

# **Recommendations for Responsible Aquaculture**

**Imre Csavas**

FAO Regional Office for Asia and the Pacific  
Phra Atit Road, Bangkok 12020, Thailand

Csavas I. 1995. Recommendations for responsible aquaculture, pp. 1-12. In: Bagarinao TU, Flores EEC (eds) Towards Sustainable Aquaculture in Southeast Asia and Japan. SEAFDEC Aquaculture Department, Iloilo, Philippines.

## **Abstract**

Aquaculture has grown rapidly in Asia. In 1992, out of the 52.8 million tons of total production of aquatic organisms, as much as 17 million tons (32.2%) came from aquaculture. However, unplanned and uncontrolled development of aquaculture has led occasionally to environmental damage and social disruption in many countries. Now attention has focused on the sustainability of aquaculture. Negative impacts of shrimp culture have been well publicized, but problems have also been caused by overinvestments in fish and mollusk culture. As sustainability is a highly complex issue, it is important to develop internationally accepted principles and guidelines for responsible aquaculture, with the use of technologies not detrimental to natural resources, ecosystems and human communities. FAO is now in the process of developing an International Code of Conduct for Responsible Fishing based on the Declaration of Cancun. One chapter of the Code will deal with aquaculture. Unfortunately, information is rather scanty on the environmental impacts of various aquaculture systems and the carrying capacity of aquatic ecosystems, especially in tropical areas. Therefore, research on these topics should receive high priority. Similarly, tightening and enforcing the rules and regulations governing existing and new aquaculture ventures is a pressing task that responsible government agencies can not postpone any longer.

## **Introduction**

Aquaculture development in the 1980s has changed once and forever the supply of aquatic products in Asia. By 1992, about one-third (32.2%) of the total production of aquatic organisms was provided by aquaculture, and for several major commodity groups, this ratio was even significantly higher. As much as 96.9% of seaweeds, 46.6% of mollusks, and 72% of freshwater fishes were cultured (Table 1). The contribution of aquaculture was only 22.9% for crustaceans and 1.2% for marine fishes, but a species by species analysis shows outstanding shares for several high-value commodities.

Table 1. The share of aquaculture in the total production of the fisheries sector in Asia in 1992. Data from FAO (1994).

Commodity group	Total fisheries production (× 1,000 tons)	Aquaculture production	
Freshwater fishes	10,240	7,371	72.0
Diadromous fishes	1,198	514	42.9
Marine fish	26,638	323	1.2
Crustaceans	3,511	803	22.9
Mollusks	5,732	2,672	46.6
Seaweeds	5,497	5,329	96.9
Total*	52,816	17,012	32.2

\*Without marine mammals and miscellaneous aquatic vertebrates and invertebrates.

Development was fast in all major species groups (Fig. 1), but at considerable cost. Much of the development especially in coastal areas was propelled by commercial interests that disregarded the limited nature of resources and the interests of local communities. Governments were unable to control the excesses of the profit-oriented rush (e.g., in shrimp culture) because suitable rules and regulations did not exist, or the authorities did not have the means or the political clout to enforce them.

