Towards Sustainable Development of the Coastal Resources of Lingayen Gulf, Philippines

Edited by Geronimo Silvestre,
Evangeline Miclat and Chua Thia-Eng

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Proceedings of an ASEAN/US
Coastal Resources Management Project Workshop
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Cover: An illustration of a coastal zonation scheme for Lingayen Gulf, Philippines, where major sustainable economic activities are encouraged (artwork by Aque).

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Annex III

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List of Acronyms

ARDP	Artificial Reef Development Project
ASEAN-US CRMP	Association of Southeast Asian Nations-United States Coastal Resources Management Project
BFAR	Bureau of Fisheries and Aquatic Resources
COSAC	Constabulary Offshore Anti-Crime Unit
CPUE	Catch per unit effort
CRM	Coastal Resources Management
CVRP	Central Visayas Rural Project
DA	Department of Agriculture
DECS	Department of Education, Culture and Sports
DENR	Department of Environment and Natural Resources
DOST	Department of Science and Technology
EPA	Environmental Protection Agency
FAD	Fish aggregating device
FAO	Food and Agriculture Organization
FIDA	Fiber Industry Development Authority
GT	Gross ton(s)
hp	Horsepower
IAD	Integrated Area Development
ICLARM	International Center for Living Aquatic Resources Management
IRDC	Ilocos Regional Development Council
JOCV	Japan Overseas Cooperation Volunteers
LOI	Letter of Instruction
MCDP	Marine Conservation and Development Program
MHS	Ministry of Human Settlements
NEDA	National Economic Development Authority
NGOs	Nongovernmental organizations
NPCC	National Pollution Control Commission
PAGASA	Philippine Astronomical, Geophysical and Atmospheric Sciences Administration
PC	Philippine Constabulary
PCG	Philippine Coast Guard
PCAMRD	Philippine Council for Aquatic and Marine Research and Development
PD	Presidential Decree
ppt	Parts per thousand
RDC	Regional Development Council

TURF	Territorial use rights in fisheries
UP	University of the Philippines
UP-CSWCD	UP-College of Social Work and Community Development
UPV	UP in the Visayas
USAID	United States Agency for International Development
USAID-CRSP	USAID-Collaborative Research Support Program

Foreword

The provinces of Pangasinan and La Union are faced with immense challenges. The urgent need for accelerated socioeconomic progress comes under conditions of scant development resources, extensively exploited natural endowments and a burgeoning human population. The two provinces have a combined population of 2.4 million growing at 2% annually. The economically active sector (15-64 years old), which comprises 43% of the population and over half of which are engaged in agriculture, is beset by low incomes and productivity levels and severe underemployment. It is estimated that 65% of the 390,000 families receive incomes below the poverty threshold for the region. Of the combined land area of 6,860 km^2, about 35% is suited for crop production and human settlement and is at present extensively utilized. Another 62% is suitable for limited grazing, fruit trees and forest production and is under increased exploitation. Within limited local government resources and increased competition with other national government development priorities, improvement in social services and infrastructure related to health, education, water and electricity, irrigation, waste disposal, transportation and communications need immediate attention.

Maintenance of environmental quality is of prime importance to the people of Pangasinan and La Union. It is recognized that concerted and long-range efforts are needed in this regard since potential stresses and degradation are likely to increase, given the pressure to meet rising socioeconomic needs and expectations. Concern has been expressed by various sectors in the two provinces for pollution and siltation from mining, farming, forest denudation and increased population in the neighboring upland provinces. Flooding in the Agno-Bued Delta is of increasing concern, together with rising urbanization and domestic pollution in the Patalan-Dagupan area. The concept of integrated area development (IAD) has been incorporated in the current five-year medium-term plans of the two provinces. Such approach is essential for development to be optimally sustainable, given the multiple, competing and sometimes conflicting uses of available areas/resources.

The coastal zone is of special significance in the two provinces. About 35% of the population is in the coastal municipalities immediately adjoining Lingayen Gulf, not to mention the bulk of population is in the Agno-Bued Delta through which rivers discharging into the gulf pass. Capture fisheries and aquaculture are important sources of income, and provide cheap fish protein to inhabitants of Pangasinan, La Union and neighboring land-locked provinces. Water-oriented tourism and recreation are important in the coastal municipalities of La Union and the Sual-Hundred Islands area of Pangasinan. Majority of the economic activities and inhabitants are situated in the coastal belt. This is reflected by the relative concentration of social services and infrastructure in these areas.

Particular concern, however, has been raised with respect to man-induced stresses in the coastal areas. Mangrove denudation, coral reef degradation, overfishing, the use of destructive fishing methods such as explosives and poisons, and siltation and pollution of coastal waters are some of the issues that have drawn increasing attention. Our capabilities in the region to assess the extent of these problems and to prescribe and enforce corrective measures are still largely in

the initial stages of development. We welcome efforts to quantify the nature and extent of these problems and assist us in formulating practical and implementable management schemes toward integrated and optimally sustainable development of the coastal resources of Lingayen Gulf.

The efforts of ASEAN-US CRMP in the Philippines come at an opportune time of serious reassessment of our development priorities and strategies. The approach undertaken offers a refreshingly holistic perspective of current realities in contrast to previous disjunct and largely land-based development orientations. For and in behalf of the people of Pangasinan and La Union, we extend our gratitude and congratulations to all individuals and organizations who have assisted in this endeavor. We particularly would like to thank the International Center for Living Aquatic Resources Management (ICLARM) and the Philippine Council for Aquatic and Marine Research and Development (PCAMRD) for choosing Lingayen Gulf as one of its pilot sites in Southeast Asia for CRM implementation, and the United States Agency for International Development (USAID) for financial support for the project. We look forward to a long and fruitful collaboration.

Rafael M. Colet
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Province of Pangasinan

Joaquin Ortega
Governor
Province of La Union

Preface

The coastal waters of Southeast Asian countries have some of the world's richest ecosystems characterized by extensive coral reefs and dense mangrove forests. Blessed with warm tropical climate and high rainfall, these waters are further enriched with nutrients from land which enable them to support a wide diversity of marine life. Because economic benefits could be derived from them, the coastal zones in these countries teem with human settlements. Over 70% of the population in the region lives in coastal areas which have been recently characterized by high-level resource exploitation. This situation became apparent between the 1960s and 1970s when socioeconomic pressures were increasing. Large-scale destruction of the region's valuable resources has caused serious degradation of the environment, thus affecting the economic life of the coastal inhabitants. This lamentable situation is mainly the result of ineffective or poor management of the coastal resources.

It is essential to consider coastal resources as valuable assets that should be utilized on a sustainable basis. Unisectoral overuse of some resources has caused grave problems. Indiscriminate logging and mining in upland areas might have brought large economic benefits to companies undertaking these activities and, to a certain extent, increased government revenues, but could prove detrimental to lowland activities such as fisheries, aquaculture and coastal-tourism dependent industries. Similarly, unregulated fishing efforts and the use of destructive fishing methods, such as mechanized push-nets and dynamiting, have caused serious destruction of fish habitats and reduction of fish stocks. Indiscriminate cutting of mangroves for aquaculture, fuel wood, timber and the like has brought temporary gains in fish production, fuel wood and timber supply but losses in nursery areas of commercially important fish and shrimp, coastal erosion and land accretion.

The coastal zones of most nations in the Association of Southeast Asian Nations (ASEAN) are subjected to increasing population and economic pressures manifested by a variety of coastal activities, notably, fishing, coastal aquaculture, waste disposal, salt-making, tin mining, oil drilling, tanker traffic, rural construction and industrialization. This situation is aggravated by the expanding economic activities attempting to uplift the standard of living of coastal people, the majority of whom live below the official poverty line.

