Sustainable Aquaculture Production and Fisheries Management[1]

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Abstract

Worldwide, fish is an important source of protein for all income groups, and in recent years, fish and fish products such as fish oils have also been promoted as health foods. Fishing is also an important source of income and livelihood to about one million people in developing countries. Food security of these people and their dependant families and communities may be threatened when fish stocks collapse from overfishing, coupled with problems of pollution and habitat degradation. Fishing grounds all over the world are exploited to and beyond their limits, and the only growth sectors in fisheries production are sustainable forms of aquaculture and stock enhancement. This paper presents some possible solutions to overcome the crisis of a depleting fish supply, and will discuss how the right kind of strategy, supported by critical research, could help to sustain the landings from capture fisheries and push for a net increase of fish production from the culture sector. The paper will argue that the research will need to address not just new technology solutions but also social and economic dimensions of the challenges facing fisheries. The focus will be on developing countries where the majority of the world's fish is now produced and where dependence on fisheries and aquaculture are greatest.

Introduction

About one billion people in developing countries rely on fish as a major source of food and protein, income and livelihood (ICLARM 1992); 50 million people are involved in small-scale fisheries through catching, processing and marketing, and fish production provides about 150 million people with employment (ICLARM, 1992). In some countries, for example in Cambodia, fish provides the necessary food and income buffer whenever crop production fails (Ahmed, 1997), and in times of war may provide a source of subsistence food (Williams and Choo, 2000). Despite its importance, fish is seldom included in projections of future food supply.

Food security may be threatened when fish stocks collapse from overfishing, pollution, habitat degradation, and even destruction. Semi-intensive and intensive aquaculture systems, especially involving carnivorous species, may also cause environmental degradation. Coupled with the need of the carnivores to consume a large quantity of fish meal and oils, their culture may actually cause a net depletion of fisheries resources (Naylor *et al.*, 2000). Issues pertaining to the environment and solutions to some of these problems were given wide coverage in the Rio Conference in 1992. However, as we approach Rio + 10, the situation has not improved, but appears to have deteriorated. More effort is needed to prevent further collapses of the world's fisheries and food crises. It is imperative that countries re-examine how they manage their fisheries,

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assess the effectiveness of management plans and ensure that fisheries resources are sustained.

Stakeholders involved with the fisheries sector face a period of formidable transition from previous resources abundance to relative scarcity; any action, even small ones, can have a great effect during the transition (Williams, 1996). Williams (1996) stressed that the bleak outlook could only be improved with better fisheries resources management, improved development of aquaculture production, and better use of resources and interventions to improve equity of access (see also Williams *et al.*,2000).

This paper attempts to briefly describe the present state of the fisheries and aquaculture resources, together with associated issues from both sectors. It presents some possible solutions to overcome the crisis of depleting fish supplies, and will discuss how the right kind of strategy, supported by critical research, could help to sustain the landings from capture fisheries and push for a net increase of fish production from the culture sector. The paper will argue that the research will need to address not just new technology solutions but also the social and economic dimensions of the challenges facing fisheries.

State of fisheries resources and associated issues

Capture fisheries

The world's capture fisheries resources have been exploited to the limit of approximately 89 million m.t. since the late 1980s, and there is general agreement that the health and resources of the aquatic environment are in crisis. A milestone FAO study (FAO 1992) showed that more than 25% of the most important 200 fished stocks all over the world were overexploited, depleted or recovering and would produce greater catches only if returned to a healthier state. Thirty eight percent were fully exploited and could not produce more catch without depleting the base stock, and only a little more than 33% could produce more. Work done by ICLARM (Pauly and Christensen, 1995) showed that the primary production required to sustain the fisheries catches from 1988-1991, plus 27 million m.t. of bycatch, amounted to 8% of global aquatic primary production, nearly four times the previous estimate. Pauly *et al.* (1998) reported that the present fisheries exploitation is unsustainable, and that marine food webs, as well as those in the inland fisheries, are being fished down. Preliminary results from a three-year collaborative project entitled "Sustainable management of coastal fish stocks in Asia", initiated by ICLARM in 1998, together with eight developing member countries of the Asian Development Bank, are confirming that the overall status of the resources is dismal, and bottom trawling effort should be greatly reduced. Many aquatic habitats that serve as important breeding and nursery grounds for aquatic organisms are also degraded or destroyed by anthropogenic activities. Coral reef habitats are amongst the most threatened, 58% of the world's reefs are under threat, with 80% of the reefs in Southeast Asia at highest risk (Bryant *et al.*,1998).

