

We do not yet have a broad empirical basis for predicting how nutrient reductions will lead to restoration, but estimates here suggest that recovery of oxygen concentration (Richardson) and eelgrass beds (Borum) may take decades after actions are taken to reduce nutrient loadings to Danish coastal waters. However, these estimates have large uncertainty because "the science of 'recovery biology' (i.e. how a system responds to a reduction in eutrophication) is not yet well established" (Richardson). This is perhaps the most important practical lesson for how we apply scientific understanding to protect coastal waters from the harmful consequences of enrichment. Our inability to predict the patterns of recovery is one consequence of a complex scientific discipline that is early in its development.

Although the title of this book suggests a general treatise, virtually all the results and lessons are from studies of Danish coastal waters. Efforts to integrate and compare results from other coastal ecosystems are limited, so it is difficult for readers to appreciate the global significance of the specific results presented here. For example, the editors could have included more comparison with results from Chesapeake Bay, another large coastal system that is strongly stratified in summer, enriched with N and P, and exhibits multiple symptoms of degradation. Smith et al. (1992) published a remarkably similar volume that described the physical, biogeochemical, and ecological aspects of eutrophication in Chesapeake Bay. Interested readers should compare these books to explore similarities and differences in the way in which eutrophication is expressed in these two well-studied, high-visibility coastal systems.

A general text would use results from other ecosystems to explore additional questions. For example, not all nutrient-rich coastal waters show clear symptoms of environmental degradation. How do physical processes constrain the expression of eutrophication? (Mombet [1992] offers one intriguing hypothesis.) How do top-down processes regulate the expression of eutrophication, especially in shallow marine waters where there is tight coupling between the production and consumption of phytoplankton biomass by benthic suspension-feeders? How do changes caused by nutrient enrichment interact with other human stressors, such as input of toxic contaminants or exotic species? Which combinations of forces promote blooms of harmful algal species? How does eutrophication affect fish recruitment? Answers to these complex questions will emerge as the science matures and moves from regional assessments to integrative, comparative analyses—the next step toward a global conceptual model of marine eutrophication.

I recommend this book for anyone interested in coastal oceanography or ecology. Some chapters are excellent references for graduate-level instruction, and comparison with the parallel chapters in Smith et al. (1992) could be an effective teaching approach. Do not expect (as the title implies) a general treatise on this subject. Rather, this volume gives a comprehensive analysis of the problem from the perspective of Danish scientists who provide a model of how to do regional assessments of coastal eutrophication.