Some ASEAN nations have formulated regulatory measures for their coastal resources management (CRM) such as the issuance of permits to fishing, logging, mangrove harvesting, etc. However, most of these measures have not proven effective due partly to enforcement failure and largely to lack of support for the communities concerned.

Experience in CRM in developed nations suggests the need for an integrated, interdisciplinary and multisectoral approach in developing plans that provide a course of action usable for daily management of the coastal areas.

The ASEAN Coastal Resources Management Project (CRMP) arose from the existing CRM problems. Its goal is to increase existing capabilities within ASEAN nations in developing and implementing CRM strategies. The project, which is funded by the United States Agency for

International Development (USAID) and executed by the International Center for Living Aquatic Resources Management (ICLARM), attempts to attain its goals through these activities:

- analyzing, documenting and disseminating information on trends in coastal resources development;
- increasing awareness of the importance of CRM policies and identifying, and where possible, strengthening existing management capabilities;
- providing technical solutions to coastal resources use conflicts; and
- promoting institutional arrangements that bring multisectoral planning to coastal resources development.

In addition to implementing training and information dissemination programs, CRMP also attempts to develop site-specific CRM plans to formulate integrated strategies that could be implemented in the prevailing conditions in each nation.

The Philippines has taken a major step in the conservation and protection of its valuable coastal resources through active participation in the development of its CRM plan for Lingayen Gulf. This workshop proceedings, a product of the third in a series of consultative meetings under the auspices of the Philippine component of the ASEAN-US CRMP, reflects the spirit of cooperation and collaboration that would make an operational CRM plan for Lingayen Gulf a reality.

Chua Thia-Eng
Project Coordinator
ASEAN-US Coastal Resources
Management Project

Introduction

The tremendous increase in human population and the intense activities to meet its economic needs have placed immense pressure on the natural resources of developing countries like the Philippines. Coupled with the need for foreign exchange, increased integration into the world commodity markets and economic system, and conventional economic development models, these have led to misuse or abuse of available resources. The fast pace of technological development and economic activities has generally not allowed for the evolution of appropriate attitudes, structures and institutions to check misuse or minimize conflicts in resource exploitation. Cognizant of the increasing problems of resource depletion and habitat/ environmental degradation (and the resulting impoverishment and alienation that these are causing), resource managers and policymakers in the Philippines have taken vigorous interest in the optimal sustainability and integrated development of the country's resources.

The Lingayen Gulf coastal area, located in the northwestern part of Luzon island, illustrates in microcosm the depletion and degradation problems resulting from unplanned and competing resources utilization in the country. Lingayen Gulf covers approximately 2,085 km^2 of water area with a 160-km semicircular coastline bounded by the provinces of Pangasinan and La Union (with an aggregate land area of about 7,000 km^2). In 1987, the combined population of these two provinces was roughly 2.4 million, most of whom were involved in activities in the natural resources sector (agriculture, forestry, fisheries and mining). Some 810,000 people resided in the coastal municipalities bordering the gulf which has an aggregate land area of 1,755 km^2. In 1985, the average income for a family of six in the two provinces was only slightly higher than the official poverty threshold of ₱2,400 (US$120) per month for the region.

The mix of water-based (e.g., capture fisheries, aquaculture, sea transport, tourism) and land-based (e.g., urban development, farming, logging, mining) economic activities in the area has put considerable stress on the resource systems which are the very basis of the viability of these activities. Issues or problems that are the subject of increasing concern in the area include, among others, the following: (1) overexploitation and/or depletion of the fisheries resources; (2) use of destructive fishing methods; (3) mangrove and forest denudation; (4) siltation and sedimentation; (5) coral reef degradation; (6) potential pollution from mining, aquaculture and agriculture runoff; (7) flooding; and (8) the consequences of these on the socioeconomic well-being of the people.

Despite the apparent resource-related problems and widespread concern for the threats to sustainable utilization of Lingayen Gulf coastal resources, the information necessary for proper resources management has remained exceedingly patchy and inadequate, and the competing human uses have remained unrelated and unplanned. It is in this context that the Lingayen Gulf area was chosen as an appropriate site for intensive studies and development of a comprehensive coastal resources management (CRM) plan. Since the commencement of ASEAN-US CRMP activities in Lingayen Gulf in July 1986, a considerable amount of primary and secondary information on the biogeographical, socioeconomic, and legal/institutional features of the study site has been compiled.

Consistent with the need for widespread consultation and the realization that planning is a dynamic, responsive and continuing activity rather than a static one, two previous national workshops were held to assess the available information. The participants came from a wide variety of disciplines and institutional affiliations. The first workshop (held in Punta Baluarte, Calatagan, Batangas, in December 1986) principally focused on the assessment of available secondary information, critical issues and data gaps, and the preliminary coastal environmental profile of Lingayen Gulf. The subjects for intensive studies to fill the existing information gaps or to clarify certain issues were also identified. The second workshop (held in the University of the Philippines (UP), Diliman, Quezon City, in December 1987), on the other hand, was primarily held to assess the data collection and studies initiated as a result of the recommendations from the first workshop.

After the first quarter of 1988, more information became available as the data collection phases of most studies were nearing completion. More concrete inferences and planning of initial management strategies were deemed largely possible based on the available data. Thus, a third workshop intended to bring together resource planners, policymakers and scientists was held in Bauang, La Union (part of Region I where Lingayen Gulf is situated) on 25-27 May 1988.

The choice of venue for this workshop was purposive. First, it encouraged wider participation of the regional government and nongovernmental organizations (NGOs). Second, it indicated that the CRMP, through an act of endorsing its scientific findings, recognized the decentralization effort of the government and the appropriateness of the regional offices being made to decide, plan and manage the coastal resources in their respective areas. Finally, it established good working relationship between the CRMP and the agencies in Region I at the early phase of CRM planning, which should be continuously strengthened until the implementation of the management plan.

The objectives of the workshop were to:

- determine the types of data needed for CRM planning;
- evaluate and analyze the available CRMP data and identify possible data gaps as viewed by both scientists and planners;
- determine preliminary action plans and environmental management strategies in order to attempt to resolve actual conflicts in resources use; and
- identify governmental and nongovernmental organizations that would be responsible for the implementation of the CRM plan.

In line with these objectives, the paper presentations were divided into three sessions:

I: Coastal resources utilization - a presentation of current resources utilization and conflicts arising from these uses;

II: Habitat restoration and enhancement and alternative livelihood - a discussion of activities which will lead to the restoration and enhancement of damaged ecosystems and proposed livelihood projects as alternatives to capture fisheries;

III: Socioeconomic/cultural and legal/institutional framework - an analysis of social and cultural aspects in coastal communities, labor and market forces, cost and return, existing legal framework for coastal resources utilization and development, institutional arrangement for planning and development and management plan formulation.

For the workshop proper, four working groups were formed to tackle (1) CRM issues; (2) socioeconomic/cultural issues in relation to alternative management options and solutions; (3) legal and institutional arrangement for CRM implementation; and (4) revisions of plans and programs of the planning division of the CRMP for Lingayen Gulf. Each working group considered issues raised during the open forum at the end of each session, in addition to those already outlined in the papers presented. For uniformity of outputs, the first three groups were tasked to: (1) outline and prioritize all issues related to their topic of concern; (2) determine and enumerate

causes of these issues; and (3) formulate workable action plans suggesting, if possible, order of priority, agencies to be responsible, timing of action and geographic areas of implementation.

Group IV, on the other hand, embarked on the review and revision of the CRM planning framework, formulation of mechanisms by which the project can accomplish its planning tasks, identification of agencies and personnel to be involved in the drafting of the integrated CRM plan, and development of outlines for the project's ultimate target outputs, namely, a general CRM policy plan, issue-oriented action plans and special area management plans.

