Marine fishes and coastal resource management: Mangrove-friendly development strategies

LUIS MARIA B. GARCIA
JOEBERT D. TOLEDO
and
RENATO F. AGBAYANI

Southeast Asian Fisheries Development Center
Aquaculture Department
5021 Tigbauan, Iloilo, Philippines
<wgarcia@aqd.seafdec.org.ph>

Recent statistics of fishery production in the Philippines reveal outputs that are either declining (municipal fishery) or levelling off (commercial fishery and aquaculture). These trends are, in part, a reflection of the serious effects of unregulated economic activities in the coastal zone. The degradation of coastal ecosystems means a loss of livelihood among many communities of impoverished fishers as catches from municipal waters have declined over the years. Considering that mangroves, seagrasses, and coral reefs are vulnerable to anthropogenic perturbations, several development strategies are presented to meet the twin issues of ecosystem conservation and food security for coastal fishing communities. Mariculture, searanching, habitat alteration and restoration are a few of these strategies. Our recent experience in village-based reef resource management in Mararison Island, central Philippines may likewise be a viable option in the management of shoreward ecosystems (mangroves and seagrasses). In particular, the establishment of a marine reserve in the island may find some relevant applications in mangrove management and development.

The practice of raising and harvesting fish from man-made impoundments has been considered an answer to the worldwide food shortage anticipated in the early 1970s. Population growth particularly in many developing countries has been increasing at rates that national natural resources cannot sufficiently support. As a consequence, many countries undertook aquaculture and fishery development as a matter of national priority.

The conditions in the Philippines exemplify this situation. Typically, the country's population subsists on rice and fish, the latter having a per capita annual consumption of about 36 kg (BFAR 1997). Of this figure, 78% consists of marine fishes, crustaceans, and molluscs or commodities that are dependent on the integrity of coastal ecosystems from where they are harvested from the fishery and aquaculture. But, the country's population has been rising at 2.3% annually, which is now slightly higher than the overall annual growth rate of fish production from aquaculture and fisheries (BFAR 1997). In fact, a closer analysis will reveal distressing signals from the country's overall capacity to produce fish to feed its growing population. Clearly, this scenario calls for sustainable strategies to

meet the twin issues of attaining national food security and the conservation of coastal resources. This paper examines these possible strategies, with emphasis on the conservation of coastal ecosystems, particularly mangroves, in the Philippines.

Fish production and coastal ecosystems

Being an archipelago, the Philippines has one of the world's most extensive coastlines that stretches for more than 17,400 km. Its coastal area of 2.2 million km^2 comprises 12% of its total territorial waters including its exclusive economic zone. Indeed, the rich fauna and flora in mangroves, seagrasses, soft-bottom communities, and coral reefs have supported the high biological productivity of coastal areas.

The functions and services of these major coastal ecosystems are interdependent with each other such that the degradation of one will result in a decline in other ecosystems (Figure 1). Generally, shoreward coastal ecosystems (mangroves and seagrasses) buffer the influence of terrestrial perturbations on seaward ecosystems (coral reefs), which in turn buffer oceanic influences on mangroves and seagrasses (Ogden 1987). For instance, mangroves and seagrasses act as sediment traps to ensure the clarity of nearshore waters that promotes the growth of coral reefs; in turn, reefs protect the coastline to enable the growth of mangroves and seagrasses. This symbiotic relationship among coastal ecosystems is highly vulnerable to natural and anthropogenic perturbations, especially when juxtaposed with the basic issue of food security for impoverished fishing communities.

