

Resource Ecology of the Bolinao Coral Reef System

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(Editor's note: The following is a summary of a forthcoming book with the same title to be published by ICLARM.)

Introduction

Coral reefs are the habitats of thousands of species in Southeast Asia. In the Philippines, several hundred species are harvested commercially. The harvesters are generally poor, occupationally immobile, culturally and linguistically diverse, clan-oriented and rapidly increasing in numbers. Many of the coastal reefs are subject to combinations of growth, recruitment and ecosystem overfishing, as well as the more destructive stages of Malthusian overfishing, such as blast and cyanide fishing. These factors make effective management of the reefs difficult in both theory and practice.

A project was initiated in 1986 to investigate the ecological aspects of a harvest system used for the coral reefs in Bolinao, Pangasinan, in northwestern Luzon. It involved the Marine Science Institute (MSI) of the University of the Philippines (UP), the International Center for Marine Resources Development (ICMRD) of the University of Rhode Island and ICLARM. The project was developed as part of the US Agency for International Development (USAID) Fisheries Stock Assessment Collaborative Research Support Program. The study included the monitoring of daily landings at 11 sites, weekly boat mappings and samplings of catches by gear, bimonthly underwater fish counts at 24 sites and sample trawlings at 12 seagrass sites, quarterly questionnaire surveys, and periodic aerial, satellite, demographic and economic data gatherings.

During 1987-1991, the project resulted in five M.S. degrees and more than 12 formal publications on subjects ranging from ecological analysis to village-level

management. As of January this year, fieldwork has been sponsored by the Fisheries Sector Program of the Philippines, a sponsorship which is expected to continue until mid-1993. Funding is currently being sought to ensure that the project's present activities will extend beyond 1993. The long-term program is aimed at elucidating mechanisms of recruitment and determining the optimal designs for the monitoring systems and marine reserves.

Economic Factors

Bolinao is a large municipality encompassing about 75 small villages with a total coral reef area covering approximately 200 m² (Fig. 1). An analysis of historical population figures indicates that its current population of approximately 50,000 can be expected to double in the next 30 years (Fig. 2), a growth rate which roughly matches that of the country as a whole. As farmlands become overcrowded, the proportion of people dependent on fisheries-related

activities will increase rapidly from its current level of 31%. In 1990, the fishery income of approximately P1,830/month (<\$70) was the lowest obtainable from

the major full-time occupations in the town, and was far below the estimated poverty level set by the Philippine Government of P2,650/month. Of the part-time occupations, the growing shellcraft business was the most lucrative, providing an additional family income of up to P1,350/month.

To enhance the family's income, the children help to gather marketable reef flat organisms. Moreover, given the municipality's generally poor educational facilities, there is often little economic incentive for a family to send its children to school. As a result, the children have become a significant economic force.

Social Factors

The coastal fisheries are dominated by people of Ilocano and Visayan descent.

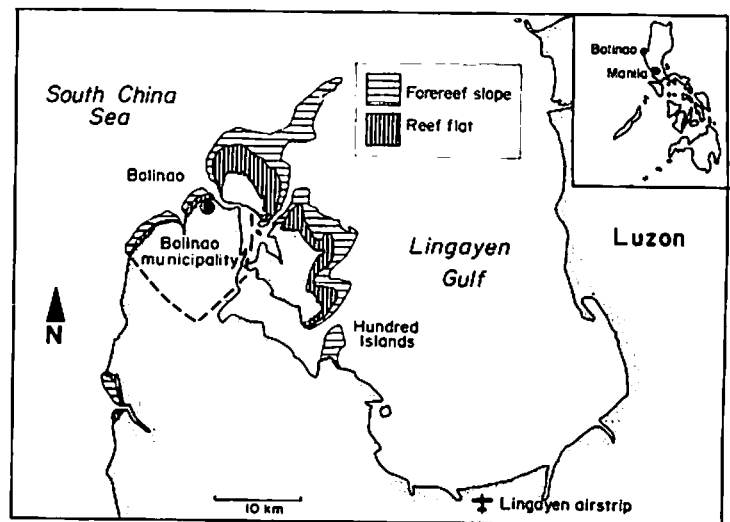


Fig. 1. Bolinao is situated on the western edge of the Lingayen Gulf, facing the South China Sea. The municipality includes areas north of the dashed line, and encompasses farmlands and coastal areas bounded by fringing reefs.