The group reports incorporated in these proceedings reflect not only the ideas and decisions generated by the group members, but also those that evolved during the plenary session. At the end, a summary of what transpired during the plenary session is provided, highlighting recommendations deemed most urgent by all participants. We believe that the results of this workshop, and the degree of participation and interaction that they facilitated, have taken us a step closer to an operational management plan towards an optimally sustainable development of Lingayen Gulf coastal resources.

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The workshop and its subsequent proceedings would not have been possible without the assistance and support of various agencies and individuals (both in government and private organizations) to whom we owe special thanks.

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Philippine Tourism Authority
Provincial Government of Pangasinan
Provincial Government of La Union
Sea Farming Research and Development Center

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Session 1

Coastal Resources Utilization

Preliminary Results of a Study of the Municipal Fisheries in Lingayen Gulf

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Abstract

This paper presents a summary of preliminary results obtained during the course of the municipal fisheries and blast fishing studies in Lingayen Gulf covering the period May 1987 to April 1988. Information on gear design and specifications and catch rates of the various municipal gears (including blast fishing) are presented. Results of initial studies on lethal ranges of explosives used in blast fishing are also given. A preliminary attempt to estimate the magnitude of landings from municipal and blast fishing activities gives an aggregate of about 10,500 t/year. This indicates relatively high annual extraction rates of 10.1 t/km^2 of municipal fishing ground, and a yield-to-biomass ratio of 3.97. Recommendations center around the need for reduction in fishing effort and improved management of the fisheries.

Introduction

The term "municipal fisheries" refers to fishing activities that utilize vessels of 3 gross tons (GT) or less, or gears not requiring the use of boats [Presidential Decree (PD) No. 704]. Municipal fisheries are roughly equivalent to artisanal, small-scale or traditional fisheries. A considerable number of residents in the coastal areas of Lingayen Gulf rely on fishing for their main source of livelihood. Of late, complaints of municipal fishermen on low catch rates and economic returns have become more frequent; and concern about the deterioration of their already low socioeconomic standing has been repeatedly expressed. Despite low catches, however, they continue to fish due to lack of alternative sources of livelihood. Some have resorted to illegal fishing methods which are ecologically destructive. The "open access" situation has resulted in an ever-increasing competition for the finite resources the gulf sustains.

The study of Lingayen Gulf municipal fisheries is deemed to be a significant part in the process of formulating an implementable CRM plan. The study, in general, aims to assess the status of the municipal fisheries in the gulf; and specifically, to: (1) estimate the

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catch by municipal gear type and its species composition; (2) determine the seasonality in catch of the various municipal gears; and (3) determine the seasonal and spatial distribution of the gear types and their catches.

Closely associated with the municipal fisheries study is the investigation of blast fishing activities in the gulf. Blast fishing is one of the most common illegal fishing methods in the area. To date, however, there has been no study to substantiate its effects and the extent of damage it causes. The blast fishing study aims to document the types of explosives used in the gulf; quantify fisheries production due to this activity in the area; and evaluate the losses attributed to it.

Lingayen Gulf and Its Municipal Fisheries

Lingayen Gulf is located approximately within latitudes 16°00'N and 16°40'N, and longitudes 119°55'E and 120°25'E (Fig. 1). It is bounded in the west and south by Pangasinan Province, and in the northeast by La Union Province. The mouth of the gulf is bounded in the west by Cape Bolinao and in the east by Poro Point. The gulf has a total area of 2,085 km^2. Table 1 gives the area distribution of the gulf by 10-fathom depth range. The gulf is mostly shallow with about 90% of the area below 90 m.

A series of shoals extends nearly halfway across the entrance from Cape Bolinao. The central and northern entrances are also studded with coralline growth (Warfel and Manacop 1950). From the southern and central portions of the gulf to the eastern coast, the substrate is generally muddy with occasional patches of hard/rocky bottom. Based on bottom type and/or characteristic ecosystems, Lingayen Gulf is often subdivided into three sectors (Mines 1986) (Fig. 1):

- Sector I (Western Coast) - extends from Cape Bolinao to Sual; characterized by coral reefs and seagrass beds;
- Sector II (Inner Coast) - extends from Sual to Damortis; characterized by mangrove and *nipa* swamps, and where the aquaculture industry of Region I is concentrated; and
- Sector III (Eastern Coast) - bounded by the coast of La Union Province; characterized by generally soft and muddy substrate.

Sixteen towns and one city (Dagupan) border Lingayen Gulf from Cape Bolinao to Poro Point. In 1985, the Bureau of Fisheries and Aquatic Resources (BFAR) reported a total of 12,464 municipal fishermen in these areas (BFAR 1985; 1985b; 1985c) (Table 2 and Fig. 2). About 46%, 36% and 18% of these fishermen are in Sectors I, II and III, respectively. A total of 7,054 boats (4,234 motorized and 2,820 nonmotorized) were reported from the area, giving a fishing boat *(banca)*-to-fisherman ratio of 0.57 (Table 2). The lowest ratio occurred in Binmaley (0.07), while the highest occurred in Rosario (1.22). Among the three sectors, Sector III (comprising the La Union municipalities) accounted for the highest *banca*-to-fisherman ratio, 0.91.

Mean municipal landing for the period 1980 to 1984 in the Lingayen Gulf area was about 6,000-8,700 t/year. This implies that each municipal fisherman landed about 0.48-0.70 t/year on the average, or about 40-70 kg/month. Average monthly incomes in 1983 were reported to be about ₱1,120 (US$80) and ₱430 (US$31) for fishermen using motorized and nonmotorized boats, respectively (Ferrer et al. 1983).

The municipal fisheries of Lingayen Gulf are typically multigear and multispecies. Mines (1986) reported 159 species belonging to 87 genera and 55 families in the landings of the municipal fishermen in the gulf. There are 32 types of fishing gears used in the gulf as gathered from various reports (Umali 1950; Lucas 1952; Cefre 1953; Bailen 1978; NCSO 1980; Kitamado 1984; and Mines 1986). Aside from bag net, purse seine and medium/large trawls, the rest of the gears are used by municipal fishermen. The most widely used fishing gears in each city/municipality bordering the gulf are given in Table 3. Note that the gill net and hook line are the most predominant gears utilized.