Indeed, this dilemma has been reflected in declining levels of fish production from coastal areas in recent years. Total fish production has been steadily rising to over 2 million tons since 1985. However, the outlook of the various sectors of the fishing industry reveals a different picture (Figure 2). While aquaculture production has been increasing, municipal fishery production has been declining since 1991 to date. Commercial fishery production appears on the rise, but it also began to decline

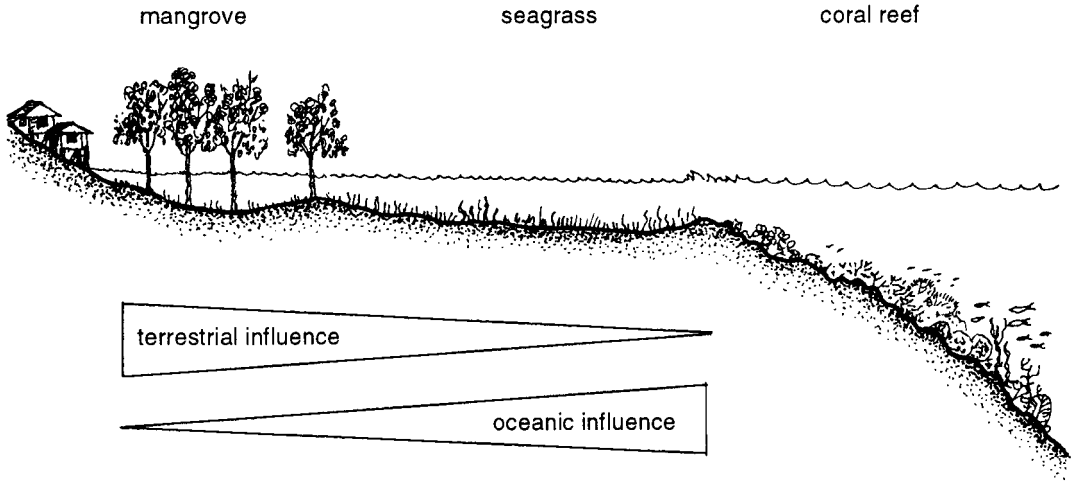

Figure 1. **Interactions of coastal ecosystems (Ogden 1987)**

beginning in 1995. These recent figures reflect a very serious conflict in the use and exploitation of resources in the coastal zone. As well, these developments have serious socioeconomic consequences, which have spawned issues in coastal zone management that are difficult to resolve.

A clear example of such a conflict is the utilization of mangroves and its associated resources. Half of the loss of mangroves in the Philippines has been a result of extensive conversion to brackishwater aquaculture ponds (Primavera 1995). Ironically, these conversions have, in part, been promoted by the national government in order to utilize these so-called "swamp and wastelands" for the generation of revenue for the national treasury. What was once common property utilized by communities of traditional users in the coastal zone has now been transformed into a single-use property employed by a few entrepreneurs (Bailey 1988). When taken as a complete system, mangroves produce multifunctional services and goods worth US$10,000/ha annually (about equal to net profits gained from intensive shrimp culture) that benefits many traditional resource-users (Primavera 1997; Constanza *et al.* 1998).

In addition, the loss of mangrove ecosystems and its attendant goods and services has consequently reduced fishery harvests over the years. Indeed, recent fishery statistics support the notion that the mangrove ecosystem is essential in maintaining productive catches from the municipal fishery (Camacho & Bagarinao 1987; Figure 3). Reduced catches from municipal waters translate into further marginalization of about 2 million impoverished coastal fishers. These fishers comprise the municipal fishery sector who, unlike aquaculture and commercial fishery workers, do not have the means to easily shift from their resource-based livelihood. Wise-use of the mangrove resource base, in addition to other critical coastal resources, that support the municipal fishery must therefore become a national priority.

Mangrove-friendly development strategies

Food production and resource conservation are at two opposing extremes. To illustrate, open pond development in brackishwater entails in varying degrees damage to mangroves, thereby increasing demands on the carrying capacity of the environment. Reconciling these two goals is a difficult issue to resolve, especially in the face of increasing population in the coastal zone. But, there are development strategies in the coastal zone that may be appropriate in the conservation of the mangrove ecosystem. These aquaculture and fishery strategies do not however totally downgrade the importance of other coastal ecosystems (seagrasses, coral reefs, soft-bottom communities), which are as critical as mangroves in supporting the biological productivity of the coastal zone. In fact, these strategies are applicable and appropriate to the other coastal ecosystems as well. For aquaculture, the impacts of producing fish may be minimized by either locating culture activities outside of mangrove areas or, if necessary, utilizing the natural biological productivity of mangroves to supplement the dynamics of the culture system. Hence, if well-managed, low-impact aquaculture may be viewed as mangrove-friendly aquaculture.

