

and if he is an ecologist he will probably find the approach somewhat stereotyped and a little old-fashioned. For example, the chapter on the macrobenthos of rocky shores has no reference to the experimental approach to community dynamics represented by R. T. Paine and his students, and the plankton chapter has no reference to the extensive Russian work in the Black Sea on productivity and energetics of zooplankton. The emphasis throughout is on description of communities and description of their distribution.

Within these limitations, the author has done a creditable job of summarizing the literature. The references are at the ends of chapters and many occur more than once but in aggregate there are nearly 2,500 (with a bias toward British sources). Spot checks revealed the occasional unfamiliar reference in an otherwise familiar field, and one Dalhousie student has already found that a few Xeroxed pages together with the relevant references gave him a good start on an essay. There are few references later than 1970. One could have wished for a better subject index—it is only two-thirds of the length of the systematic index. Considering the readership toward which it is directed, the chapter on management (7 p.) is thin and trivial, consisting chiefly of a series of rhetorical questions about whether it is necessary to despoil the coastal environment.

On the whole, a useful reference work with a rather misleading title.

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MIDDLEBROOKS, E. J., D. H. FALKENBERG, AND T. E. MALONEY [EDS.]. 1973. **Modeling the eutrophication process**. Ann Arbor Science. 228 p.

Few words in recent aquatic literature can arouse greater misunderstanding and polarity than can "modeling," unless we include in that number "eutrophication" and its consequences. This book blends both potential firebrands in its title, but no hint of controversy emerges from its pages. Composed of papers contributed during an EPA-sponsored convention at Utah State University in 1973, the book addresses eutrophication with the collected energy of authors convinced that they will eventually model the process with great success. If any discord is sought, it can be found only in the diverse paths taken by the authors as they try to realize their goal. Individual papers address topics from gas diffusion to population dynamics to whole ecosystem behavior, seemingly connected only by their potential applicability to management of aquatic environments, and by a kinship fostered through the ubiquitous model.

The aquatic models proposed by the various authors fall into two main categories. Most of those that can be segregated under the rubric of ecosystem dynamics attempt to trace the fate of particular substances, usually phosphorus, by calculating mass budgets, partition coefficients, and exchange rates between free and bound phases. These models deal largely with physical processes alone, or with crudely aggregated physical and biological processes, but they offer a guide for management decisions based on the identification of controllable nutrient sources and their evaluation in terms of a total nutrient budget. These models try to predict new steady states resulting from particular input reductions, and they often include estimated recovery rates as well. Most are, on the other hand, tied to the assumption that water quality is best assessed from the distribution or flux of particular compounds, and they are restricted by their generality from predicting details of community dynamics. Some are furthermore tailored to individual watersheds and not easily adapted to different circumstances.

The second mode of approach is a more mechanistic one, an attempt to describe what happens in a system consisting of algal cells and dissolved nutrients that is subjected to particular physicochemical regimes. Although specific rationales are discussed in only a few papers, these mechanistic models all have their bases in physiological studies of nutrient kinetics and cell division, most of which have used cells at or near steady state conditions. Because kinetics of response in nonsteady states are largely unknown, the authors can only extrapolate from steady state kinetics as they try to predict natural events. Some very detailed models are produced by these means, with attendant proliferation of (hopefully) measurable parameters vital to their implementation.

The most elaborate aquatic model described in the book, that produced by the IBP-Eastern Deciduous Forest Biome, lists almost 200 individual variables, most of them subscripted so that the count could potentially extend into the thousands. Numerical values for the variables are wholly neglected in the paper, although the model is implemented and some rudimentary results are shown. Rather, the authors point out that the model is "tuned" or "calibrated" by varying the parameters within particular undescribed ranges to obtain the best fit to observed data. They further maintain that the model "embodies much of the 'state of the art' of modeling in the Biome."

Sometimes the simplest models seem most useful for evaluating natural conditions because the authors spend proportionately less time describing equations and computer algorithms than they devote to sounding strengths and weaknesses of the models, or investigating discrepancies between model predictions and actual events. Many of the papers end before the authors have discussed any but the most preliminary predictions of their models. Most of their space is apportioned to de-

scription and to discussion of the general utility of modeling per se, rather than to the rationales for particular choices, or to any rewards already realized from modeling efforts. Only a small number of authors succeed both in describing and documenting their models and in using them for provocative simulations. The paper by Bierman and coworkers, one of these refreshing few, evinces a thoughtful regard for the utility of models in evaluating and dissecting such complex matters as species dynamics and competition in lakes.

The book falls far short of realizing its ambitious title, as most of the authors present little or no evidence that their models can serve profitably as predictive tools or as reliable means of making corrective judgments in actual cases of eutrophication. Some of the failure must be blamed on our inadequate knowledge of eutrophication processes in general, an obstacle no model alone can overcome, but some is probably due to inadequate communication among ecologists, physiologists, and system modelers. Such oversights stem from the fact that the book focuses for the most part on model building rather than on the practical or theoretical insights gained from models. A reader drawn by the topic of eutrophication is likely to be disenchanted with the book as a whole, but students of models will find that the papers can be weighed on their individual merits, for each represents a separate background and philosophy. Most

of the papers are direct results of EPA and IBP resources and personnel, and, as such, reflect the diversity and competence in aquatic system modeling attained by these groups at the time of the conference. The papers printed are noteworthy as some of the few accessible sources to a modeling literature otherwise available only through internal circulars and memo reports. In one paper, 24 of 31 literature citations refer to such limited distribution items.

The book is most profitably regarded as a compendium of hypotheses about aquatic ecosystems whose compound predictions still await demonstration and testing; it is the effort of an embryonic science that desperately wishes to become predictive. Some of the models have been or will be abandoned as their limitations are assessed. The fate of most, however, is to be modified, absorbed, or otherwise adapted under new schemes and into new models. Whether any model opens new vistas is bound to depend on the insights sought in its predictions. The criticism cannot be applied uniformly to all papers in this volume, but in most any such analysis is lacking.

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