Each group is linguistically and culturally distinct, including the Bolinaos who developed a unique language prior to the migration of the Ilocanos and Visayans

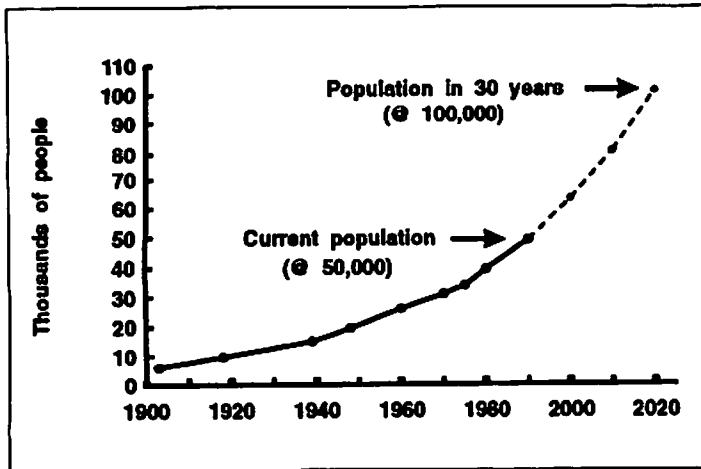


Fig. 2. Population growth estimate for the Bolinao municipality. The estimate was based on a log-linear regression and is close to the current national growth rate. An effective program of family planning would be critical to the success of any local development program (Local Government Office, Bolinao).

a few decades ago. The people are divided into clans of extended families and close associates. The elders of each clan strongly influence opinions, decisions and votes. Interclan and intercultural group rivalries have been important factors in determining the success and failure of local development programs.

Local attitudes have caused the failure of numerous programs to eliminate blast and cyanide fishing. While it is generally known that these techniques are destructive (and illegal), there is insufficient societal pressure to overcome the perceived need for the individual gain to be achieved with their use. This attitude is similar to that in the US toward jaywalking, which is illegal and yet rampant. To make destructive fishing socially unacceptable, group dynamics sessions and information campaigns, especially among the young, as well as community organizing activities must be vigorously pursued and made a major developmental goal for the municipality of Bolinao.

Ecosystems

At Santiago Island, where most of the fishing and research occurred, the

fringing reef consists primarily of a slope and flat, separated by a wave-breaking reef crest (Fig. 3). An analysis of the periodic data from 15 transects on the reef slope revealed that adult fish populations had dropped substantially in abundance over a four-year period. Even a sudden pulse of abundance in 1991 quickly dissipated, although a diversity of juveniles settle on the reef slope during the month of May.

Determining whether or not these abundances are dependent on the local stocks of adult fish which will decline as well will require several more years of data, and thus be the major focus of future monitoring efforts.

The wave-breaking reef crest is critical to fishery as it permits the use of flat bamboo rafts for the reef flat. The 32 km² area of reef flat includes an irregular lagoon of 2 km² which surveys in 1978 showed to be filled with dense abundances of corals and fish. However, a survey in 1986 revealed that 60% of the corals had been killed, mostly by blast and possibly

by cyanide fishing. Fish are now noticeably reduced among the remaining living corals and difficult to find in the sand and rubble. As with the reef slope, adult fish on the reef flat are uniformly reduced nearly to the point of rarity. Unlike the slope, however, juvenile recruitment in six visual transect sites was very irregular from year to year, with no simple relationship to seasonality.