Mariculture

Mariculture in nearshore waters may be in the form of stake and bottom culture of oysters, mussels, and seaweeds, a low-impact practice for augmenting income from artisanal fisheries. Rock mounds ("amatong") deployed in shallow waters aggregate fishes and crustaceans (Yao & Bojos 1988).

A practice called "tambak tumpangsari" introduced from Indonesia involves the integration of open

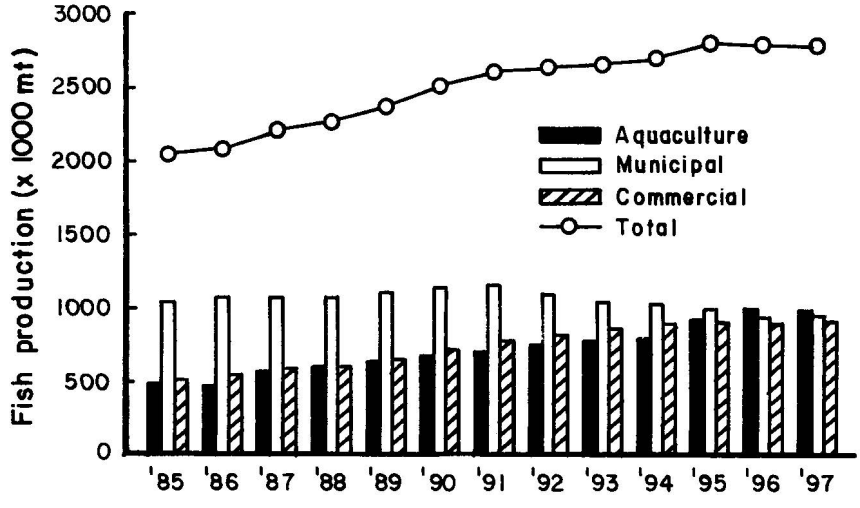

Figure 2. **Fish production of the Philippines 1985-1997** (BFAR 1997)

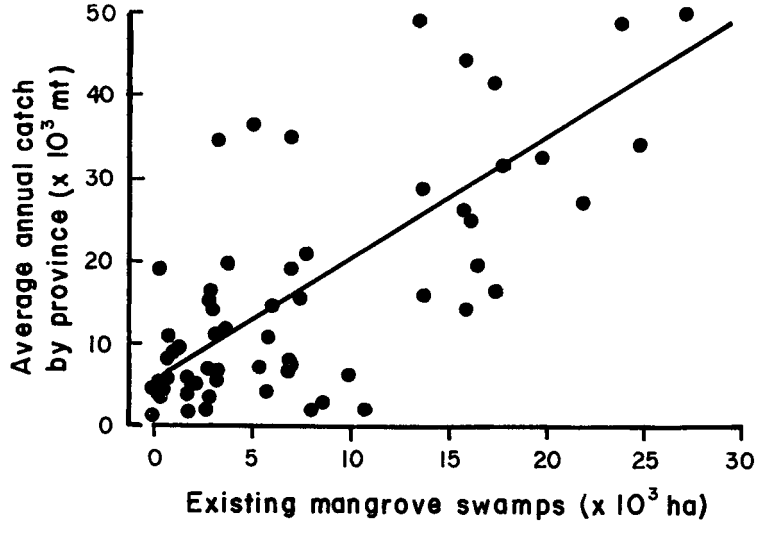

Figure 3. **Relationship between existing mangrove area and municipal catch in the Philippines** (Camacho & Bagarinao 1987)