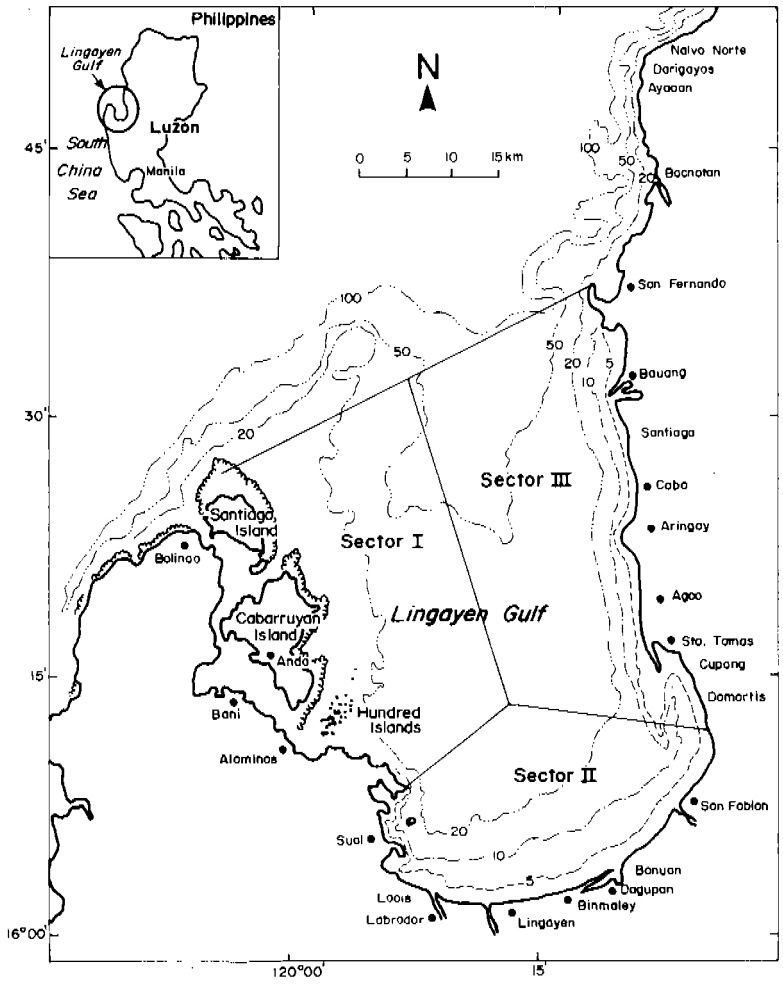

Fig. 1. Lingayen Gulf showing the geographical divisions of its internal waters and surrounding coastal areas. Depth contours in fathoms.

Table 1. Area distribution of Lingayen Gulf by depth range.

Depth range Fathoms	Depth range Meters	Area (km^2)	% of total area
0- 10	0- 18	467	22.4
10- 20-	18 36	352	16.9
20- 30-	36 54	325	15.6
30- 40-	54 72	346	16.6
40- 50-	72 90	374	17.9
> 50	> 90	221	10.6
		2085	100.0

Table 2. Distribution of the number of fishermen and boats by sector in Lingayen Gulf as of 1985.

	Municipal fishermen	Motorized boats	Nonmotorized boats	Boat-to-fisherman ratio
Pangasinan	10,286	2,519	2,550	0.49
Sector I	5,740	1,510	1,930	0.60
Bolinao	2,670	430	1,300	0.65
Anda	1,492	512	292	0.54
Bani	288	102	48	0.52
Alaminos	566	235	195	0.76
Sual	724	231	95	0.45
Sector II	4,546	1,009	620	0.36
Labrador	900	75	15	0.10
Lingayen	1,800	205	55	0.14
Binmaley	56	4	-	0.07
San Fabian	600	100	50	0.25
Dagupan City	1,190	625	500	0.94
La Union				
Sector III	2,178	1,715	270	0.91
Rosario	58	43	28	1.22
Sto. Tomas	336	162	12	0.52
Agoo	464	416	-	0.90
Aringay	313	260	55	1.01
Caba	116	109	20	1.11
Bauang	532	495	48	1.02
San Fernando	359	230	107	0.94
Total	12,464	4,234	2,820	0.57

Source: BFAR municipal fisheries data, BFAR Region I Office, San Fernando, La Union.

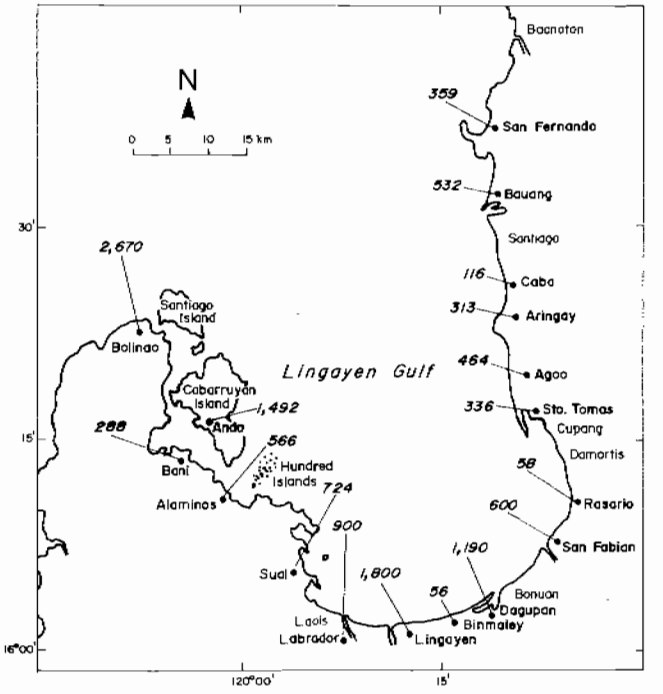

Fig. 2. Distribution of municipal fishermen in the coastal towns of Lingayen Gulf. (Source: BFAR 1985b).

Table 3. Dominant municipal fishing gears used in the coastal municipalities bordering Lingayen Gulf.

Area	Dominant gear	Other gears
Sector I		
Alaminos	Crab lift net	Hook and line, cast net, long line, push net, fish corral
Anda	Cast net	Troll line, fish corral, hook and line, filter net, gill net, beach seine, long line, push net, ring net, *lambaklad*[a]
Bani	Push net	Lift net, gill net, beach seine, cast net, fish corral, long line
Bolinao	Hook and line	Crab lift net, gill net, fish corral, push net, beach seine, filter net, cast net, lift net, long line, dredge
Sual	Hook and line	Gill net, long line, push net, beach seine
Sector II		
Labrador	Troll line	Gill net, push net, long line, beach seine, hook and line
Lingayen	Gill net	Lift net, push net, beach seine, cast net, hook and line, fish corral, filter net, baby trawl, dredge, long line, *lambaklad*
Binmaley	Crab lift net	Cast net, push net, hook and line, gill net, fish corral, round haul, seine, baby trawl, filter net, beach seine, troll line, ring net, *lambaklad*
San Fabian	Gill net	Push net, troll line, cast net, beach seine, crab lift net, dredge, long line, filter net
Dagupan City	Gill net	Cast net, hook and line, push net, crab lift net, beach seine, fish corral
Sector III		
Agoo	Hook and line	Long line, baby trawl, troll line, beach seine, gill net, push net, round haul seine, cast net, ring net, crab lift net
Aringay	Gill net	Crab lift net, baby trawl, push net, cast net, beach seine, dredge, fish corral
Bauang	Hook and line	Gill net, long line, beach seine, cast net, fish corral, ring net, push net, baby trawl
Caba	Gill net	Fish corral, ring net, troll line, push net, baby trawl
Rosario	Gill net	Hook and line, baby trawl, long line, cast net, push net, ring net,
San Fernando	Push net	Cast net
Sto. Tomas	Gill net	Hook and line, push net, fish corral, cast net, filter net, baby trawl, long line

[a]*Lambaklad* is a modified fish corral made of bamboo and net.
Source: NCSO 1980.

Data Collection

Data gathering (beginning May 1987) for the municipal fisheries study was conducted in six fishing towns selected on the basis of dominant (and other) gears found in the area. The fishing towns of Aringay, Agoo and Rosario (all in La Union) were monitored every other day by locally contracted researchers. In Pangasinan, the towns of Sual, Labrador and Alaminos were monitored twice a month by researchers based in UP Diliman, Quezon City, for an average of seven sampling days in one month. Data collected include the magnitude of the catches of municipal fishing gears and their corresponding species and length compositions. Some biological data (e.g., maturity, length, weight) on the more abundant species composing the catches were also obtained. Members of the research team joined fishing trips to observe operations and obtain information for use in validating the data generated through the monitoring surveys.