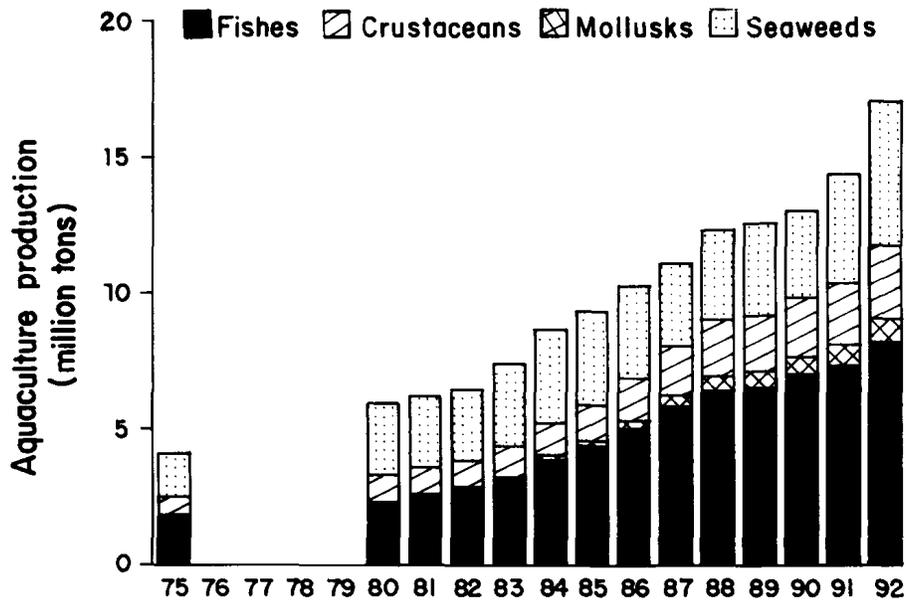


Fig. 1. Growth of aquaculture production in Asia. Data from Csavas (1988) and FAO (1994).

The unplanned and uncontrolled development of aquaculture led occasionally to suicidal environmental damages and social disruptions, especially in shrimp culture in Taiwan, China, Thailand, and Indonesia, but also in freshwater fish culture (e.g., in Laguna de Bay in the Philippines), marine fish culture (e.g., in the Seto Inland Sea in Japan), and even in mollusk culture in Japan and the Republic of Korea.

The occasional negative impacts of aquaculture development were widely publicized, but it was seldom pointed out that in all major cases of environmental damage attributed to aquaculture, there were other guilty parties as well: industrial and communal polluters (e.g., in Laguna de Bay, inner Gulf of Thailand, Bohai Bay, Seto Inland Sea) or destructive logging of mangroves (e.g., in the Philippines). In fact, an analysis has demonstrated that the northern European salmon and trout industry, which developed as rapidly as shrimp culture did in Asia, contributed only 0.4% of the total nitrogen load and 1.5% of the total phosphorus load of the sea (Knell and Ackefors 1992). Atmospheric deposition of nitrogen was two times higher and municipal sewage contributed 2.5 times more nitrogen and 6.6 times more phosphorus load than the salmon and trout farms, despite the fact that Nordic countries have efficient sewage treatment, unlike Asian urban centers.

In order to avoid a biased public opinion, aquaculturists have to tell the true story, admitting their own mistakes but also demonstrating the responsibility of others. It is imperative to map with scientific accuracy the ecological and social limits of aquaculture development and to ensure the sustainability of future growth.

### **Ecological Limits of Aquaculture**

In terms of national averages, aquaculture is far from its ecological limits in Asia, although the continent produced 88.2% of the global aquaculture output in 1992. The aquaculture production per capita per year was only 21.6 kg in the Republic of Korea, 11-13 kg in Taiwan, the Philippines, and Japan, and was below 9 kilograms in the rest of Asia, including major producers like China and Thailand (Table 2, column 2). It is misleading, of course, to use such averages and more detailed analysis is needed to trace ecological limitations.

First of all, inland and coastal aquaculture have to be scrutinized separately as they differ in many respects. Currently, only 44.3% of the total aquaculture production in Asia comes from inland areas (Table 3). Inland aquaculture produces primarily fishes (99.6%), and crustaceans and others make up 0.4%. Most of the inland fish production in Asia comes from photosynthesis-dependent ponds of small farmers that blend well in the rice-based agroeconomies and social structures of the continent.

In inland areas, the most important limits to aquaculture development may be the scarcity of land or water. When inland aquaculture production is averaged per unit land area, the figures are highest indeed in densely populated areas. But even in Hong Kong, Taiwan, and Bangladesh, it is below 5 t/km<sup>2</sup> (Table 2, column 3). In the rest of the continent, this indicator is below 0.5 t/km<sup>2</sup>.

Table 2. The major aquaculture producers in Asia in 1992 by various indicators. Indices computed from production data from FAO (1994).