ponds in mangrove areas. The dikes of these open ponds and seaward tidal flats are planted various mangrove trees for protection against wave action, firewood, and organic fertilizer (from leaf litter) for natural plankton growth in the pond (Primavera 1993). In this practice, forestry and aquaculture activities (aquasilviculture) appear compatible with one another. Relative to the pond area, the areal cover of the mangrove forest may vary from 60% to 80% (JH Primavera, F Takashima, WJ Fitzgerald, this volume). Instead of open ponds, a variation of "tambak tumpangsari" is the integration of pen culture in mangroves. The feasibility of such method has been recently tested in grouper and mud crab (JD Toledo and A Triño & E Rodriguez, this volume).

Searanching

Searanching refers to the release of hatchery seed to the open sea and their harvest after attaining market size. Although well established for over a century in Japan, very few successful attempts have been recorded with open water releases of warmwater fishes (Bohnsack 1996). Practical aspects that must be considered in applying this strategy for resource enhancement includes low survival and potential damage to wild populations. And, for many temperate species, the economic feasibility of hatchery seed releases depends on the cost of juveniles, return rate, and the market price of re-captured fish (Moksness & Stole 1997).

In the Philippines, there is no report of any large scale attempt at searanching in mangroves or in the other marine ecosystems, in part, because of these practical considerations. Reports of the number of fish released by government agencies are common, but survivors and effects on fishery yields are lacking. The application of searanching initiatives developed in Japan may not, as yet, be suitable in developing countries. Obstacles in these countries abound in the form of prevailing values and attitudes towards resource use (e.g., “catching more fish means more money”), infrastructure (e.g., few hatcheries, poor research practices), legal framework and capacity (e.g., poor enforcement of fishery regulations), and capital (Ungson 1993). Nonetheless, this strategy may in time be a viable option to re-seed the fishery in the coastal zone.

Habitat alteration and restoration

A major impact of increased anthropogenic activities in the coastal zone has been the degradation of natural habitats provided by coastal ecosystems. Extensive deforestation of mangroves over the years have reduced fishery harvests as mangrove-associated habitats produced recruitment failures of economically important fishes (Pauly & Chua 1988; Turner 1977; Figures 2 and 3). Recently, various initiatives to restore these habitats have been attempted, but the magnitude of the effort remains insignificant due to the extensive loss of mangrove areas estimated at 3,000 km^2 (Primavera 1995). These efforts were initiated by a development aid-funded government program in 1991 until 1994, but the actual reforested area fell short of targeted levels (FSP 1996). In contrast, a development strategy involving coastal communities fared better, supporting the concept that involving local stakeholders positively promotes co-management of fishery resources (Johannes 1981; Jentoft 1989; Christie & White 1997; Baticados *et al.* 1998). With support from both local government and non-government organizations, and the pre-requisite need for community preparation and organizational development, mangrove reforestation initiatives have been carried out with a measure of success. Each awarded a 25-year land tenure on the mangrove reforestation area, households belonging to a fishermen’s cooperative in Kalibo, Aklan were able to re-plant a 50 ha foreshore area near an estuary, maintain, and then derive income from it to date (through partial harvesting of nipa and other mangrove-associated by-products). Similar cases have been documented in Thailand and Vietnam (Quarto 1996).