James E. Cloern

U.S. Geological Survey  
Menlo Park, California 94025

#### References

- MONBET, Y. 1992. Control of phytoplankton biomass in estuaries. A comparative analysis of microtidal and macrotidal estuaries. *Estuaries* **15**: 563–571.
- NIXON, S. W. 1995. Coastal marine eutrophication: A definition, social causes, and future concerns. *Ophelia* **41**: 199–219.
- SMITH, D. E., M. LEFFLER, AND G. MACKIERNAN. 1992. Oxygen dynamics in the Chesapeake Bay. A synthesis of research. Maryland Sea Grant College, College Park, Maryland.
- SAND-JENSEN, K., AND O. PEDERSEN [EDS.]. 1997. **Freshwater biology, priorities and development in Danish research.** G. E. C. Gad, Copenhagen. ISBN 87-12-03135-6. 254 p.
- Danish limnologists have written a book marking the 100th anniversary of the Danish Freshwater Biological Laboratory (FBL). The first chapters (Sand-Jensen and Dall) recount the founding of the FBL by Carl Wesenberg-Lund on the shores of Lake Fure, near Copenhagen, in May 1897. Wesenberg-Lund, who is known as an early authority on planktonic invertebrates and for his studies of cyclomorphosis, was the force and inspiration behind the founding of Danish limnology. His comprehensive study of Lake Fure shows his commitment to the study of lakes as ecosystems, with full attention to the combination of physical, chemical, and biotic components in a manner reminiscent of Forel and Forbes. Wesenberg-Lund also directed Danish limnology toward comparative studies similar to those beginning concurrently in Wisconsin, and he broadened the base of limnology by enticing physical scientists to assist in developing ways of studying lake sediments. Danish limnology thus was blessed very early with a commitment to holism.
- The FBL was moved in 1911 to Hillerod near Frederiksborg Castle Lake, where it remained small but active through the 1950s. In the 1960s, the FBL expanded at a fast pace, culminating in an equilibrium scientific staff of 10 and a technical staff of 14, as well as an expansion of facilities and programmatic extension into streams and brackish waters.
- The introductory chapters of *Freshwater Biology* are followed by two chapters that describe and analyze 100-year records of change in the trophic state of Lake Fure (Sand-Jensen) and in the profundal fauna of Lake Esrom (Lindegaard et al.). Given that such extended records are exceedingly rare, these chapters are really quite interesting, and the authors have provided some provocative interpretation as well.
- The final nine chapters deal with topics that are currently of special interest at the FBL. These include community ecology of macrophytes, coastal eutrophication, modelling, bacteria and dissolved organic carbon in lakes, zooplankton studies, metabolic studies of benthos, water transport by aquatic plants, and the dependence of stream macroinvertebrates on riparian forest cover. All of these chapters are well written and have general appeal. Many are enriched by years or even decades of research. The chapters are not focused exclusively on Danish waters, but have more the flavor of review papers with special emphasis on Danish work by way of example. Many of the papers would stand alone as definitive reviews of their subjects, and the book as a whole makes a good foundation for a graduate seminar or supplementary reading for a limnology course.
- Freshwater Biology* reveals some characteristic features of Danish limnology. First is a commitment to understanding the distribution and diversity of organisms. The FBL can still claim the competence to deal with the systematics and life history of many of the groups of organisms that are important to aquatic ecosystems; this capability is much eroded elsewhere. Danish limnology also has a constant element of physiological ecology that can be traced back to Berg and Krogh. The limnological potential here is well illustrated by chapter 11 (Hamburger et al.), which explains how the mechanisms of oxygen distribution, time course of oxygen depletion, and interspecific variation in tolerance to oxygen depletion interact in determining the composition and distribution of the benthic fauna in lakes. Another thread is the study of sediments and sediment-water interactions. Zooplankton studies, which began with Wesenberg-Lund, are prominent, as shown in a chapter by Christoffersen and Bosselmann. Macrophytes also figure very im-

portantly in Danish limnology, possibly because the lakes of Denmark are small and usually shallow.

The FBL might be a useful model for national programs in limnological research. The first element of the model seems to be reliable financial support, at least as judged from the constancy of full-time personnel at the FBL. Also, the FBL has shown evolutionary rather than catastrophic programmatic change, and the result is much beneficial continuity over time. There seems to be a well-established connection between the trainees of the laboratory and governmental technical posts that deal with limnological subjects. If so, this is a marked contrast with the United States, where limnological tasks in government often are performed by individuals whose main expertise lies elsewhere. A final point concerns the organizational philosophy of the FBL, which appears to work through the scientific motivations of independent investigators rather than through a master plan with fixed component directed from above.

Denmark is a nation of only 5 million persons. If the United States were to follow the Danish model with linear scaling to population, it would have some 60 limnological centers staffed by 600 research limnologists, all of whom might spend more time solving limnological problems and less time writing proposals than the present ones do. This seems improbable in the short term, but it is food for thought.

*Freshwater Biology* concisely satisfies one's curiosity about Danish limnology, and is also an excellent general reference work. There is one unanswered question: Why does *limnology* appear only inside the book and not on the cover?

William M. Lewis, Jr.

University of Colorado  
Center for Limnology, CB 216  
Cooperative Institute for Research in  
Environmental Sciences  
Boulder, Colorado 80309-0216

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HAUER, R., AND G. LAMBERTI [EDS.]. 1996. **Methods in stream ecology**. Academic Press, San Diego. ISBN 0-12-332905. 674 p.