The initial approach in collecting data for the blast fishing study involved the establishment of sampling stations in selected communities. Twelve areas were identified around the gulf, but only six stations were being monitored thus far (Fig. 3). This is because access to information required systematic building of rapport with fishermen in

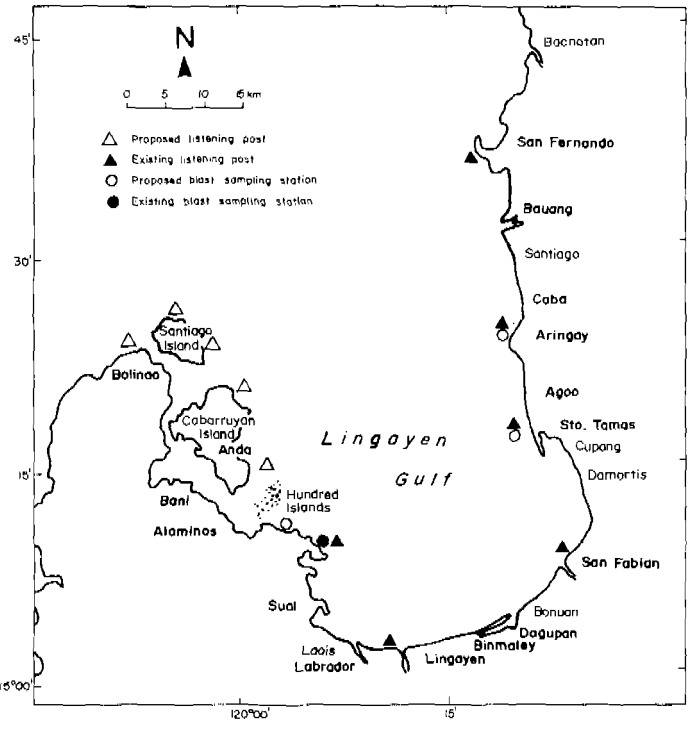

Fig. 3: Sampling stations and listening posts around Lingayen Gulf for the blast fishing study.

the identified localities. The six areas served as listening posts for monitoring the frequency of explosions per unit time interval, and also as catch data collection stations. Systematic sampling of catches has so far been possible only in one of the six areas. Data collected included the total catch/boat-trip, number and type of explosive used, species composition and length-frequency distribution of the more abundant species caught. *In vivo/in situ* experiments (in cooperation with blast fishermen) to determine the lethal ranges and remote damage zones of the different types of explosives used in the area will also be conducted.

Design, Operation and Catch of Municipal Fishing Gears

The data generated thus far allowed the research team to characterize (albeit preliminarily) the typical design and specifications, operation, and catch rate and species composition of the various municipal fishing gears used in the gulf. Illustrations and detailed specifications of the more common or dominant gears/techniques are given in Appendix 1. The species composition data generated for selected fishing gears and towns covered in the study are given in Appendix 2. The mean catch per unit effort (CPUE) and operational details on the various gears in the study sites monitored are presented in Table 4.

Gill nets

Gill nets are rectangular panels of netting designed to gill or entangle fish. They are the most widely used fishing gear in the gulf since they can be used at various depths or types of bottom substrate, either anchored at the bottom or set adrift at the surface or mid-depth.

Bottom Gill Nets (Sigay). These are operated with the use of either a motorized or

Table 4. Mean CPUE, period of operation and estimates of production of various municipal fishing gears in Lingayen Gulf.

Fishing gear	Catch/boat-trip (kg)	Boat-trip/day	Catch/boat/day (kg)	Fishing days/mo.	Fishing mo./yr	Catch/boat/yr (kg)	No. of boats[a]	Production (t/yr)
Motorized bottom gill net	5.37	1	5.37	24	12	1,547	2,168	3,354
Nonmotorized bottom gill net	1.59	1	1.59	24	12	458	1,413	647
Drift gill net	15.25	1	15.25	24	8	2,928	271	794
Hook and line	7.08	1	7.08	12	8	680	186	126
Danish seine	26.80	1	26.80	26	8	5,574	80[b]	446
Speargun	6.84	1	6.84	24	6	985	303	298
Fish corral	4.35	1	4.35	24	12	1,253	39[b]	49
Beach seine	19.66	2	39.32	15	8	4,718	14[b]	66
Lift net	43.33	1	43.33	22	8	7,626	116[b]	885
Drive-in net	57.40	1	57.40	17	4	3,903	32[b]	125
Shrimp trawl	13.85	1	13.85	24	4	1,330	621	826
Beam trawl	118.28	1	118.28	26	4	12,301	36[b]	443
Crab pot	3.79	1	3.79	26	12	1,182	330	390
Fish pot	2.10	1	2.10	15	12	378	258	98
Long line	180.34	1	180.34	12	4	8,656	95	822
Round haul seine	345.00	1	345.00	7	4	9,660	8[b]	77
Scoop net	6.74	1	6.74	24	4	647	31	20
Squid jig	1.81	1	1.81	24	3	130	31	4
Blast fishing	-	1	21.32[d]	26	6	3,326	317[c]	1,054
Total							6,349[e]	10,524[f]

[a]Based on motorized and nonmotorized boat distribution by gear type in the six study sites, with exceptions as noted.
[b]Based on actual counts of existing units in the coastal municipalities of Lingayen Gulf, and observed gear unit-to-boat ratio.
[c]5% of total boat number used for fishing (i.e., 6,349).
[d]From 13.0 kg/blast x 1.64 blasts/boat/day.
[e]Based on 7,054 boats less 10% used for transport, tourism and other activities.
[f]Implies extraction rate of 5.0 t/km^2 for the entire gulf (2,085 km^2) and 10.1 t/km^2 of municipal fishing ground, as well as yield to total biomass (2,655 t) ratio of 3.97/yr.

nonmotorized *banca*, usually with a complement of two persons. The gears are set in waters 4 m to 40 m deep. Nonmotorized units operate in nearshore, shallow waters while motorized units, farther offshore. Fishing usually lasts about 3 hours either at dawn (5 a.m.-8 a.m.) or at dusk (4 p.m.-7 p.m.) and, quite rarely, both dawn and dusk hours depending upon the season. Between 6 and 30 panels or units of netting are used in a single operation, each panel measuring an aggregate of 40-80 m in length by 1.5-2.5 m depth. Mesh size is shifted depending upon the seasonality of preferred target species (e.g., scombroids in July-August, hairtails in November-December, etc.).

Mean CPUEs (kg/boat-trip) for bottom gill nets were 5.37 and 1.59 for motorized and nonmotorized units, respectively (Table 4). The catches of motorized units (operating farther offshore) have been noted to be less diverse compared to those of nonmotorized units (operating in shallower waters). Mean landings by motorized boats in Dulao, Aringay, were dominated (84.2%) by *Megalaspis cordyla, Scomberomous commersonii* and *Euthynnus affinis*. These species made up 50.2% of landings by motorized units in Bani, Rosario. The catch composition data for nonmotorized units from the same localities showed more even distribution among the exploited species. The contribution of demersal species, such as slipmouths (*Gazza minuta, Leiognathus* spp.), goatfish (*Upeneus sulphureus*) and crabs was more significant.

Surface/Midwater Drift Gill Nets (Largarete). These gill nets are designed for catching pelagic species. Each operation involves a motorized *banca* (with 16 hp engine) usually with the complement of two persons. The gears are normally set about 3 km offshore and a single setting involves 15-30 panels/units. Each panel measures about 50 m in length by 3.2-4.0 m depth when set in water. Peak months are from March to September when the sea is calm. The gill nets are used at night and operations ease around the period of full moon. Mean catch rate is 15.2 kg/boat-trip in Tobuan, Labrador, from May 1987 to April 1988. Mackerels (*Rastrelliger* spp.) comprise 58.8% and *Chirocentrus dorab* and *Selar crumenopthalmus*, 22.7% of the drift gill net catches in the area.