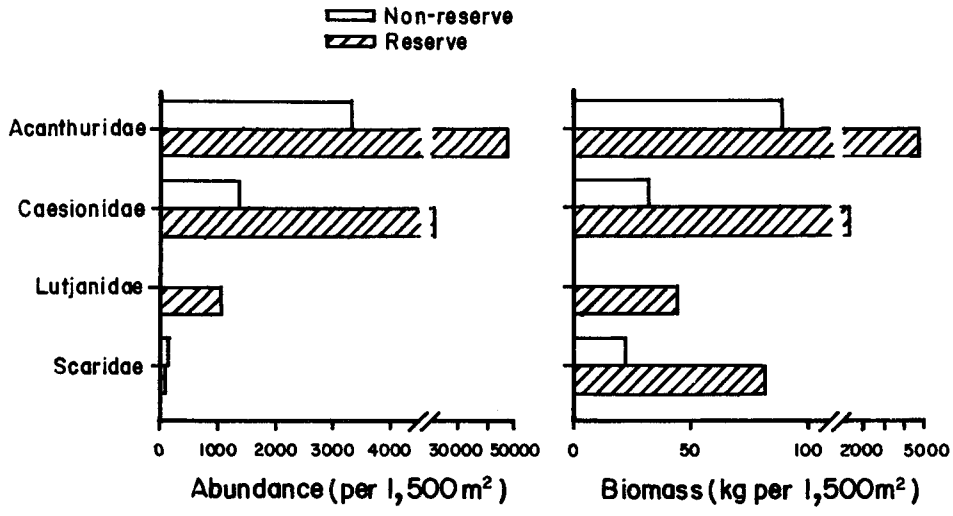

Figure 4. **Abundance and biomass of target fishes from adjacent reefs in Mararison Island, central Philippines declared a reserve (Gui-ob) or a non-reserve (Nablag)**

Protective management

A conservation strategy is a realization of the importance of coastal ecosystems in supporting the municipal fishery. Indeed, a conservation strategy that sets aside a certain area as a "no-take" zone is becoming widely popular, particularly in many reef areas (Roberts & Polunin 1993). The establishment of these zones or marine reserves has been justified with its perceived benefits on coastal fisheries, notably the replenishment of recruits that will seed fished areas by protecting spawning stock biomass (Roberts & Polunin 1991). Available evidence from marine reserves show an increase in abundance, mean size, and fecundity of fishes that are preferably targeted by fishers, including the emigration ("spillover effect") of fishes from the reserve to adjacent fished areas (Bohnsack 1996; Russ & Alcala 1996). Likewise, site-attached grouper from marine reserves appeared to have a higher age range compared with those from fished areas (Ferreira & Russ 1995). Dramatic differences in the biomass and abundance of target fishes from fished and no-take zones after two years of protection of a 28 ha reef in Mararison Island, Antique support these previous reports (Figure 4).

The magnitude of degradation and loss of mangroves in the Philippines and elsewhere now calls for the preservation of the remaining growth. The establishment of reserves may be applied to these remaining mangroves as well, enhancing its role in providing critical nursery habitats for many food fishes (Primavera 1998). For instance, the Matang mangrove reserve appeals vital to the maintenance of shrimp fishery in Malaysia by providing a hydrodynamic trap whereby recruitment is enhanced at spring tides, thereby trapping young shrimp at neap tides (Chong *et al.* 1996). In the Philippines, mangrove reserves are few in number (e.g., Bais Bay, Pagbilao Bay) and have yet to be integrated in village-based co-management strategies (Alder 1996). Nonetheless, designating the few remaining stands of mangroves as protected areas may be the last viable option left to arrest the decline of this valuable resource.

Prospects

The need to attain food security has compromised the integrity of natural resources. This dilemma has become very apparent in the coastal zone wherein impoverished fishing communities depend on the municipal fishery for sustenance. Indeed, mangroves and other coastal ecosystems that support fishery productivity have not been spared from degradation. Yet, the promotion of aquaculture and other food production activities may still be compatible with mangroves. Low-impact development activities whether outside of or within mangroves should be viewed as a recognition of the overall importance of this resource to sustain the productivity of the coastal zone. Efforts that involve the participation of all resource stakeholders are essential to maintain the delicate balance of food security and mangrove resource conservation.