Producer	Total aquaculture production (kg/capita)	Inland aquaculture production			Coastal aquaculture production per length of coastline (t/km)				
		per land area (t/km <sup>2</sup> )	per renewable fresh water (t/km <sup>3</sup> )	Total	Seaweeds	Mollusks	Crustaceans	Fishes	
Rep Korea	21.6	0.20	317	382.7	240.3	140.3	0.2	1.9	
Taiwan	12.7	3.68	na	80.1	6.9	39.4	11.8	22.0	
Japan	11.3	0.24	165	95.2	42.4	33.3	0.2	19.3	
Philippines	11.3	0.33	306	28.3	15.5	1.6	3.5	7.7	
DPR Korea	9.0	0.11	194	75.9	48.7	22.0	5.2	0	
China	8.8	0.53	1,777	374.7	245.0	110.2	15.5	4.0	
Thailand	6.4	0.22	1,007	77.1	0	20.5	55.9	0.7	
Malaysia	4.2	0.05	35	13.6	0	12.2	0.6	0.8	
Indonesia	3.6	0.13	93	8.3	2.4	0	3.2	2.7	
Laos	3.6	0.07	59	-	-	-	-	-	
Vietnam	2.7	0.45	391	11.6	1.4	0	10.2	0	
Bangladesh	1.9	1.61	154	36.2	0	0	36.2	0	
Hong Kong	1.6	4.93	na	6.1	0	0.7	0	5.4	
India	1.6	0.45	730	1.9	0	0.2	1.7	0	
Singapore	0.9	0	0	12.2	0	6.1	2.0	4.1	
Iran	0.7	0.03	361	0	0	0	0	0	
Asia average	5.5	0.34	516	64.4	36.2	18.1	5.3	4.8	

na, not applicable

Table 3. Inland and coastal aquaculture production in Asia compared with the rest of the world. Data from FAO (1994).

Sector Species groups (contribution)	Production (million tons)	
	Asia	Rest of the world
Total	17.033	2.278
Inland aquaculture	7.538	0.936
Fishes (99.6%)	7.508	0.902
Others (0.4%)	0.030	0.034
Coastal aquaculture	9.495	1.342
Fishes (7.4%)	0.703	0.307
Seaweeds (56.2%)	5.336	0.060
Mollusks (28.2%)	2.678	0.830
Crustaceans (8.2)	0.779	0.145

The order of countries is distinctly different when inland aquaculture production is related to renewable internal freshwater resources. China and Thailand are the leading countries in this respect, producing 1,000-2,000 tons per cubic kilometer of their renewable freshwater resources (Table 2, column 4), which translates to 1-2 g/m<sup>3</sup> per year. The achievements of these countries are commendable, but obviously still far from the limits of inland fish culture in terms of freshwater resources.

In inland areas, the most vulnerable ecosystems from the point of view of aquaculture are the natural lakes and man-made reservoirs. There are several examples regionwide that show that the carrying capacity of these waters is limited and can be breached with cage or pen culture with intensive feeding. One of the earliest such problems emerged in Laguna de Bay in the Philippines (Librero 1988).

Most of the environmental troubles, however, have been caused by the uncontrolled development of coastal aquaculture. The 55.7% contribution of coastal aquaculture to the total production (Table 3) itself reveals a discrepancy. The coastal zone used for aquaculture is a strip only a couple of kilometers wide on the continental shelf and on the low-lying flatlands beyond the tidal zone. This narrow strip produces more cultured aquatic commodities than the vast land areas they skirt. The total length of Asia's coastline is 147,400 km. With an average width of 10 kilometers (a generous overestimate), the continent's coastal area is about 1.5 million km<sup>2</sup>. The total land area of Asia is 15 times bigger — 22.2 million km<sup>2</sup>.

The problem is aggravated by the stiff competition between various sectors of the economy for the use of the coastal zone and the fluid state of the use rights there. Not so long ago, much of the coastal area was an open-access resource; now it is increasingly privatized, legally or illegally. Aquaculturists are active, but not the only or even the strongest, players in this privatization (Bailey 1988, Bailey and Skladany 1991).

The volume of aquaculture commodities produced in the narrow coastal zone is amazing indeed. The output of the Republic of Korea and China reached almost 400 t/km coastline and those of Japan, Taiwan, Thailand and the DPR Korea were between 75 and 100 t/km (Table 2, column 5). Of course, it is important to know what commodities are produced in various countries as there are significant differences between the major commodity groups in terms of their environmental impact. In Asia, seaweeds dominate coastal aquaculture; in 1992 they represented 56.2% of the total production (Table 3).

An increasing portion of seaweeds is produced for extraction of phycocolloids rather than for direct human consumption. Despite the recent successes of several tropical countries, seaweed culture is still dominated by the traditional producers. China and the Republic of Korea each produce almost 250 t/km coastline (Table 2, column 6). As seaweeds are consumers of dissolved nutrients and producers of oxygen, seaweed culture is the most environmentally compatible form of aquaculture. However, in the leading countries, seaweed culture is a high-tech industry with indoor hatcheries, genetic manipulation of stocks, and intensive fertilizer application in the grow-out areas occupying significant stretches of the coastline. These advanced monoculture systems are increasingly dependent on external inputs and their social and ecological impacts should not be ignored.

