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The University of the Philippines—Marine Science Institute (Diliman)—College of Fisheries (Visayas)

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WORKING PAPER SERIES

Working Paper 52

OVERFISHING ON A PHILIPPINE CORAL REEF
A GLIMPSE INTO THE FUTURE

by
A.G.C. del Norte, C.L. Nanola,
J.W. McManus, R.B. Reyes,
W.L. Campos and J.B.P. Cabansag
University of Rhode Island
University of the Philippines

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The Fisheries Stock Assessment CRSP (sponsored in part by USAID Grant No. DAN-4146-G-SS-5071-00) is intended to support collaborative research between U.S. and developing countries' universities and institutions on fisheries stock assessment and management strategies.

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The University of Rhode Island
126 Woodward Hall
Kingston, Rhode Island 02881

ABSTRACT

Increased fishing effort by coastal populations heavily dependent on coral reef fisheries in developing countries has led to overfishing, ecosystem degradation and reduced fish yields. Efforts to model fish populations making up these entire communities are currently limited by inadequate stock assessment methods. In particular, current methods based on length-based modal progression analysis are ineffective when overfishing severely limits the range of length classes available for analysis.

This paper reviews the available information pertaining to the overfished reef fishery in Bolinao, Philippines. The impacts of fishing are evaluated through various fishing practices (both destructive and non-destructive), catch and effort information and species composition data from multiple gears. Management schemes through the application of both fishery regulations and environmental enhancement measures are suggested to ensure the viability of the ecosystem.

INTRODUCTION

Coral reefs provide an important source of animal protein in developing countries. Reported fish catches in Southeast Asia are composed of some 30% coral reef fish. In the Philippines, coral reef fisheries contribute 10-20% of the total marine catch (Carpenter, 1977; Murdy and Ferraris, 1980; Alcala, 1981). However, the increase in fishing effort due to the increase in coastal populations dependent on these resources, has led to overfishing, ecosystem degradation and declining fish yields. On the other hand, stock assessment techniques and methodologies appropriate for multispecies tropical environments exploited with the use of multiple gears are currently inadequate to guide management and ensure the sustainability of these fisheries.

The reef fisheries system in Bolinao, northern Philippines, is an example of these multispecies and multigear operations. To address the challenge stated above, a long-term intensive monitoring of the fishery and <u>in situ</u> fish community commenced in July 1987 with funding from the U.S. AID Stock Assessment Collaborative Research Support Program (CRSP).

In this paper, we review the most important characteristics of this fishery, as well as the preliminary

results of our survey activities. This project is expected to last for several years, during which, we will generate a good database for the study of Southeast Asian reef fisheries. Concurrent with efforts to understand the fisheries potential of this complex fishery are attempts to search for methods that can be applied to model fish populations that constitute the entire community.

The Study Area:

Bolinao lies on the southwestern tip of Lingayen Gulf in northwestern Luzon, Philippines (Fig. 1). The reef flat that fringes Santiago Island is located approximately between $16^{o}28'$ north latitude and between $119^{o}53'$ and $120^{o}00$ east longitude. It is approximately 24 km^2 and averages 2 m in depth. The inshore areas are dominated by seagrasses, mostly *Thalassia hemprichii* and *Enhalus acoroides*. Lagoons which are 3-4 m deep, cut across this generally shallow reef flat. Wide sand flats in the northeastern portion are emergent at extremely low water. Towards the reef crest and slope areas, coral rock and rubble substrate replace seagrasses.