References

Alder J. 1996. Have tropical marine protected areas worked? An initial analysis of their success. Coastal Management 24: 97-114

Baticados DB, Agbayani RF, and Gentoral FE. 1998. Fishing cooperatives in Capiz, central Philippines: their importance in managing fishery resources. Fisheries Research 34: 137-149

BFAR (Bureau of Fisheries and Aquatic Resources). 1997. Philippine fisheries profile. Department of Agriculture-BFAR, Manila. 48 p

Bohnsack JA. 1996. Maintenance and recovery of reef fishery productivity. In: Polunin NVC and Roberts CM (eds). Reef Fisheries, p 283-313. Chapman and Hall, London

Camacho AS and Bagarinao T. 1987. Impact of fishpond development on the mangrove ecosystem in the Philippines. In Mangroves of Asia and the Pacific: status and management. Technical Report of the UNDP/ UNESCO Research and Training Pilot Programme on Mangrove Ecosystems in Asia and the Pacific. p 383-405

Chong VC, Sasekumar A, and Wolanski E. 1996. The role of mangroves in retaining penaeid prawn in Klang Strait, Malaysia. Mangroves and Salt Marshes 1: 11-22

Christie P and White AT. 1997. Trends in development of coastal area management in tropical countries: from central to community orientation. Coastal Management 25: 155-181

Costanza R, d'Arge R, de Groot R, Farber S, Grasso M, Hannon B, Limburg K, Naeem S, O'Neill RV, Paruelo J, Raskin RG, Sutton P, and van den Belt M. 1998. The value of the world's ecosystem services and natural capital. Ecological Economics 25: 3-15

Ferreira BP and Russ GR. 1995. Population structure of the leopard coral grouper, *Plectropomus leopardus*, on fished and unfished reefs off Townsville, central Great Barrier Reef, Australia. Fishery Bulletin 93: 629-642

Fishery Sector Program (FSP). 1996. Executive summary: fisheries sector program review. Report compiled by Primex, Inc., Manila

Jentoft S. 1989. Fisheries co-management: delegating government responsibility to fishermen's organizations. Marine Policy 13: 137-141

Johannes RE. 1981. Working with fishermen to improve coastal tropical fisheries and resource management. Bulletin of Marine Science 31: 673-680

Moksness E and Stole R. 1997. Larviculture of marine fish for searanching purposes: is it profitable? Aquaculture 155: 341-353

Ogden JC. 1987. Cooperative coastal ecology at Carribean marine laboratories. Oceanus 30: 9-15

Pauly D and Chua TE. 1988. The overfishing of marine resources: socioeconomic background in Southeast Asia. Ambio 17: 200-206

Primavera JH. 1993. A critical review of shrimp pond culture in the Philippines. Reviews in Fisheries Science 1: 151-201

Primavera JH. 1995. Mangroves and brackishwater pond culture in the Philippines. Hydrobiologia 295: 303-309

Primavera JH. 1997. Socio-economic impacts of shrimp culture. Aquaculture Research 28: 815-827

Primavera JH. 1998. Mangroves as nurseries - shrimp populations in mangrove and non-mangrove habitats. Estuarine, Coastal and Shelf Science 46: 457-464

Quarto A. 1996. Cases of successful community involvement in sustainable management of coastal resources. Aquaculture Asia (October-December 1996). p 18-21

Roberts CM and Polunin NVC. 1991. Are marine reserves effective in management of reef fisheries? Reviews in Fish Biology and Fisheries 1: 65-91

Roberts CM and Polunin NVC. 1993. Marine reserves: simple solutions to managing complex fisheries. Ambio 22: 363-368

Russ GR and Alcala AC. 1996. Do marine reserves export adult fish biomass? Evidence from Apo Island, central Philippines. Marine Ecology Progress Series 132: 1-9

Turner RE. 1977. Intertidal vegetation and commercial yields of penaeid shrimp. Transactions of the American Fisheries Society 106: 411-416

Ungson JR. 1993. Implications of sea ranching in developing countries. Naga, The ICLARM Quarterly 16: 11-13

Yao CE and Bojos R Jr. 1988. Amatong. Canopy International 13: 7-8