The major producers of cultured mollusks are almost the same ones producing high volumes of cultured seaweeds. The Republic of Korea and China produce 110-140 t/km coastline, and tropical countries lag way behind (Table 2, column 7). Culture of filter-feeding mollusks is usually considered environmentally beneficial; however, their metabolites can contribute significantly to the organic load at the culture site. Overuse of traditional oyster culture grounds in Korea and Japan has led to self-pollution and the deterioration of the environment (Mito and Fukuhara 1988, BH Park, personal communication), not unlike the effect of shrimp and fish farming. Mollusk culture is declining already in the Republic of Korea where it peaked in 1987 with 185 t/km, and stagnates in Japan where the current level of 33 t/km was reached in 1988. Thus, ecological limits do exist in mollusk culture and these have already been surpassed at several locations.

The negative impacts of shrimp culture are well documented, especially in Asia. The collapse of the Taiwanese shrimp industry in 1988 sent clear warning signals about the ecological limits of aquaculture (Lin 1989, Macintosh and Phillips 1992). Before the collapse, Taiwan reached an average production of 55.9 t/km; this was reduced to 11.8 t/km by 1992 (Table 2, column 8). The current leader, Thailand, reached a shrimp production of 55.9 t/km in 1992, and the production is apparently still increasing. However, a more detailed analysis of the Thai shrimp industry reveals that shrimp culture has peaked and collapsed after 1988 in several provinces in the Inner Gulf of Thailand (Csavas, unpublished data from the CURSI-ORSTOM Project, Chulalongkorn University). Samut Prakan, Samut Sakhon and Samut Songkhram reached shrimp production levels of 217, 356, and 582 t/km, respectively, before they crashed. Right before the collapse, there were 336 hectares of shrimp ponds on every kilometer of Samut Songkhram's coastline, equivalent to a 3.4 km wide contiguous belt of ponds. New investments in other sections of the Thai coastline (Fig. 2) kept the total national output increasing, even as the pioneering provinces suffered environmental damage not unlike that experienced in Taiwan.

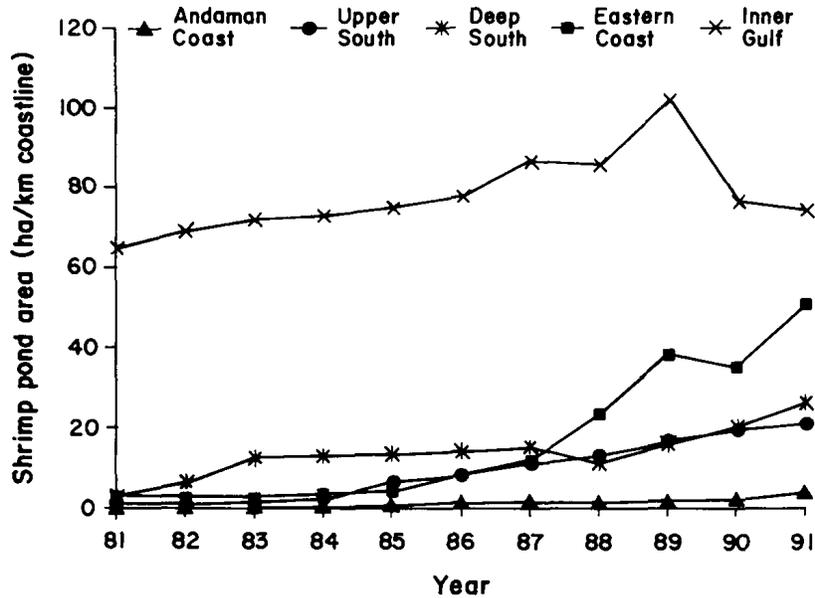


Fig. 2. Increase of shrimp culture area in coastal regions of Thailand. From Csavas (unpublished manuscript, Coastal Aquaculture in Thailand, CURSI-ORSTOM Project, Chulalongkorn University).

Local overinvestments in shrimp culture also caused similar problems in 1993 in China and Indonesia, although these countries do not show dangerously high levels of production per hectare or per kilometer of coastline. This again shows that broad averages can be misleading.