Bolinao and the rest of the Lingayen Gulf experience both wet and dry seasons. The southwest monsoon brings rain from June to October coinciding with the typhoon season in the

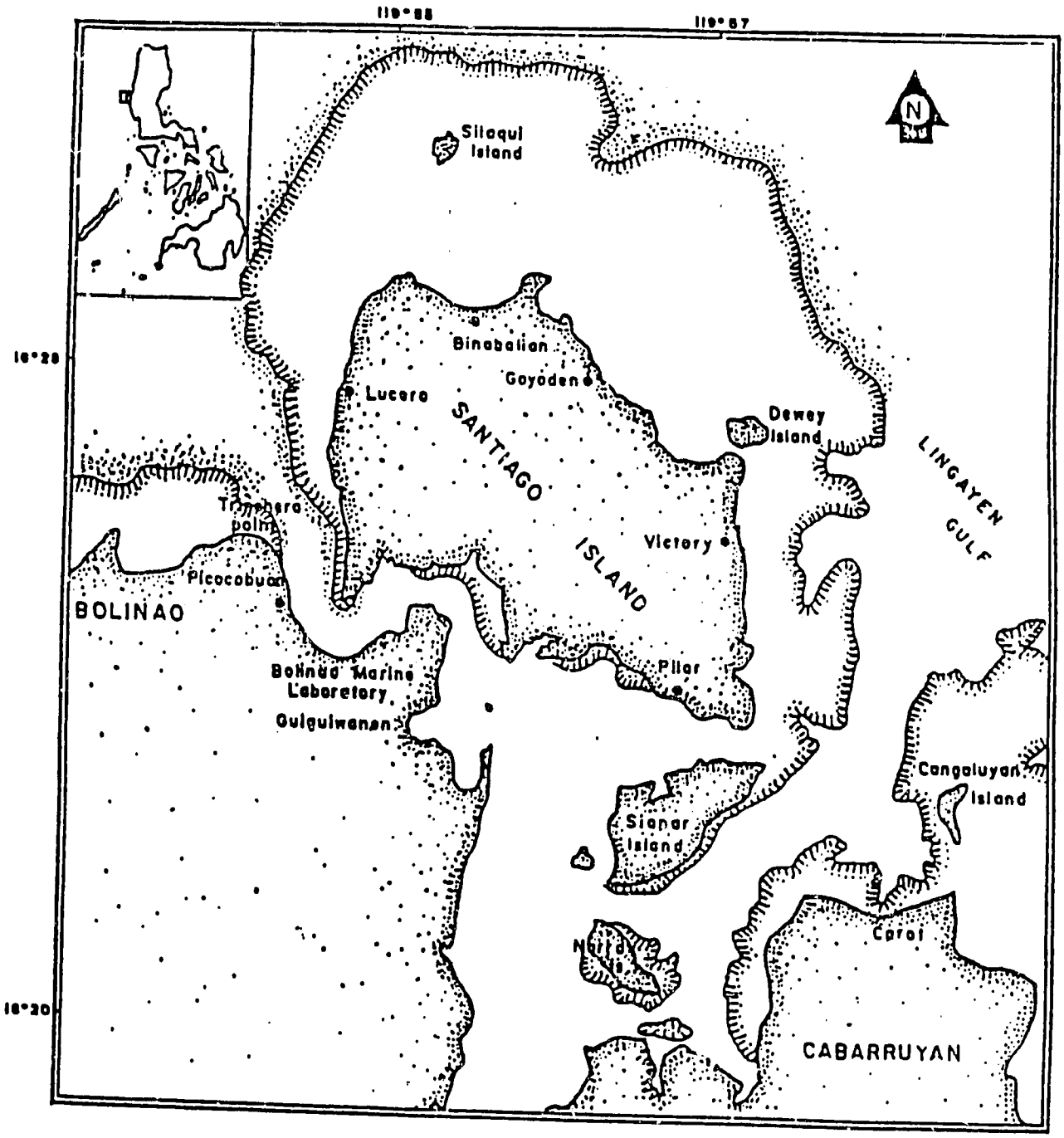


Fig. 1 Map of Bolinao, Philippines, showing location of sampling sites. Inset map: Philippines.

Philippines. The dry season occurs from November to May during the northeast monsoon. On an annual basis, the average wind flow is northwesterly (de las Alas, 1986). Rainfall is less than 100 mm between November and April but exceeds 100 mm between May to October (Estudillo et al., 1985). Air temperature ranges between 31.5°C (June) and 25.2°C (December). Mean surface range of water temperature is 28°C-31°C. Salinity ranges from 31 °/oo to 36 °/oo. The tidal range is about 1.6 m.

