as necessary. When species in the model change in the wrong direction, the authors suggest how the system might be modified or state why the model should be accepted the way it is. In general, model ecosystems contain fewer species than wild ones; they also often act as a refuge for rare species. Interestingly, parasites and pathogens are often more of a problem with freshwater than saltwater models.

This book will be useful to anyone interested in creating marine, estuarine, or freshwater model ecosystems. The presentation is excellent, including many detailed, high-quality figures. Although it is a little distracting to be constantly reminded that humans are destroying the earth, it is understandable that building living models sensitizes one to how easily things can go awry. The authors (and we!) should take heart from the fact that they have never had a model ecosystem totally collapse.

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