Marine fish culture did not reach such extreme production levels per kilometer of coastline, although the national averages for Taiwan and Japan are rather high, around 19-22 t/km (Table 2, column 9). It is important to note, however, that the present level in Taiwan is well below the peak 65 t/km reached in 1990. The Japanese marine fish production has also declined slightly since 1991. Obviously, there is an ecological problem in the more frequent algal blooms that result in massive fish kills even in the well regulated Japanese fish culture industry (Y Taki, personal communication). It is clear that domestic and industrial pollution are significant factors in the deterioration of the environment, but self-pollution can not be ignored either.

All these negative examples in the early 1990s called the attention of both the government and the industry to the need of addressing the problems caused by overinvestments in certain commercial aquaculture systems. At that time 'sustainable development' was already a hot issue in agriculture circles.

### Sustainable Development

Initially, 'sustainable development' was used and interpreted in different, sometimes incompatible ways, according to the biases of the users. Finally, FAO (1991) proposed and used the following definition at the 44th session of its Council:

Sustainable development is *"the management and conservation of the natural resource base, and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development conserves land, water, and plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable, and socially acceptable."*

The above definition, which was prepared originally to be used in agriculture, is comprehensive and suitable for use without any modifications in both capture fisheries and aquaculture. However, sustainability, even in its broadest sense, addresses only the supply side of the problem faced by the fisheries sector at the end of the twentieth century.

Aquaculturists have learned the hard way that in the mature phase of the industry, supply and demand become balanced and further growth depends on processing and marketing rather than on additional investments in culture facilities. To increase demand is the only way to maintain growth once markets are saturated with a commodity. The predicaments of the 'pork cycle,' that is, the periodically oversupplied markets, are now all too familiar to aquaculturists (Csavas 1994). This is the reason why the new term, 'responsible fisheries and aquaculture,' was coined to cover both the sustainability of production and the desirable postharvest handling, processing, and marketing.

### **Responsible Fisheries and Aquaculture**

The International Conference on Responsible Fishing held at Cancun, Mexico, in 1992, launched the concept, and its Declaration of Cancun requested FAO to draft an International Code of Conduct for Responsible Fishing (FAO 1992). At its Twentieth Session in March 1993, the FAO Committee on Fisheries considered the possible scope and content of such a Code and concluded that 'responsible fishing' means the sustainable utilization of fishery resources in harmony with the environment. 'Responsible fishing' encompasses sustainability of production, proper transformation processes to add value to fishery products, and appropriate commercial practices that provide consumers good quality products (FAO 1993).

Given the wide scope contemplated for the Code of Conduct, it will be elaborated in such a manner that parts of the Code may be readily incorporated in national laws and regulations and may also be adopted as separate international legal instruments. The Code of Conduct on Responsible Fishing will consist of a section on general principles and six sections covering major thematic areas, one of which will be aquaculture development. Each section of the Code will be elaborated through appropriate consultations with experts and concerned organizations, of which SEAFDEC is an important one in the Asia-Pacific region. For this purpose, the FAO Secretariat has prepared the first draft of the Proposed Preliminary Principles and Guidelines for Responsible Aquaculture in March 1994.

Interested governments will be invited to consider and adhere to a set of preliminary principles related to responsible aquaculture practices. These principles are a summary outline of the possible duties and responsibilities of states under the International Code of Conduct on Responsible Fishing. Based on these preliminary principles, a set of guidelines is proposed,

addressed primarily to responsible government agencies, but also to public or private institutions and persons engaged in promoting or practicing aquatic farming. It is understood that given the diversity of natural, social, and economic conditions and aquaculture practices, more specific guidelines must be developed on a country by country basis to meet local requirements.

The draft of Preliminary Principles for Responsible Aquaculture proposes three sets of principles, one for the national level, one for international level, and one for the farm level as follows:

1. *States and their fishery and aquaculture authorities, aiming to promote responsible development and management of aquaculture within their national jurisdiction, agree, in principle, to:*
  - a. *Establish and maintain an appropriate administrative and legal framework for aquaculture*
  - b. *Produce and regularly update comprehensive aquaculture development strategies and plans to ensure that all aquaculture development is appropriate, sustainable, and in the public interest, to allow for compatible use of resources shared by aquaculture and other activities*
  - c. *Establish procedures to undertake appropriate environmental impact assessment and monitoring to minimize adverse ecological changes resulting from water extraction, effluents, use of drugs and chemicals, and all other farm activities*
  - d. *Ensure adoption of appropriate practices in the genetic improvement of broodstocks, and in the production, sale and transport of eggs, larvae or fry, broodstock, or other live materials, in order to avoid adverse effects on wild and cultured stocks*
2. *States and their fishery and aquaculture authorities, aiming to protect international seas, rivers, and lakes, especially the living resources of those waters, from irresponsible aquaculture practices within their territories, agree, in principle, to:*
  - a. *Accept the obligation to their neighboring States to ensure responsible siting and management of aquaculture activities in or bordering international waters*
  - b. *Develop appropriate means to monitor the economic performance of their aquaculture activities and their impacts on other activities*
  - c. *Share relevant data to permit forecasting of aquaculture development opportunities and needs at national, regional, and global levels*
  - d. *Promote joint research efforts and exchange of knowledge and technical assistance on aquaculture systems most suitable to their regions*
  - e. *Promote regional trade in equipment, feeds and other inputs with neighboring states, and, at the same time, to develop adequate regulatory mechanisms to control the appropriateness and quality of such materials when produced and traded*

- f. *Contribute to the protection and enhancement of stocks of endangered species by supporting the development of appropriate techniques for aquaculture of endangered species*
  - g. *Conserve genetic diversity and maintain genetic integrity of aquatic communities and ecosystems by minimizing the risks of introducing non-native species or genetically altered stocks used for aquaculture into waters where there is a significant potential for spreading into the waters of other States*
3. *States, farming communities, producer organizations, and farmers should ensure responsible aquaculture practices at the farm level, by undertaking efforts to:*
- a. *Promote active participation of local communities and farmers in the management of aquaculture practices*
  - b. *Improve selection and use of feeds and feed additives*
  - c. *Improve selection and use of manures and fertilizers*
  - d. *Improve the use of hormones, drugs, antibiotics or other disease-control chemicals as well as the disposal of excess veterinary drugs, and of hazardous offal, dead, or diseased fish*
  - e. *Improve product quality through particular care before and during harvesting, on-site processing, and in storage and transport of the products*
  - f. *Promote the use of appropriate procedures for selection of broodstock and production of seed*

The document Preliminary Principles and Guidelines for Responsible Aquaculture, distributed among participants of the ADSEA '94, is now under revision and redrafting. Every interested institution or individual is encouraged to raise recommendations that would help in the process of improving, correcting, or completing it. Send comments to the FAO Regional Office for Asia and the Pacific (Phra Atit Road, Bangkok 10200, Thailand) or the Inland Water Resources and Aquaculture Service (FAO, Viale delle Terme di Caracalla, 00100 Rome, Italy).

### **Recommendations for Responsible Aquaculture**

The International Code of Conduct on Responsible Fishing attempts to provide a comprehensive set of guidelines for the sustainable development and management of the whole fisheries sector, including aquaculture. The following recommendations are especially relevant in Asia:

1. *Develop suitable rules and regulations to restrict the establishment of production capacities that exceed the carrying capacity of the environment.*

Licensing of aquaculture production units has to be based on solid scientific and engineering principles. Licenses must regulate the size of the culture facility, production volume,

culture techniques, water intake, and the volume and quality of wastewater discharge. The allowable conversion of farmlands, wetlands, mangroves, and coastal waters into aquaculture facilities must be carefully scrutinized site by site. The regulations, guidelines, and standards applied in developed countries with moderate climates must be carefully revised and adapted to the climatic and social conditions of developing tropical countries.

2. *Enforce the rules and regulations and monitor regularly.*

It is naive to expect responsible behavior from profit-oriented producers when rules and regulations are not enforced. The biggest difficulty with enforcement is the lack of a suitable monitoring system or methodology. Remote sensing has proven to be a very efficient technique to enumerate and regularly monitor production capacities, especially ponds. In order to set globally applicable standards, the Joint Group of Experts on the Scientific Aspects of Marine Environment Protection is currently developing international procedures for monitoring the ecological effects of coastal aquaculture.

3. *Involve the local community in the management of resources.*

Community-based management of resources and production facilities is more efficient than reliance on government controls only. The rape-and-run approach of outsiders caused most of the severe environmental damage in Asia in recent years. Rural communities are expected to be, and usually are, less exploitative and more caring of the local resources and environment.