The shores that border Santiago Island are either sandy or rocky in nature. Observations from an ultralight aircraft indicate that a substantial area of former mangrove swamps, especially in the eastern portion, have been converted into milkfish (Chanos chanos) and prawn (Penaeus spp.) ponds. A substantial portion of the natural vegetation has been replaced by rice paddies and coconut plantations.

IMPACTS OF FISHING

Fishing Practices:

Fishermen in Bolinao use a variety of fishing methods, both non-destructive and destructive. Table 1 lists the different fish methods/gears as employed in both reef flat and slope areas. A wide variety of legal fishing gears are

Table 1. Different types of fishing methods or gear types used in the Bolinao reef flat and slope areas.

LOCAL NAME	ENGLISH EQUIVALENT/DESCRIPTION
	REEF FLAT
pana	spearfishing aided with light
nasa	bamboo traps with conical opening
pasabing/baklad	fish corrals or weirs
taba	bottom set gill net (10-11 segments)
tabar/tegray	drive-in gill net (can involve 2-38 fishermen)
karukod	seine towed with 2 bamboo rafts with sails
kawil	hook and line
tabukol	cast net
	REEF SLOPE
pana de kompresor	spearfishing with compressor ("hookah" diving)
Kawil	hook and line
parisris	surface drive-in net used with scarelines
bumbong	blasting
palaoy	octopus luring
basnig	bagnet (seasonal: March-October)
	REEF FLAT AND SLOPE
sodyum	sodium cyanide fish poisoning

employed including spearfishing, traps, fish corrals, hook and line and several types of gill nets. The most common illegal fishing methods are blasting and poisoning.

Blastfishing refers to a variety of practices, but the most common involve small charges of explosive powder in bottles or dynamite ignited with fuses (Gomez, 1980). The cost of blastfishing has been reduced even more recently, with the discovery that nitrogen-based fertilizer or powdered urea foam used in boatbuilding can be mixed with small amounts of gasoline and gunpowder to produce bombs (McManus, et al., 1988). Armada (1988) estimated an average catch of 13 kg/blast, with a range of 1.0 and 75.0 kg from blastfishing operations in Lingayen Gulf. However, this estimate is based primarily on the use of dynamite on schools sighted over sandy bottoms. Schools of fish in coralline areas tend to be more highly concentrated, and more adjacent fish tend to be affected. We have recorded an average of 6 explosions/hours around Santiago Island during the months of July, September and November 1987 and April 1988. With 6 hours of fishing, it is not unreasonable to expect that as much as 1800 kg of fish per day are being harvested by blastfishing on the Santiago reef. This figure is extremely crude, and better means of estimation need to be developed.

Blasting is a wasteful fishing practice because fishes of

all sizes, including juveniles, are killed far more than are harvested. The detrimental effects on the coral and other invertebrate fauna are also well-known. Recent reef transect surveys on reef slopes in the area have led to estimates that more than half of the existing coral has been damaged (Menez et al., 1988). In 1986, we estimated the coral damage in 53 lagoonal patches of coral, and determined that approximately 60% of the living coral had been killed. This study was based on ratios of living to dead coral, and did not account for coral which had been washed away or buried. It is therefore an underestimate of the total coral damage, and is indicative of damage only within the past two or three years.

The aquarium fish export industry earns more than $1 M annually for the Philippine economy. Bolinao is one of the three major trading areas (Albaladejo and Corpuz, 1981). Poison is used to stun fish for easy capture, and involves the use of sodium cyanide contained in squirt bottles. This practice leads to high mortalities in the captured fish, and is harmful to corals and other associated fish. Poisoning is also employed in the capture of food fish. Poisons can include sodium cyanide, commercial bleach, or extracts from local roots and seeds. Poisons are reportedly applied directly from various containers, or mixed with shrimp or other bait and scattered by hand. From the ultralight aircraft, we have seen larger scale operations wherein a

motorized boat spreads poison in a large circle up to 100 m across. The stunned fish are then gathered by 20 or more fishermen operating from small bamboo rafts. Blast fishing is often conducted in a similar manner. Both poisoning and blasting are often used in conjunction with circling or drive-in nets.