Many reasons have been put forward for the poor state of fisheries resources and most relate to failures in fisheries management. Knauss (1994) suggested that this is because the management of most marine fisheries began only recently, after 1980, when the United Nations Convention on the Law of the Sea (UNCLOS) paved the way for the establishment of the 200-nautical mile exclusive economic zone. Garcia and Newton (1997) suggested that the global crisis is mainly due to open access policies and subsidy-driven over-capitalization. Smith (1998) reviewed the reasons given for the failures of fisheries management including "folly" and deficiencies in data and information, as well as poor management by institutions. Hannesson *et al.* (2000) concluded that "effective governance of fisheries requires the assignment of enforceable rights to share of fisheries".

Seeking more effective ways to manage the resources has become an imperative. ICLARM's research findings suggest that apart from technological solutions, the following approaches, which take into consideration the economic and social dimensions of the challenges facing the fisheries sector, may help

improve resources management (ICLARM, 1999):

* Co-management may be an equitable, efficient and sustainable management strategy,
* Information on resources, fishers, consumers of fisheries products, users of aquatic habitats, and institutions which affect resources exploitation, may help to improve resources management,
* The use of an ecosystem approach that includes people and their livelihood could be a better option than the species by species approach,
* The establishment of marine protected areas, facilitated through simple "best practice guides" and based on the best available scientific information could help in the conservation and management of fisheries resources.

Aquaculture

Presently, aquaculture is the only growth sector in fisheries production and accounts for about 25% of all fish directly consumed by humans (Naylor *et al.*, 2000). Although it has a long history, intensification has only taken place since the 1970s. Asia currently leads in aquaculture production, but Africa and Latin America have great potential for expanding their aquaculture activities (Kapetsky, 1994 and 1995; Brummet and Williams, 2000).

Naylor *et al.* (2000) concluded that aquaculture could only add to the world's fish supplies if four goals are met, namely:

* Culture of organisms low in the food chain,
* Reduction of fish meal and oils in feeds,
* Development of integrated farming systems,
* Promotion of sound environmental practices.

ICLARM (Williams *et al.*, 2000) advocated a fifth goal — that aquaculture developments must include access for poor consumers and small-scale producers, and stressed the potential of enhancement of natural fish stocks. ICLARM has successfully demonstrated that in poor developing countries such as Bangladesh, the culture of fish like carps, catfish and tilapia that require low level inputs, is able to benefit the small-scale producers, and even landless women and men, when well-targeted development assistance is provided. Moreover, fish culture can lower the price of fish (Dey, 2000). Cultures of environmentally benign and high value species, like the giant clam (*Tridacna* spp.), blacklip pearl oyster (*Pinctada margartifera*) and the sea cucumber (*Holothuria scabra*) were also successfully demonstrated in the small island developing states in the Pacific, with significant economic benefits to the islanders.

ICLARM considers that increasing the access of the rural poor to productive resources is the key to sustained increases in food security (Ahmed *et al.*, 1997). Aquaculture research priority areas of ICLARM (ICLARM 1999) are as follows:

* Small-scale aquaculture, including integrated aquaculture-agriculture systems that can make fish more widely available and affordable to consumers,
* Genetic improvements in farmed species, where the enhanced fish can be consumed locally to increase productivity and ensure food and nutritional security,
* Issues including ecosystem interactions, sustainability indicators, resources valuation, extension methods for aquaculture, governance theory and issues influencing transnational management and equity.

Social and economic challenges

Problems related to good resources management cannot be solved by science alone, as is borne out by the many stock collapses all over the world, despite attempts in sustaining the stocks with sophisticated

monitoring and enforcement programs. The solution to this global crisis could be better addressed with partnerships and clear definitions of the interests and responsibilities of governments, resources users, researchers and the community, including users of the commons (Williams, 1996).

Similarly, aquaculture must not be seen simply as a way of fulfilling the increasing demand for fish but has to be seen as part of the overall development framework, so that its costs and benefits are assessed relative to other economic activities that complement or compete with it. ICLARM recognizes the positive role that aquaculture can play in diversifying and expanding the economic base of local communities, and advocates that those who have the knowledge and the means develop this source of food for the millions of people that are still hungry and undernourished (ICLARM: Focus for Research, 3(2) 2000).

In its second Strategic Plan (2000-2020), ICLARM endeavors to address some of these issues so that its research outputs will provide the means for increasing food production, sustaining aquatic environments, and enhancing livelihoods and the well-being of poor people dependent on aquatic resources (ICLARM, 1999).