The stated intent of this book is a compilation of techniques and exercises useful in a wide array of teaching and research in stream ecosystems. Chapter topics range from stream geomorphology to fish competition. Each chapter includes a brief introduction to the topic, followed by a discussion of general approaches, the important questions, and then one or more detailed exercises. The common structure of chapters (Introduction, General Design, Specific Exercises, Review Questions, and Material Lists) adds greatly to the overall coherence and utility. The cross-referencing among chapters is generally good and the overall structure (physical, organismal, community, ecosystem) is quite logical. Most chapters include some discussion of statistical analyses of data and sampling design, which are too frequently ignored. Fortunately, a few chapters include sample datasets (e.g. "Primary Production" by T. Bott, "Macroinvertebrate Production" by A. C. Benke) that are very helpful for instruction purposes since the actual data collection process for many of the exercises is prohibitive. There are relatively few typographical errors, although two occur in equations (8.1 and 16.5).

Stream ecology encompasses many disciplines and this book has quite a broad coverage. No book can be all-inclusive but there are a few topics that are underrepresented in these exercises. Dissolved

organic carbon appears only sporadically (yet prominently in "Heterotrophic Microorganisms" by A. Ward and M. Johnson). A simple survey of stream waters, springs, riparian wetlands, and debris dams would be informative as to the sources and sinks of DOC in streams. Simple absorbance measures may often provide sufficient resolution to obviate the need for automated carbon analyzers. Second, fungi do not even appear in the index, although there are a number of easy techniques (spore collection in "bubblers," plating) that could be used to demonstrate their occurrence and distribution among habitats in streams and rivers. Nitrogen cycling and(or) limitation receives no attention, although nitrate in surface waters is recognized as a serious problem and an indicator of anthropogenic effects as well as being a limiting nutrient in many cases. Information on sampling for solutes in general is underrepresented (e.g. alkalinity is not mentioned). A range of simple exercises examining storm samples, samples above/below farmland, and subdivisions could be used to demonstrate solute inputs and potential effects on biota. Alternatively, data are readily available for nitrate concentrations in a wide range of streams (e.g. USGS Water Resources reports and National Summaries) and could be used in laboratory or classroom exercises.

The editors intend the book to be useful for both undergraduates and seasoned scientists, and the editors have largely met these goals but they are to some degree mutually exclusive. The rigor and sophistication that make this a useful research reference make it less desirable as a set of undergraduate laboratory exercises. Most of the exercises are much too technical and time-consuming to fit into one or two laboratory periods of an undergraduate course. A graduate-level or more intensive summer course can probably use approximately half the exercises. The other half of the suggested exercises would be most useful in designing the initial steps of a thesis or multi-year research project. Most of the exercises are simplified (sometimes not) versions of the authors own research interests and as such tend not to cover the full range of exercises feasible to explore any one subject, and the authors tend to underestimate the difficulty of gearing up for a technique they use every day. The level of detail provided is quite valuable when using this book as a research reference, which is clearly beneficial for graduate students in the early phases of thesis planning or starting a new research project.

In reading this book, the "large river phobia" that permeates stream ecology as a discipline is quite evident although some chapters have a more balanced view (e.g. "Transport and Storage of FPOM" by Wallace and Grubaugh). There is a need for lotic ecologists trained in approaches and techniques appropriate for all classes of running water ecosystems, and perhaps more importantly, our conceptual frameworks occasionally seem to be constrained by sampling logistics rather than fundamental differences between large and small rivers. The societal impacts and dependence on rivers are clear (e.g. Boon et al. 1992), yet we run the risk of not training the scientists required to deal with future science, management, and policy issues in these larger systems. Obviously, from a practical point of view, one cannot arrange boat transportation for a whole class of undergraduates but one can imagine a range of simple exercises (temperature, suspended sediment above/below dams, power plant effluent streams, artificial substrate incubations adjacent to channelized vs. natural shorelines) to expose students to the habitats, flora, and fauna and to desensitize their anxiety about large river systems. Just as useful and appropriate would be use of existing datasets as instructional examples. For instance, most larger rivers have relatively long-term flow and water chemistry records readily accessible from the USGS that could be used in a wide array of instructional activities. There may be historical maps that could be used to show large-scale habitat modifications, or a class could compare historical with recent faunal surveys to detect invasive species and(or) extinctions.