Another 27 km² of the reef flat is dominated by seagrass, interspersed with a few square kilometers of intertidal sand flats. The seagrass is very heterogeneous in composition, density and depth, making it difficult to analyze through remote sensing. The dominant fish is a rabbitfish, *Siganus fuscescens*, which migrates off the reef slope to the east as an adult (*barangen*) 2-4 days after a new moon twice a year. Its juveniles (*padas*) enter the area soon afterwards, and are caught for use as fermented salty fish paste (*bagoong*). Besides rabbitfish, cardinalfish (Apogonidae) are also proportionally very abundant in the seagrass at night where they and other seagrass fish are relatively safe from blast fishing because of their wide dispersion and mobility. However, the general dependence of cardinalfish on corals for cover during the day suggests that a substantial change in the seagrass fish community will occur if coral depletion continues.

Recommendations

The major gear use areas on the reef flat are illustrated in Fig. 4 along with the proposed marine park/reserve system. The location accounts for fish and invertebrate breeding, migration and distribution patterns, current patterns, and habitat diversities. The site does not totally encompass the fishing grounds of any particular gear. The displacement of fishing activities among several villages is distributed.

It would be a simple matter to initiate

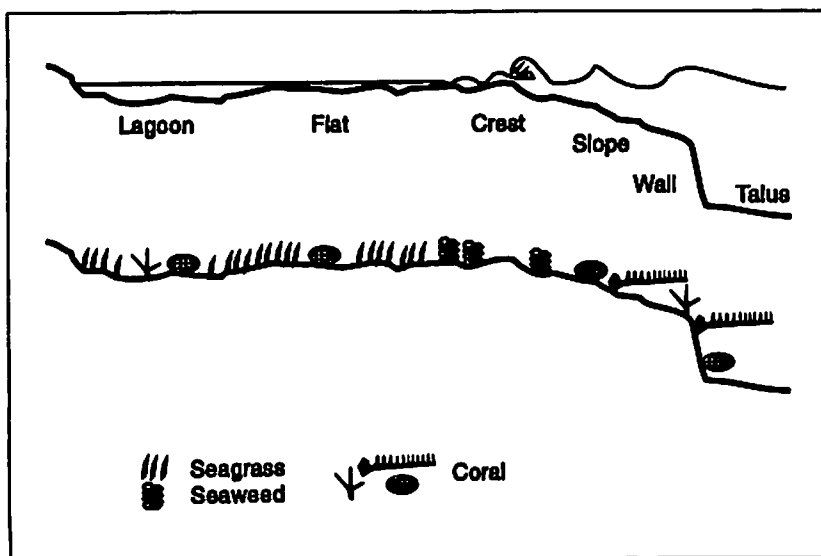


Fig. 3. Reef profile along a northward transect from Santiago Island (3x vertical exaggeration). Reef geomorphology governs the distribution of gear types and target organisms.