Past fishing practices in the lagoon area included drive-in net operations such as muro-ami and kayakas. Both involved breaking corals with scarelines (muro-ami) and bamboo poles (kayakas) to drive fish into the nets. Due to this, a larger bulk of the fish caught in the reef flat are now from species associated with seagrass beds.

Illegal fishing practices continue to proliferate for a number of reasons such as: high profits, present market structure which hinders fishermen from earning more than they should, traditional use and social acceptance of illegal gears, fishermen's perception of the resources, declining catch and weak or nonexisting law enforcement (CRMP, 1987).

Another fishing technique used on the Bolinao reef flat is the "karukod", a type of fine-meshed seine (3 mm in the cod end), operated with the use of 2 rafts with sails. This gear is not illegal, but is harmful because the catches constitute newly-settled juveniles of almost all fish species. The more

commercially-important species in the catch, such as siganids, are usually made into fish paste, a common practice especially on Dewely Island within the Santiago Island reef flat complex.

Fish are not the only important edible resources for coastal villages in Bolinao. Gathering on the exposed reef flat areas during low tides is common especially among women and children. The harvest is comprised of bivalves, gastropods, octopus, sea cucumbers and sea urchins, seaweeds and crustaceans. A recent study of this and neighboring reefs indicated that of the total harvest, 39% was finfish, 28% was seaweed, and 33% was composed of invertebrates. Seaweeds and invertebrates were primarily obtained by gathering (McManus et al., 1988). Further information on these aspects of the fishery has been reported in McManus (1989).

Catch and Catch Composition:

Fishing effort and catch rates, as recorded by middlemen, were monitored for the following gears on the reef flat: spear, traps, fish corrals and two types of gill nets (bottom-set and drive-in). Results of the one-year monitoring (April 1987 - May 1988) under the CRSP were presented in Campos et al. (1988). The mean daily catch rates for the various fishing methods were 1.4 kg/mhr for spearfishing, 0.1 kg/trap for traps, 3.5 kg/corral for fish corrals, 0.2 kg/hr

for bottom-set gill nets and 0.4 kg/person for drive-in gill nets. These average daily CPUE's were multiplied by total daily effort to estimate total daily catch. Total annual yield for the entire reef flat was estimated to be at least 12 $t/km^2/yr$ and can be as high as 16 $t/km^2/yr$, if fish kept by individual fishermen are included. These figures show that the high production in seagrass beds approximate known values for coralline areas. However, these are considered preliminary because of inadequate information on fishing effort. More precise estimates of total daily effort by gear and a broader sampling program covering more localities and gears during the second year of survey, will help refine these preliminary estimates.

A short-term monitoring survey of catch and effort for some of the gears was conducted independently by the ASEAN-US Coastal Resource Management Program (CRMP). According to this survey, catch rates for "karukod" and "parisris" (see Table 1) were 54 kg/day and 40 kg/day, respectively (Jimenez et al., unpublished data). However, these figures are again preliminary estimates due to the limitations of the sampling scheme.

Aside from the use of multiple gear types, the overlapping multispecies nature of catches and the lack of representative samples of adult fish compound the complexity of this reef

fishery. To estimate fish biomass on the Bolinao reef flat, a trawl net survey has been underway since August, 1988. Twelve stations are sampled every other month using a roller-frame trawl with a fixed opening of 2 m^2. Initial results presented in Table 2 show low monthly densities of individuals per m^2 and average number of species per station. The catches are dominated mostly by fish juveniles and sub-adults, as well as penaeid shrimps.

Table 2. Preliminary results of the trawl survey over 12 stations, conducted on the Bolinao reef flat.