Tuna Drift Gill Nets (Liting). Designed to catch tuna and tuna-like species, these gears are operated by two fishermen from a 16 hp motorized boat in waters 15-20 km offshore outside the gulf. Sharks are also a considerable part of the catch. The gears are operated overnight, from 4 p.m.-6 a.m. The fishing season lasts from January to May. Some fishermen who use surface drift gill nets shift to these gears and fish as far as the Ilocos coast.

Hooks and lines

The hooks and lines used in the gulf are single- or multiple-hook types. There are two varieties of the former: one for use in surface waters and the other for deepwater operations. Hooks and lines involve either a motorized or nonmotorized *banca* with a complement of two to three persons. Operations last from 5 a.m. to 4 p.m. at depths of 5-50 m. The gears are used during the entire year although the peak season is from October to December. Catches from the multiple hook and line are often used as bait in the single-hook varieties which are designed for catching larger species/individuals.

Mean catch rate for these gears is 5.9 kg/boat-trip in Tobuan, Labrador, and 7.1 kg/boat-trip for all the study sites. The hook and line gears catch mainly pelagic species. The landings in Tobuan, Labrador, are dominated by *S. crumenopthalmus* (43.3%); and including *S. commersonii, R. kanagurta* and *S. barracuda,* make up 82% of the landings in the area. *Lethrinus lentjan* and *Leiognathus equulus* are usually caught by multiple hook and line in coralline areas.

Long lines (*Kitang*)

These are multiple-hook fishing gears for bottom operations. They are usually set by

two fishermen from either a motorized or nonmotorized boat during daytime in deeper, offshore waters (>40 m). The process of baiting, setting and hauling the gears takes long hours of hard work. Thus, many long line fishermen have shifted to the use of Danish seines which involve lighter work. Mean CPUE for these gears is about 180 kg/boat-trip, 85% of which are sharks. This catch rate, however, is based on a very low sample size (i.e., six observations) because of the previously cited shift in gear preference.

Danish seines (*Buli-buli*)

Danish seines are trawl-like gears generally operated by three fishermen from a motorized *banca* with 16 hp engine. Operations entail enclosure of a given area with the gear at depths of 5-75 m and driving the fish through a funnel-like netting and bag. Operations are usually made from 6 a.m. to 4 p.m. Between six and nine hauls are made in a day's operation.

Mean catch rate for the gears for all areas covered by the study was 26.8 kg/boat-trip. The landings from Danish seines in Masamirey, Sual, in May 1987 to April 1988 were dominated by the red bull's eye *(Priacanthus tayenus)* and threadfin breams *(Nemipterus* spp.*)* which compose 76.5% of the mean CPUE for the area. Danish seine catches are primarily demersal species/ groups.

Spear fishing units (*Hookah*)

Spear fishing operations involve homemade spearguns and spears. The former consist of a wooden handle fitted with a steel nozzle and rubber band. The spears are made of wood and are single- or multitipped; the latter are usually used for smaller fish. Homemade goggles enable divers to see clearly underwater; and for longer periods underwater, plastic tubes (*hookah*) attached to a compressor on the *banca* are used. The latter was adopted from aquarium fish collectors in the area.

The spear fishing unit usually consists of three fishermen. Two dive and spear fish while one remains on board the 10-16 hp motorized *banca* to attend to the compressor and plastic tubings. Spear fishermen operate in depths of up to 50 m for one to two hours during daylight. Some deaths have been reported from spear fishing operations apparently due to lack of decompression.

Some spear fishing activities also occur at night with the aid of light. These operations are particularly attractive during moonless nights. These do not require divers, and fishermen simply fish from their boats. The *hookah* spear fishermen operate in relatively deeper waters for prolonged periods, thus catching bigger and higher-priced species. The light-aided spear fishers usually operate in shallow waters and are thus limited to small-sized siganids and other light-attracted fish.

Mean catch rate for spear fishermen in Lucap, Alaminos, was 6.8 kg/boat-trip. This includes catches of both night-time and daytime spear fishers. *Siganus canaliculatus* and *S. guttatus* make up 58% of the catch; and squids *(Loligo* spp.*)*, cuttlefish *(Sepia* spp.*)* and octopi compose 35%. High-priced lobsters *(Panulirus* sp.*)* and groupers *(Epinephelus* spp.*)* are also landed by spear fishers. It can be noted that most of the species are typical of coral/hard-bottom fishing grounds.

Fish corrals (*Pasabing*)

Fish corrals are semipermanent gears commonly found in the western side of the gulf (Sector I). They are noted for catching live, juvenile fish suited for culture in brackishwater ponds. Harvesting of fish in the bag or catching box is usually done once daily. The net in the bag is set in the evening and hauled the next day, depending on tidal fluctuation. Either a motorized or nonmotorized *banca* is used in inspecting the gear and hauling the catch. Mean catch rate of fish corrals in Lucap, Alaminos, from July 1987 to April 1988, was 4.4 kg/boat-trip. The catch was dominated by siganids and shrimps, both

composing 66.3% of the total. Although making up only a small portion of the total catch in weight, the siganid and grouper fries harvested using fish corrals were important in the overall economics of the operations.

Beach seines *(Kalokor)*

Beach seines are commonly used in Agoo (La Union), San Fabian (Pangasinan) and other soft-bottom areas in the inner coast (Sector II) of the gulf. The gears are operated twice daily, during early morning and late afternoon. One motorized and one nonmotorized *banca* are used in setting the gear in nearshore waters (up to 15 m deep), and the operation usually involves 16 fishermen. The net is dragged to shore by fishermen on the beach.

Mean catch rate for seines in San Isidro, Agoo, was 19.7 kg/setting during the period May 1987 to April 1988. Five species (*Atule mate, Trichiurus haumela, Leiognathus bindus, M. cordyla* and *Selaroides leptolepis*) composed 71.2% of beach seine landings in the area. Juveniles of these species were abundant in the catches because the gear was operated very close to shore and the mesh size used at the cod-end was only 1.5 cm stretched length. The catch/fisherman using the beach seine was quite low (i.e., 1.2 kg/fisherman) because of the high labor input.

Lift nets *(Parigdig)*

Lift nets are semipermanent, stationary fishing gears that employ light attraction to catch fish. Commonly found in the western part (Sector I) of the gulf, they are usually set near river mouths along the migration path of fish and parallel to the current flow. Operations usually last from 6 p.m. to 5 a.m. involving 8-10 fishermen. Between five and six hauls are made during an overnight operation. The platforms are set in sheltered areas as deep as 30 m. A motorized boat and a larger nonmotorized dugout are usually used to ferry the fishermen and the catch to and from the lift net site. Operations usually cease around the period of the full moon.

Mean catch rate was 43.3 kg/day during the period June 1987 to March 1988 in Sual, Pangasinan. The catches consisted of stolephorid anchovies (69%) and *Acetes* (30%), which are important to the fish paste/sauce *(bagoong)* industry in the area. Other species caught were juveniles of commercial species/groups (e.g., hairtails, goatfish and slipmouths).

Drive-in nets

Drive-in nets used in the gulf include municipal versions of the muro-ami and its modifications. The gear designs are basically similar for drive-in nets although modes of operation are quite different. The versions utilized in Agoo, for instance, employ fish aggregating devices (FADs) and explosives, and are used in catching pelagic species. Mean catch rate for drive-in nets in Agoo during the period January to April 1988 was 63 kg/boat-trip. The catches consisted of pelagics dominated by roundscads *(Decapterus* sp.) which made up over 90% of the total. Mean CPUE for all drive-in nets in the study sites covered was 57.4 kg/boat-trip.

