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KENNISH, M. J. [ED.] 2000. **Estuary restoration and maintenance: The national estuary program.** CRC Press. x + 359 p. $89.95. ISBN 0-8493-0720-1.

Estuaries are extremely valuable ecosystems both in terms of economic and ecological value. Roughly half of the world's fisheries harvest occurs in or is dependent upon estuaries, and the vast majority of the commerce of goods in the United States is transported through them. Unfortunately, estuaries are also major sites of industrial activity, and more than half of the world's population lives in the coastal zone; estuaries are also downstream of watersheds that drain most of the land mass of the world. As a result, they are among the most degraded ecosystems on earth.

In the United States, the National Estuary Program (NEP) was established in 1987. Its purpose is to identify environmentally threatened estuaries and to recommend steps to better manage and restore them. Currently 28 estuaries are part of NEP, which has been quite successful in focusing management attention on estuaries. This success is due at least in part to the structure of the program: for each site, the administrator of the Environmental Protection Agency appoints a ''management conference'' with representatives from government (local, state, and federal), business, citizen groups, and academic institutions. This group works on a continuing basis to describe the estuary's problems, develop a management strategy, and implement and monitor its effectiveness. The approach of focusing on problems perceived by the local community has engendered political support and local interest, which is all to the good. On the other hand, this is not an effective way to achieve a broad understanding of how estuaries work as ecosystems or to develop a forward-looking view of their management.

This book edited by Kennish is an attempt to produce such a synthesis. It is an excellent introduction to and overview of the NEP and should be read by anyone interested in the management or study of estuaries. Chapter one is particularly useful. It describes the legislative history of estuarine management and then goes on to summarize anthropogenic influences on estuaries, with particular emphasis on the input and fate of pollutants, loss and alteration of habitat (especially wetlands), and control of pollution fluxes from watersheds. It ends with brief presentations on the effects of modification of freshwater inputs to estuaries, the effects of shoreline development and sea level rise, the consequences of introduced species, and the status of fishery resources.

The rest of the book is devoted to case studies of four NEP sites: Long Island Sound, Delaware Bay, Galveston Bay, and San Francisco Bay. For all four, more space is devoted to the discussion of toxic substances than to any other anthropogenic influence. Toxic substances are indeed a major problem in these and many other estuaries, but this is largely the residual effect of inadequate control on pollution sources in earlier decades; for the most part, the input of new toxic substances now is only a tiny fraction of the amount from the 1970s and earlier. Removing these contaminants from estuaries should be a high priority, but this issue is largely unaddressed both in the NEP and in this book.

In fact, the largest problem faced by estuaries in the United States today is nutrient pollution, particularly nitrogen (NRC 2000). Unlike point source emissions of toxic substances to estuaries, which as noted above have declined since the 1960s and 1970s, the flux of nitrogen has increased, particularly from non–point sources, which are now the dominant source to most coastal waters (Howarth et al. 1996; NRC 2000). This has led to increased eutrophication, larger volumes of anoxic and hypoxic waters, loss of seagrass beds, increased frequency and duration of harmful algal blooms, and loss of biotic diversity. A recent assessment of eutrophication in 138 estuaries in the United States concluded that 60% of the estuaries in the continental states are moderately to severely degraded from nutrient pollution (Bricker et al. 1999).

Nitrogen pollution is mentioned as a problem in all four of the case studies in this book, but is highlighted as a major problem only for Long Island Sound. The assessment of nitrogen inputs from non–point sources is completely lacking from the case studies for Delaware Bay and San Francisco Bays. Estimates for non–point sources of nitrogen into Long Island Sound and Galveston Bay are given, but as is typical of the NEP, different methodologies are used in the two systems, and these are poorly documented and largely unverified (NRC 2000), leading to confusion over management options. For example, in Long Island the book reports that 60% of nitrogen loading from land comes from anthropogenic sources and 40% from natural sources; the anthropogenic sources are overwhelmingly dominated by sewage in this view, with non–point sources from atmospheric deposition and agriculture contributing less than 10% of the total. This ''natural'' flux corresponds to an export of 920 kg N km^{-2} yr^{-1} from the watershed. The recent report of the National Academy of Sciences committee on causes and management of coastal eutrophication (NRC 2000) singles out this analysis for comment, stating that it must be in error and noting that the supposed ''natural'' flux ''is a high value, not seen anywhere on Earth in undisturbed landscape of the temperate zone. . . .'' The likely error is that the contribution of nitrogen deposition (with the nitrogen originating from fossil fuel combustion) onto the landscape with subsequent export to Long Island Sound was severely underestimated for the Long Island Sound NEP (NRC 2000). Some 90% of the ''natural'' flux is probably actually due to this atmospheric deposition. That is, in contrast to the case study reported in this book, it seems likely that 95% of the nitrogen inputs to Long Island Sound come from human-controlled sources, with sewage contributing two-thirds of this amount and atmospheric deposition contributing one-third.

Despite a large non–point source input of nitrogen to Long Island Sound, sewage is the dominant source. This is not true of most estuaries, where contributions from runoff from agricultural fields, wastes from animal feedlots, and atmospheric deposition usually dominate (Howarth et al. 1996; NRC 2000). The relative contribution from these sources varies from site to site and from region to region, and as demonstrated by the treatment in this book, the tools available to managers to assess sources are often poorly developed. Comparative analyses of inputs across systems are rapidly leading to new insights on sources of nutrient pollution (NRC 2000).

The future challenge to the NEP is to build on their success in developing local interest and connectivity to develop a true national program that can develop effective forward-looking management strategies. Such a program must be comparative in nature.

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