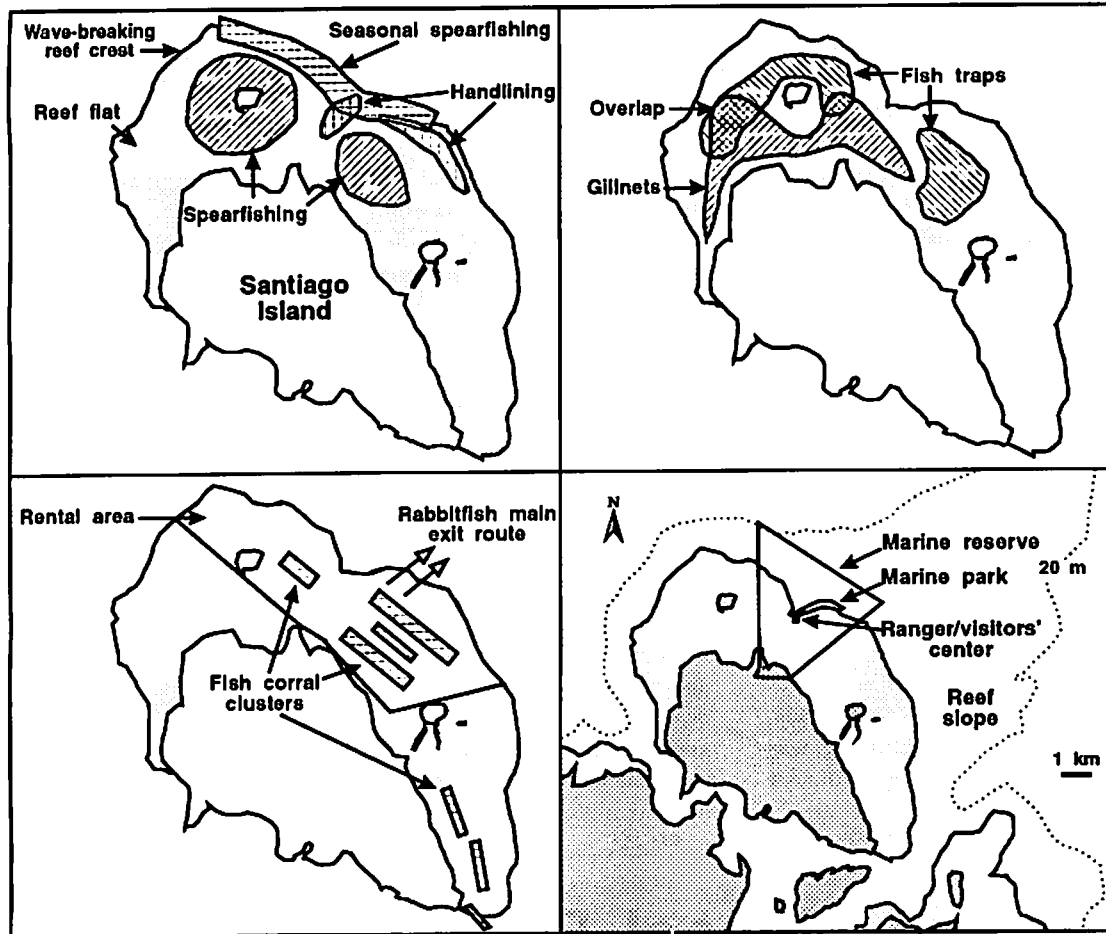


Fig. 4. Primary fishing areas on the Santiago Island reef flat and the proposed marine reserve/park system. Fees charged from diving tourists for the use of permanent moorings in the marine park will help support the marine reserve.

government legislation to make the reserve official. However, experience has clearly demonstrated that in order for the reserve to be effective, it must be initiated at the village level. Thus, the programs recently launched by Foster Parents Plan International will seek to bring their recommendations for the reserve/park system and other affected areas as close to reality as possible.

For now, the project has resulted in the following recommendations:

1. Establishment of a committee to plan and regulate the development of tourism to ensure that it is directed toward providing employment for fishers and maintaining local natural resources.
2. Development of alternative livelihoods for at least 60% of the existing fishers and gatherers, and all future residents who would otherwise become occupied

in the harvesting of marine resources. To be effective, a livelihood should provide an income beyond the combined incomes of a harvester and her or his children. Upgrading local educational facilities would increase occupational mobility.

3. Development of nondestructive mariculture activities to provide food, income and livelihood to alleviate some of the harvest pressures borne by the natural ecosystem, and to provide a strong incentive for the maintenance of a healthy marine environment. The introduction of sustainable multicrop agriculture (e.g., permaculture) will further reduce harvest pressure.
4. Establishment of reserve areas to provide undisturbed breeding grounds for reef species and to augment stocks

of fish and invertebrates in surrounding areas through larval dispersal and adult migration.

5. Implementation of a program of public education and enforcement to eradicate completely blast and cyanide fishing from the area because of their destructive effects on the organisms and their environments, and on the potential growth of diving tourism.
6. Banning of compressor diving (hookah) to protect existing deepwater breeding populations from overexploitation and to remove the myriad occupational hazards associated with this practice.
7. Improvement of fish handling facilities so as to reduce postharvest losses to spoilage, minimize health hazards from unsanitary conditions, increase local incomes by promoting more local processing, and increase the market value of exports by

meeting higher quality control standards.

8. Establishment of programs to reduce local birth rates so that as total resource levels rise, so will the returns of the individual harvesters.

These recommendations could be critical in avoiding a very distressing future scenario for the municipality of Bolinao. However, it is hoped that they will also serve as starting points in designing the assessments of other coral reef systems with similar problems.

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