MONTHS	DENSITY (no./m^2) FISH	SHRIMPS	AVE. NO. SPECIES/STATION FISH	SHRIMPS
August 1988	0.23	0.28	13.0	3.0
October	0.26	-	10.6	-
December	0.20	0.17	13.4	2.3
February 1989	0.25	0.16	11.3	1.7

Two hundred eighty species of fish belonging to fifty three families were recorded from sampling the catch of local fishermen at least thrice a month between April 1987 to May 1988. Although catches from the various gear types represented different species compositions, the ten most abundant species consistently comprised at least 60% of their respective catches by weight (Campos et al., 1988). Figure 2 shows the length-frequency distributions of some of these species.

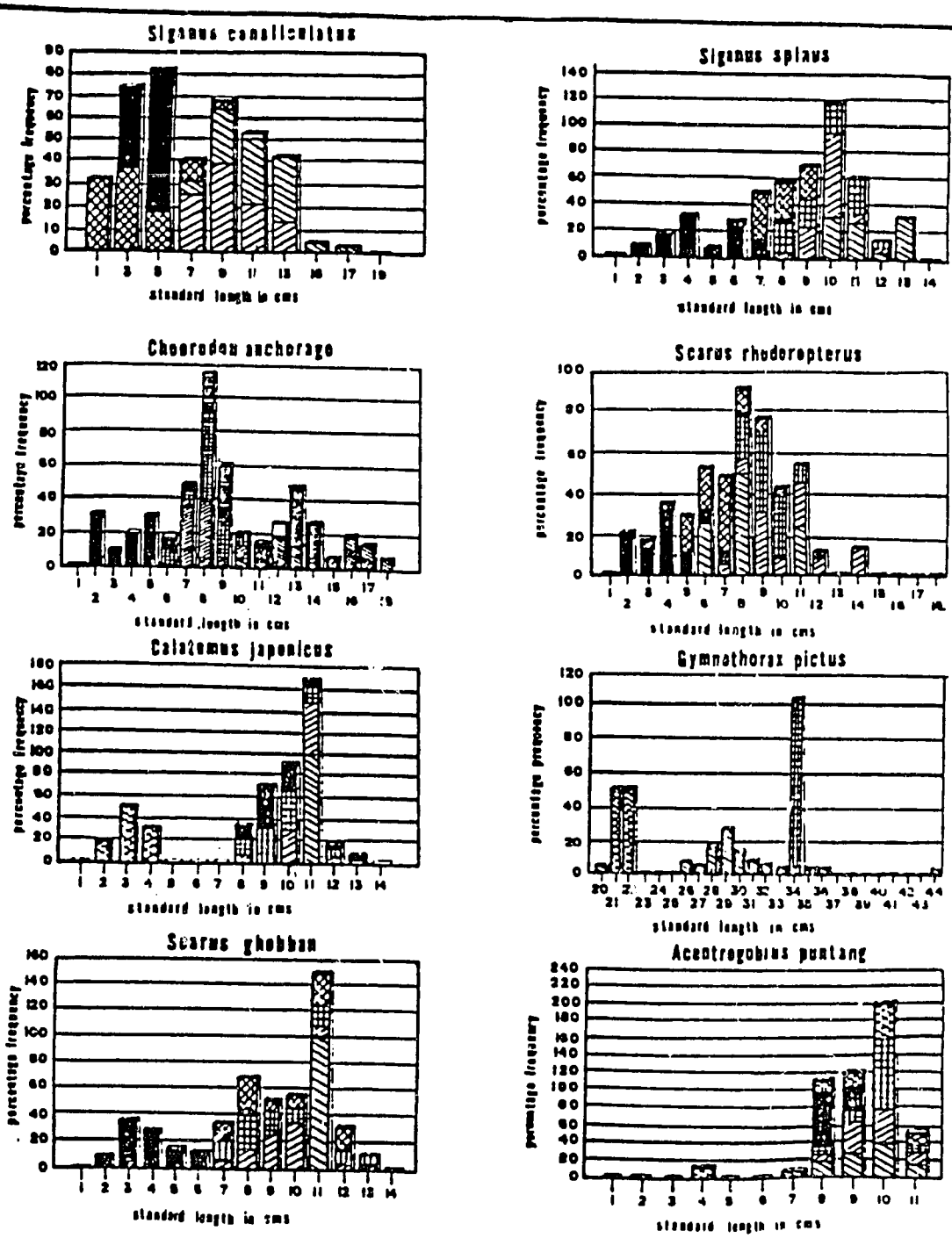
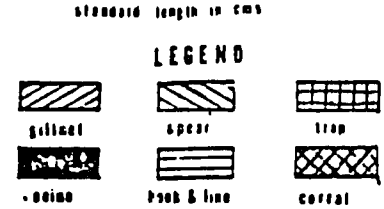