4. *Conduct research on the carrying capacities of sensitive ecosystems.*

The determination of allowable nutrient loads to the environment is essential in developing scientifically sound guidelines and standards related to licensing aquaculture facilities. Unfortunately, there is scarcely any information on this topic, especially under tropical climates. Accelerated research is necessary to determine the carrying capacity of coastal areas, natural lakes, and man-made reservoirs.

5. *Conduct research and development in the use of the open seas for aquaculture.*

The overstressed coastal ecosystem may be relieved somewhat if more aquatic commodities were produced through searanching or in offshore cages. Both these technologies are extensively studied and used in Japan. However, the cultured species may be different under tropical climates. Technologies from Japan and other developed countries must be adapted and verified in the culture of local species in southeast Asia.

6. *Study the macroeconomic and social feasibility of intensive monoculture systems.*

The profitability of the export-oriented feedlot-type intensive systems is generally easily demonstrated at the farm level, but their benefits may be more dubious at the national level, especially when the macroeconomic costs of resource use and the social costs of displacing traditional users are also considered. Such studies are still rare and this keeps the decision-makers biased in favor of the environmentally problematic intensive systems.

7. *Apply the principles of integrated farming.*

One of the environmental advantages of freshwater fish farming over coastal aquaculture is that the former is easily inserted in the farming systems of small farmers in Asia. This allows sustainable levels of production and develops interdependence of the various elements of the farming system even without direct integration of fish with swine, poultry, or plant crops. A similar indirect integration of fish and shrimp with mollusks and seaweeds would prevent overstressing the coastal environment. Research and development in direct and indirect integration of aquaculture and agriculture must be given high priority.

8. *Improve public relations.*

The mistakes committed in the development of aquaculture and the occasional negative effects of aquaculture on the environment are widely publicized. However, not much is done to inform the general public about the positive aspects of aquaculture or about the environmental damage caused by other sectors, along with aquaculture. Scientists publishing only in scientific journals do not keep the general public sufficiently informed. The relevant information must be disseminated in the language of the common man, through media accessible to the broadest segments of the population.

## References

- Bailey C. 1988. The political economy of fisheries development. *Agric. Human Values* 5(1-2): 35-48.
- Bailey C, Skladany M. 1991. Aquaculture development in tropical Asia: a re-evaluation. *Natural Resources Forum* (Feb): 66-73.
- Csavas I. 1988. Problems of inland fisheries and aquaculture, pp. 137-180. In: *Fishing Industry in Asia and the Pacific*. Asian Productivity Organization, Tokyo.
- Csavas I. 1994. Important factors in the success of shrimp farming. *World Aquacult.* 25(1): 1-23.
- Enell M, Ackefors H. 1992. Development of Nordic salmonid production in aquaculture and nutrient discharges into adjacent sea areas. *Aquacult. Europe* 16 (4): 6-11.
- FAO. 1991. Environment and sustainability in fisheries. COFI/91/3, 23 pp. 19th Session of the Committee on Fisheries. Food and Agriculture Organization, Rome.
- FAO. 1992. Declaration of the International Conference on Responsible Fishing, Cancun, Mexico, 6-8 May 1992. COFI/93/Inf.7, 5 pp. 20th Session of the Committee on Fisheries. Food and Agriculture Organization, Rome.
- FAO. 1993. Conservation and rational utilization of living marine resources with special reference to responsible fishing. COFI/93/5, 16 pp. 20th Session of the Committee on Fisheries. Food and Agriculture Organization, Rome.
- FAO. 1994. Aquaculture Production 1985-1992. FAO Fisheries Circular No. 815, Revision 6, 213 pp. Food and Agriculture Organization, Rome.
- Librero AR. 1988. Philippines, pp. 403-428. In: *Fishing Industry in Asia and the Pacific*. Asian Productivity Organization, Tokyo.
- Lin CK. 1989. Prawn culture in Taiwan - what went wrong? *World Aquacult.* 20(2): 19-20.
- Macintosh DJ, Phillips MJ. 1992. Environmental issues in shrimp farming, pp. 118-145. In: de Saram H, Singh T (eds) *Shrimp '92 Hong Kong*. Infofish, Kuala Lumpur.
- Mito S, Fukuhara O. 1988. Aquaculture development in Japan, pp. 39-72. In: Juario JV, Benitez LV (eds) *Aquaculture Development in Southeast Asia and Japan*. SEAFDEC Aquaculture Department, Iloilo, Philippines.