Shrimp trawls

These gears are mini-otter trawls used in the coastal towns from Agoo to Lingayen during the shrimp season. Mean catch rate for shrimp trawls in these areas was 13.8 kg/boat-trip. In Balawarte, Agoo, the catch consisted of shrimp (93.1%); portunid crabs (5.3%); and hairtails *(T. haumela).*

Crab pots

Crab pots are basketlike traps made of bamboo set in nearshore waters. A nonreturn entrance effects capture of crabs lured by the bait placed inside the traps. The traps are set in the early morning hours and retrieved before noon. Setting and hauling operations

usually last from 30 to 60 minutes. Mean catch rate for this gear in Lucap, Alaminos, was 3.8 kg/boat-trip. The catch was 99% portunid crabs *(Portunus pelagicus* and *P. trituberculatus).*

Blast fishing

There are four types of explosives used in blast fishing operations in Lingayen Gulf based on source of explosive materials and extent of processing. These are dynamite sticks, "lump type," "bogey type" and oxidizing chemicals (i.e., potassium chlorate, potassium nitrate, sodium nitrate, ammonium sulfate). Dynamite sticks, generally used in mining operations, are procured from illegal sources and used in blast fishing without additional processing. Lump type explosives are processed from contents of dynamite sticks rewrapped into bigger charges, while bogey type charges are explosive materials extracted from unexploded bombs or high caliber munitions. The most commonly used explosive component, however, is the oxidizing chemicals which are mostly nitrogen-based fertilizers and are quite accessible to everybody. The oxidizing chemicals are usually placed in bottles before gasoline is added. Blasting caps are usually acquired from illegal sources.

Blast fishing operations usually follow a routine procedure of scouting for fish concentrations, blasting and collecting the fish. Some operations are conducted with the aid of FADs. Collection of blasted fish sometimes involves the use of compressors to enable divers to stay longer underwater. Additional details pertaining to the blast fishing activities in the gulf are given in Galvez et al. (this vol.).

The average catch rate of blast fishermen from August 1987 to April 1988 (regardless of explosive type used) was 13.0 kg/blast. Minimum and maximum values were 1.2 kg/blast and 75.5 kg/blast, respectively. Table 5 shows the fish families making up the catch of blast fishermen from the areas monitored during the period. Carangids, mugilids and siganids made up 86.1% of the total

Table. 5. Relative abundance of the 10 most important families of fish caught by blast fishermen in the study sites monitored.

Families	Relative abundance (%)
Carangidae	66.2
Mugilidae	10.8
Siganidae	9.1
Engraulidae	2.6
Lutjanidae	2.1
Leognathidae	2.0
Scombridae	1.6
Sphyraenidae	1.3
Lethrinidae	1.1
Serranidae	1.1
Total	97.9

catch. These groups are preferred target species because of their high market value. Table 6 shows the 10 most abundant species in the catch of blast fishermen. Except for *Stolephorus indicus*, all species in the table command high market prices. The high schooling densities of anchovies, however, compensate for their lower value.

Table 6. Relative abundance of 10 most important species caught by blast fishermen in the study sites monitored.

Species	Relative abundance (%)
Selar crumenopthalmus	13.5
Mugil cephalus	10.8
Alepes djedana	5.6
Siganus canaliculatus	4.4
Siganus guttatus	1.8
Rastrelliger kanagurta	1.6
Sphyraena barracuda	1.3
Lates calcalifer	1.0
Stolephorus indicus	0.8
Lethrinus ornatus	0.8
Total	41.6

A total of 76 species groups in 24 families composed the catch. These, however, did not include undersized and heavily damaged individuals which were not landed at all for economic and other practical reasons. The high proportion of target species in the landings compared to undersized/trash species indicates that blast fishing is relatively selective. Considerable time is spent in scouting

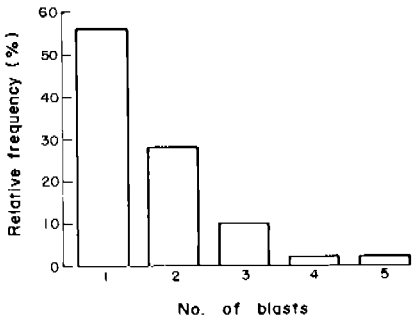

Fig. 4. Relative frequency of the number of blasts per fishing unit (defined as one boat) per day in a study site monitored in Lingayen Gulf.

for schools/concentrations of target species.

Fig. 4 gives the relative frequency distribution of daily blast frequency per fishing unit/boat engaged in blast fishing in a certain sampling station. An average of 1.62 blasts/fishing unit/day was estimated for this area.

Results of Initial Blast Fishing Experiment

In cooperation with blast fishermen with whom good rapport has been established, the study dealing with blast fishing intends to conduct *in vivo/in situ* experiments to determine the lethal range of different types of explosives and the remote damage zones that they create. On 25 April 1988, the experimental setup was tested to determine the feasibility of such study. Three pairs of cages were placed at a distance of 5 m from each other (Fig. 5). Each pair was suspended on floats with one cage at 1.5 m depth and the other at 3.5 m depth. Maximum depth in the experimental site was 5 m. Between seven and eight fish with swimbladders (i.e., *Chromis* sp. and *Epinephelus* sp.) were placed in each cage. A 537 g lump type explosive in a bottle container was exploded at 3.5 m depth at 2 m, 5 m and 10 m away from each pair of cages.

Table 7 gives a summary of results from the initial experiment, indicating that the lethal range in the horizontal direction is limited. Only the specimens nearest (2.0 m) to and midway (5.0 m) from the blast were found dead. Those farthest (10.0 m) from the explosion were able to survive for as long as an hour after the blast. The vertical lethal range could not be determined conclusively because of the limited depth and numbers of cages involved. Examination of the dead fish showed that the effects of the blast included rupture of the swimbladder, compound fracture of the vertebrae and blood clots within the visceral region.

The damage range observed in this experiment cannot be compared directly to results of other studies (e.g., Aplin 1947, CBL 1948) because they utilized extremely large charges (20-300 lb TNT) on caged fish, compared to the homemade bombs being used in Lingayen Gulf. Nevertheless, the results of these other studies are quite informative with respect to differential vulnerability of fish with differing shapes, sizes and swimbladders. In a series of experiments, Aplin (1947) presented evidence that small fish are more vulnerable to explosions compared to larger ones. He also showed that under similar conditions (i.e., specimens about 15 m away from a 20 lb TNT charge), fish without swimbladders were not harmed while those with swimbladders in the same cages were killed by the blast. Fitch and Young (1948) noted that different species of fish had different reactions to shock pressures. Fish species with thick-walled swimbladders and cylindrical body shapes appeared to be more resistant to pressure changes compared to laterally compressed fish with thin-walled swimbladders.

Theoretically, we could infer that physostomous fish (i.e., with open swimbladders connected to the alimentary canal) are more capable of adapting to pressure changes than physoclistous fish (i.e., with closed swimbladders). This difference in swimbladders, however, may not be significant given that pressure changes during explosions occur within microseconds. This period may be too short for normal gasexchange mechanisms to function. However, this difference might play an important role at the outer limits of the lethal range.