Fig. 2. Length-frequency distributions of the most common species.



The rabbit fish, Siganus canaliculatus distinctly dominated the catches, comprising more than 40% of the total yield of reef flat finfish by weight (Campos et al., 1988). Studying the exploitation patterns and population dynamics of this fish might help us understand the fishery as a whole. This species is caught by various gears (i.e. spear, corrals, gill nets, seine and bagnet) at various stages in its life. This makes ordinary length-frequency analysis based on any one gear biased for selection. Thus, length-frequency data from spear, fish corrals and gill nets (which catch late juveniles and subadults) for S. canaliculatus were assembled and used to derive growth and mortality parameters. The monthly catch-at-length data were then used as inputs to a length-structured form of virtual population analysis (VPA) to estimate monthly recruitment and biomass for the sampling area (del Norte and Pauly, in prep.). Analysis will be continued with the additional inputs of catch and length-frequency data from the seine and bagnet fisheries which target early juveniles of the species. In addition, a broader sampling program has been initiated in the CRSP second year of fishery monitoring in Bolinao. This will provide a more complete data set for more precise estimates of potential harvests and exploitation rates in this reef flat species. Unfortunately, the low individual abundances and restricted size ranges of the remaining species will make analysis difficult even with the summarized VPA approach.

MANAGEMENT APPROACHES: SOME CONSIDERATIONS

Current efforts to manage coral reef areas in the Philippines include coastal zone plans, fishery regulations and the establishment of marine parks and reserves (McManus, 1988). The effect of the latter in increasing fish abundances and standing stock of the highly fished species has been documented (Alcala, 1988). The basis of most of these management schemes is a village-level approach involving the introduction of community organizers who are cross-trained in fisheries and environmental assessment to assist villages in formulating adaptive management strategies specific to local situations (Cabanban and White, 1981; Fox, 1985; 1986; Savina and White, 1986). An extension of this approach to the general case of coastal zone management has been proposed (McManus et al., 1988). Termed Coastal Adaptive Management and Resource Assessment (CAMRA), this approach was designed primarily for the Philippine situation, but some aspects may be feasible in other countries as well.

Fishery regulations and active environmental interventions represent the dualistic nature of activities needed for fishery or coastal resources management (Pauly and Chua, 1988). The success of these projects depend not only on having internal organization, but also external political support to implement the management strategy (McManus et al., 1988).

In the case of the Bolinao reef fishery, the more plausible management measures, not necessarily in this order, include: 1) the establishment of a reserve area where absolutely no fishing operations will be conducted; 2) closed seasons for the siganid fishery, most appropriate during offshore migrations of gravid females (March-May and August-October) to spawn; 3) ban on the use of the "karukod", especially during the siganid juvenile run seasons; 4) habitat enhancement measures such as coral, seagrass and mangrove transplantation, and 5) initiation of efforts to mariculture commercially-valuable species of fish (i.e. floating cage culture) and invertebrates (e.g. giant clams, sea urchins and sea cucumbers) to provide local fishermen of alternative livelihood sources. The increase in mariculture activities may help to focus some social pressure against blasting and poisoning. Concurrently, a high priority must go to programs directed toward giving these activities the extreme level of social unacceptability that they truly warrant. An even higher priority, however, must be placed on the establishment of alternative sources of livelihood to alleviate the immediate pressure on the fishery, and on limiting population growth to keep fishing pressure from growing in the future.

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