ICLARM's strategic research priorities (2000-2020)

The aquatic resources systems approach, which involves evaluation of the problems and opportunities within eight aquatic resources systems and seven regional groupings, is used for the research priority-setting process in the ICLARM Strategic Plan (2000-2020), as shown in Table 1.

While the previous ICLARM Strategic Plan (ICLARM, 1992) was mainly fisheries-oriented, the present Plan, which was developed in 1998-1999, has broadened, and considers equity, sustainability and efficiency (ICLARM, 1999). This Plan addresses some of the most important concerns for the future , including sustaining aquatic environments to stabilize or increase food production for humans, protecting aquatic biodiversity on which future productivity depends, and integrating the biophysical, socio-economic and policy elements of aquatic resources management.

This Plan emphasizes the development of aquaculture in ponds and small water bodies, the sustainable exploitation of coral reefs within integrated coastal zone management, as well as the generic contributions to tools and knowledge to enhance fisheries production in developing countries. An ecosystem approach to formulate integrated models for management and governance of whole resources systems is being adopted. Aquatic genetic research and critical issues in aquatic biodiversity are also being pursued.

Asia will be the area of research focus, but activities in Africa and the small island developing states of the Indo-Pacific and Caribbean will be stepped up. Work in mainland Latin America will not be given priority, mainly because most fishing, such as in the offshore fisheries, and aquaculture production, in Latin American countries is highly commercialized, much like fishing and aquaculture in developed countries.

Priority will be placed on the most relevant and effective ways of sharing research and management outputs to achieve the greatest local and global input. Strategic training will be conducted, scientific data disseminated, analysis and management advice will be given to the stakeholders and national aquatic/agricultural research systems in developing countries. National capacities to formulate policies for the sustainable management of aquatic resources will be strengthened. Research and capability-building activities will be undertaken in partnership with national aquatic/agricultural research systems and other stakeholders, and will draw upon multidisciplinary expertise in the biophysical, socio-economic, legal/institutional and other relevant fields. The impact of the research outputs, especially on the poor, will be continually assessed, and the value of research on the environment evaluated.

Table 1 ICLARM's priority research thrusts (2000-2020) by aquatic resources system and regional focus (ICLARM 1999)

Aquatic resources system	Priority	Research thrusts	Regional focus
Ponds	Very high	Introduce integrated aquaculture systems & impact analysis Enhance genetic techniques	Asia, sub-Saharan Africa (SSA)
Small water bodies, reservoirs, & lakes	Medium	Develop knowledge base Enhance productivity Integrate management	SSA
Floodplains, streams & rivers	High	Enhance yields Develop appropriate research methods & data to evaluate the resources & improve policy decisions & institutional framework	Mekong Basin, South Asia
Coastal water (including estuaries & lagoons)	High	Co-manage coastal & fisheries resources Plan for integrated resources use Introduce sustainable coastal aquaculture & stock enhancement	Southeast Asia (including Mekong Basin), SSA, Small Island Developing States (SIDS)
Coral reefs	Very high	Integrate data on coral reefs to determine parameters of reef health Practice better management within ICZM context Encourage sustainable exploitation of coral reef resources through aquaculture & marine protected areas (MPAs)	SIDS (Pacific, Caribbean), Southeast Asia, East Africa
Soft bottom shelves	Medium	Conduct policy analysis & study implications of changes in coastal fisheries	Asia, Africa
Upwelling shelves	Low	Keep watching brief on productivity & influences of catch on trade & other aquaculture development	
Open oceans	Low	Monitor world catch statistics & trade for their effects on ICLARM's target beneficiaries & other resources systems & global patterns	

Note: "Very high" represents the core of ICLARM's research, and will be allotted 15-30% of ICLARM's total financial and human resources and preferentially protected from budget shortfalls; High priority will be pursued by ICLARM, but allocated not more than 15% of resources; medium priority normally not more than 7.5-10% of resources; low priority indicates that extant data will be used from these systems to contribute to generic research and any additional research will generally be conducted by collaborators.

Conclusion

The world's fisheries resources are in crisis. A need to implement more effective aquatic resources management and research strategies is an imperative. ICLARM's Strategic Plan (2000-2020) has been designed to address some of the pressing problems faced by the fisheries sector in the developing countries, with the aim that its research outputs will help alleviate the stress on overfished resources and degraded aquatic environments.

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