CHAPTER 1

ENVIRONMENTALLY RESPONSIBLE AQUACULTURE—A WORK IN PROGRESS

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Abstract: Aquaculture yields important benefits to humans—food, essential products used in developing new industries and maintaining current industries, and fish and shellfish used to supplement depleted natural populations. Three objectives of the aquaculture industry are to provide food and income for people in developing countries; reduce fishing pressure on wild stocks; and maintain sufficient numbers of fish to sustain commercial, recreational, and subsistence fisheries. But these benefits come with a price. The ecological and genetic effects associated with aquaculture operations have received a great deal of attention for at least 20 years. This focus has been stimulated by several factors: (1) the high-profile presence of aquaculture activities and facilities, which operate principally in inland and coastal waters where humans tend to concentrate and conduct numerous other activities that compete for space and resources; (2) the physical evidence of environmental decline in the vicinities of aquaculture operations; and (3) the promise that aquaculture products can provide considerable, reasonably priced protein throughout the world. The negative effects of aquaculture are numerous, diverse, and complex. They are not easily mitigated or alleviated because they are tied to the actual and potential benefits of the industry. The effects of aquaculture can compromise biodiversity at all levels—from genetic through ecosystem, or broader in scope—and can interfere with the interactions of organisms at all biodiversity levels. Collectively, the authors of the chapters in the four sections of this book identify many ways that aquaculture has affected biodiversity and present new perspectives on some previously documented ways. They also provide specific, applicable solutions for the effects they address. They provide detailed documentations of the status of various types of aquaculture effects in their respective countries, evaluations of the success of various aquaculture endeavors, and overviews of the type of thinking and planning that could lessen all types of ecological and genetic problems caused by aquaculture. This book is unique in that it provides in-depth evaluations of specific effects resulting from aquaculture operations in countries throughout the world and suggests specific solutions to the problems described.
1. THE IMPORTANCE OF AQUACULTURE

A quick perusal of a literature search produced using the keywords “aquaculture,” “ecology,” and “genetic” will illustrate that a great deal of attention has been paid to the environmental effects¹ of all types of aquaculture activities. Numerous workshops, symposia, and conference sessions have addressed these issues (e.g., Pullin et al., 1993; Food and Agriculture Organization of the United Nations [FAO] and Government of Japan, 1995; Pullin et al., 1999; Svennevig et al., 1999; ; Network of Aquaculture Centres in the Asia-Pacific [NACA] and FAO, 2001; Subasinghe et al., 2001; Holmer et al., 2002; Stead et al., 2002; Morry et al., 2003; Nakamura et al., 2003; Phillips et al., 2003). Many national and international organizations and groups have prepared codes, recommendations, guidelines, or policies for conducting responsible aquaculture (e.g., Turner, 1988; GESAMP, 1991, 1996, 2001a, b, c; Working Group on Aquaculture, Standing Committee on Fisheries and Aquaculture (Australia), 1994; FAO, 1995, 1997; FAO and Government of Japan, 1995; ICES, 1995; Reinertsen and Halland, 1995; Bartley et al., 1996; Pullin et al., 1999; Secretariat of the CBD, 2004 [also see http://www.fao.org/documents]). Several organizations and companies award certifications or recognition for practicing environmentally conscientious aquaculture (e.g., British Columbia Innovation Council, Canadian Aquaculture Industry Alliance, FAO, Global Aquaculture Alliance, NACA, North Atlantic Salmon Conservation Organization [NASCO], World Bank, World Wildlife Fund). Many articles and books have been written that document the general environmental problems common in the practice of aquaculture and provide principals and methods for developing sustainable aquaculture systems and programs (e.g., Welcomme, 1988; Barinaga, 1990; Pillay, 1992; Pullin et al., 1993; Lassuy, 1995; Schramm and Piper, 1995; Thorpe et al., 1995; Azeta et al., 1997; Bardach, 1997; Barg and Phillips, 1997; Goldburg and Tripllett, 1997; Tringali and Bert, 1998; Svennevig et al., 1999; Bert and Tringali, 2001; Bert et al., 2001; Black, 2001; Goldburg et al., 2001; Naylor et al., 2001; Read and Fernandes, 2003; Bello et al., 2004; Leber et al., 2004b). Lastly, a number of

¹ In this chapter, I use the term “environmental effects” in a very broad sense—inclusive of ecological, genetic, and biodiversity effects on all living natural ecosystem components and their independent and interactive processes as well as effects on nonliving ecosystem components. This special usage allows me to dispense with longer phrases, such as “ecological, biological, genetic, and biodiversity effects,” when discussing the broad range of aquaculture effects that affect natural ecosystem components. Similarly, I use “environmental” in the broad sense, to refer to living organisms and their interactions plus the habitats in which they live. When the adverse effects under discussion are pronounced and widespread, I use the term “impacts” rather than “effects.”