ly discussed (p. 300). In the N.E. Pacific, the role of El Niño gets little more than a mention.

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Environment and Aquaculture in Developing Countries, R.S.V. Pullin, H. Rosenthal, and J.L. Maclean, 1993. International Center for Living Aquatic Resources Management, Manila, and Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, Eschborn, Federal Republic of Germany, 359p., ISBN 971-8709-05-3.

By the mid-1970's it became apparent that world capture fishery production would peak somewhere near 100 million tons annually, while it was also apparent that demand would continue to increase in response to exponential growth of the human population. Aquaculture, the controlled rearing of aquatic organisms, was seen as the solution to meeting an increasing demand for seafood in the face of a stable or diminishing contribution from capture fisheries. Rosy projections for aquaculture expansion were heard through the 1970's and well into the 1980's. Aquaculture was generally viewed as being environmentally benign. That view is no longer widely held.

Criticism of aquaculture in the United States began to develop perhaps a decade ago, and for at least a few years was largely ignored by the aquaculture community, but not by regulatory agencies. As stringent effluent controls began to be implemented in various states, and as the federal government actually reduced the number of drugs and chemicals approved for use in conjunction with aquatic food animal production, U.S. aquaculture expansion became increasingly constrained. Those constraints were accompanied by growing criticisms concerning potential problems resulting from the use of exotic species, the release of antibiotics into the natural environment, and the potential alteration of natural genetic diversity as a result of the interbreeding of hatchery and wild fish, to name but a few. At the same time it was becoming increasingly apparent that even without regulation, appropriate sites for aquaculture in the United States were becoming increasingly difficult to find, due to competition for space and water. In the meantime, aquaculture continued to expand at a phenomenal rate in the developing countries of the world where there were few, if any regulations.

If asked, it is unlikely that many aquaculturists would have predicted anything but continued expansion of the industry in developing countries; that is, until now. *Environment and Aquaculture in Developing Countries* is the product of an international conference at which environmental issues associated with aquaculture in the developing world were scrutinized in great detail. All of the issues that aquaculturists in the developed nations of the world have been struggling with, along with some additional ones, are detailed in this volume and recommendations are provided for dealing with each of them.

The book encompasses both freshwater and marine aquaculture and looks not only at environmental issues but also at the socioeconomic framework in which aquaculture is conducted in the developing world. In depth treatments by renowned authorities are provided, which have regional (Africa, Asia, Latin America) and topical (*e.g.*, use of wastewater, conservation of genetic diversity, disease transmission, effects of harmful algal blooms), and even organism-specific (Latin American shrimp culture) foci. Each of the papers in the conference proceedings provides a good deal of background information and is well documented with literature citations. Many of them contain compilations of data in tabular form or in figures. The book pulls together a considerable amount of demographic and production information that may not be otherwise readily available to scientists, policymakers, or aquaculture practitioners.

At the end of most of the papers in the volume is a transcript of the discussion that was held during the conference. By reading the discussions, one can develop an appreciation for the dilemmas surrounding some aquacultural practices. For example, organic fertilizers have been widely employed in conjunction with finfish culture in developing nations. Animal manure and nightsoil are often used as fertilizers. Such nutrient sources may also transmit pathogens that become resident in the cultured fish and pose a health threat to those who handle and eat those fish. A logical solution is to employ only treated sewage effluent in aquaculture, but the cost of doing so is often prohibitive. Problems associated with high levels of trace metals, biocides, and other contaminants in wastewater are another topic that is discussed.

Many of the recommendations made involve the implementation of stricter controls on aquaculture development. Unrestricted construction of ponds in mangrove communities, the uncontrolled use of treatment chemicals, and previously mentioned widespread use of untreated sewage effluent could be regulated by governmental agencies, but there has been little effort expended to date. Impetus for change may come, in part, through requirements imposed by international assistance organizations and lending institutions as part of the price for obtaining grants and loans.

When reading through this book it is possible to develop a gloom and doom impression of where aquaculture is going. Given that while some 85% of the aquaculture in the world is practiced in Asia but that less than 1% of the farmers on that continent are involved in aquaculture (paper by Peter Edwards entitled "Environmental issues in integrated agriculture-aquaculture and wastewater-fed fish culture systems"), coupled with the fact that many of the best sites for aquaculture are already taken, gives one reason to pause and consider just how important aquaculture will be in the future. Disease problems (possibly brought about by poor pond water quality) decimated shrimp production in Taiwan a few years ago and have recently led to devastating losses in China. Toxic algae blooms have been increasing and have affected the safety and marketability of shellfish in both coastal and inland waters. Whether aquaculture is associated with the increase in toxic algae blooms remains to be determined.

The rallying cry, "aquaculture will feed the world," is no longer heard. Increasingly, the niche for aquaculture has become one of producing high value products that are beyond the economic reach of the masses in most developing nations.

The question as to whether governments will impose the necessary controls on aquaculture siting and practices to ensure protection of the natural environment remains to be answered. The need for those controls has, thus far, been recognized largely by scientists, economists, and sociologists familiar with aquaculture, and at least to some extent by practitioners. Certainly those who have experienced heavy mortalities from deteriorated water quality and disease epizootics or who have seen much lower than expected production levels because of acid soils in ponds established in mangrove swamp areas recognize that nature can only be pushed so far.

Sustainability is the current buzzword with respect to agriculture, and is becoming fashionable in aquaculture as well. To be sustainable, an enterprise must not cause environmental degradation that will lead to declining production levels. In some instances, it seems as though aquaculture development has exceeded the capacity of the environment to provide sustainability.

In the developed world, the long-term solutions to use conflicts surrounding aquaculture involve development of recirculating water systems and movement of mariculture operations to offshore areas. Those options are not available in the developing countries because they are clearly not economically viable.

Environment and Aquaculture in Developing Countries speaks clearly and informatively to the issues facing aquaculture, and in the final chapter by Roger Pullin, the current situation with respect to aquaculture and the environment is summarized and a number of recommendations are made. It remains to be seen how those recommendations will be received but it is clear that regardless of them being accepted or rejected, aquaculture in the developing world is changing and will change even more dramatically in the future. Ultimately, aquacultured products from throughout the world must be nutritious and safe for human consumption, and they will have to be produced in an environmentally sound, and therefore, sustainable manner. This book provides a framework for how we might begin to achieve those goals. It provides an excellent starting point upon which modifications in current aquaculture practices in the developing world can be made. Aquaculture will undoubtedly continue to make a significant contribution to world fish and shellfish supplies, but significant changes in aquaculture practices are upon us. An appreciation for some of the reasons for those changes can be found in this excellent volume.

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Climatic Change in the Intra-Americas Sea, edited by G. A. Maul, 1993. Edward Arnold, London, 389p. ISBN 0-340-58981-7, $99.50.