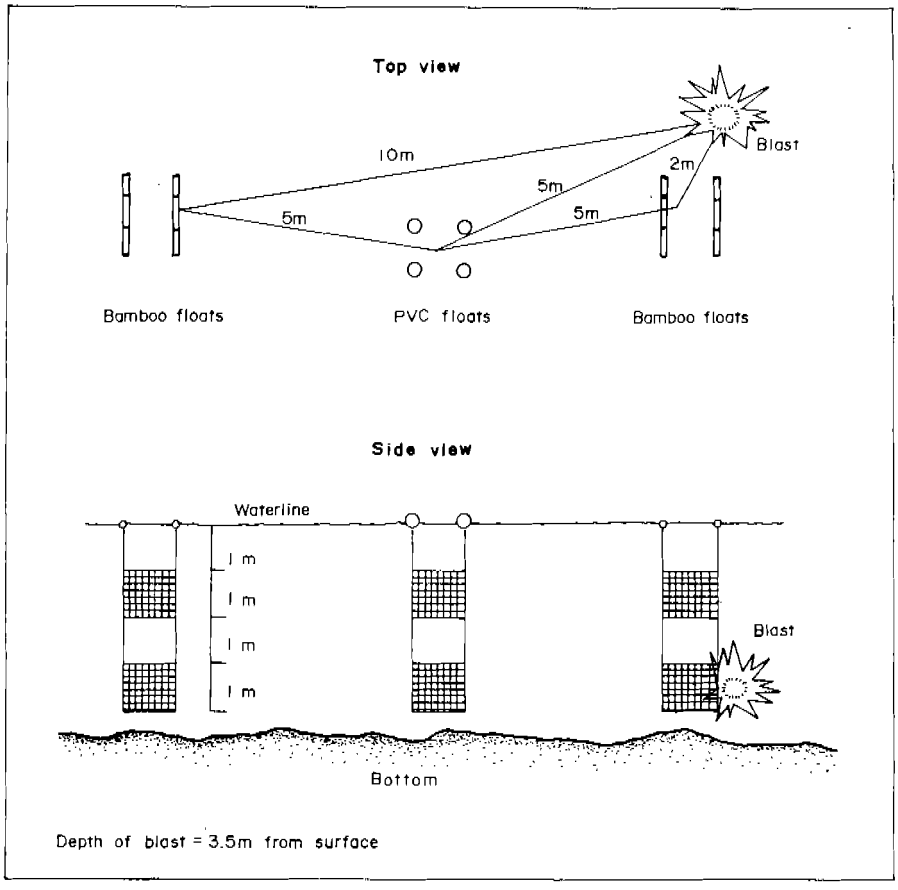

Fig. 5. Blast fishing experimental setup.

Table 7. Lethal range of 537 g explosive from the results of an initial experiment. (See also Fig. 5).

First observation (immediately after the blast)				
Cage position		Dead	Stunned	Alive
Nearest	(up)	6	1	0
	(down)	7	0	0
Middle	(up)	4	3	0
	(down)	4	3	0
Farthest	(up)	0	0	8
	(down)	0	0	8
Second observation (1 hr after the blast)				
Nearest	(up)	7	0	0
	(down)	7	0	0
Middle	(up)	4	3	0
	(down)	5	2	0
Farthest	(up)	0	0	8
	(down)	0	0	8

Estimate of Municipal Fisheries Production

A preliminary attempt to estimate the magnitude of municipal fisheries production in Lingayen Gulf was made using the catch rate information and operational periods observed for the various gears. Table 4 gives a summary of the data and procedure used for this purpose. The catch/boat in a span of one year (C_i) was computed for each gear type from the equation:

$$C_i = CPUE_i \times D_i \times M_i$$

where $CPUE_i$ is the mean catch/day of a boat using i (and is computed from the catch/boat-trip and number of boat-trips/day for boats using gear i); D_i the number of days/month that a boat using gear i operates; and M_i the number of months in a year that gear i is used by a given boat or fishing unit. The C_i value was subsequently multiplied by an estimate of the number of boats using gear i to give the fisheries production for the specific gear type used in the gulf.

The distribution of the total number of boats in the gulf (7,054 as of 1985) into the different gear types involves the following steps: (1) 705 boats or 10% of the total number of boats were assumed to be used for transport, tourism and other activities; (2) of the remaining 6,349 boats, 5% (317 boats) were assumed to be used for blast fishing; (3) 6,032 boats were distributed among the various gears using actual counts for specific gear types throughout the gulf, as well as the motorized and nonmotorized boat distribution by gear types in the six sites covered by the study. The assumptions involved in the distribution of fishing boats emphasize the need for a census to accurately determine gear and boat distribution, number of fishermen and related information. The conduct of a census is currently being planned and requires coordination among all ongoing studies under CRMP for cost effectiveness.

The procedure discussed above gives an estimate of 10,500 t from the mix of municipal fishing gears/techniques used in the gulf. This production implies extraction rates of about 5.0 t/km^2 for the entire gulf area of 2,085 km^2 and 10.1 t/km^2 of municipal fishing ground (i.e., the area enclosed by the 7-km, 7-fathom ban). In addition, Ochavillo et al. (this vol.) gives an estimate of mean trawlable biomass of 1,192 t for the entire gulf. The demersals comprising this estimate total 885 t. Assuming a demersal-to-pelagic biomass ratio of 1:2 (as reflected in BFAR catch statistics for the period 1980-1984), the total biomass of fisheries resources in the gulf on the average is 2,650 t. These figures imply a municipal yield-to-total biomass ratio of 3.97. This level of extraction of fisheries resources becomes even higher when the estimated municipal production is combined with mean production of commercial trawlers of about 3,350 t/year. Aggregate yield (Y)-to-biomass (B) ratio for the entire Lingayen Gulf fisheries adds up to 5.23, with 1.26 coming from commercial trawl operations, 0.40 from blast fishing activities, and 3.57 from the rest of the gears utilized by the municipal sector.

Information Gaps and Management Recommendations

Research needs to fill up critical information gaps include a general census to determine the number of fishing units (boats) and municipal fishermen, types of fishing gears and the seasonality of their use, and number of blast fishermen in Lingayen Gulf. The vulnerability of different types of fish to explosive charges and the lethal ranges of the various types of explosives used in the gulf need further investigation. In addition, biomass estimation of fisheries resources in the gulf is highly dependent on the results of the ongoing commercial fisheries study which is highly dependent on data collected from medium trawlers in the gulf (Ochavillo et al., this vol.). These trawlers operate in shallow areas and places where fish density is expected to be higher. In this context, therefore, the biomass estimates derived may be biased towards higher figures. Emphasis is thus placed on the need for more representative sampling (via a trawl survey), which covers the full range of depths in the gulf, to provide more reliable biomass estimates

essential to meeting the objectives of the fisheries assessment subtask.

The most pressing problem confronting the capture fisheries of Lingayen Gulf is biological overfishing. Preliminary estimates of prevailing extraction rates presented in the previous section are quite high (i.e., F = Y/B = 5.23). The overfishing problem is symptomatic of the greater need for improved management of fisheries, which appears to be the general case for the capture fisheries of the country as a whole. As an initial step to reduce the magnitude of extraction rates in the gulf, the strict enforcement of existing fisheries laws/regulations (i.e., the 7-km, 7-fathom ban on commercial vessels, the ban on the use of explosives and poisons in fishing operations and the 3-cm mesh size regulation) is suggested. This will reduce effectively the extraction rate from trawlers of 1.26, and totally eliminate those from blast fishing activities (0.40). The remaining municipal extraction (3.57), however, would still be considerable, even without the fishing pressure from trawlers and blast fishers. These figures indicate that even municipal fishing effort would have to be cut by about 50% to ease fishing pressure on the resources and assure their sustainability.

Over the long-term, improved management of the fisheries would have to be effected. Measures toward this end include the: (1) creation of a fisheries management council with representatives from the government, academe, and participants in the exploitation of the resources to oversee management of the fisheries; (2) creation of alternative employment opportunities to draw effort away from capture fisheries; (3) clarification and identification of management goals/objectives; and (4) exploring supplemental strategies of viably enforcing laws and regulations aside from the penal provisions of the laws. The latter can include information dissemination/education campaigns, extension activities to form fisheries/community organizations, and organization of resource-user participation in the formulation and enforcement of laws and regulations.

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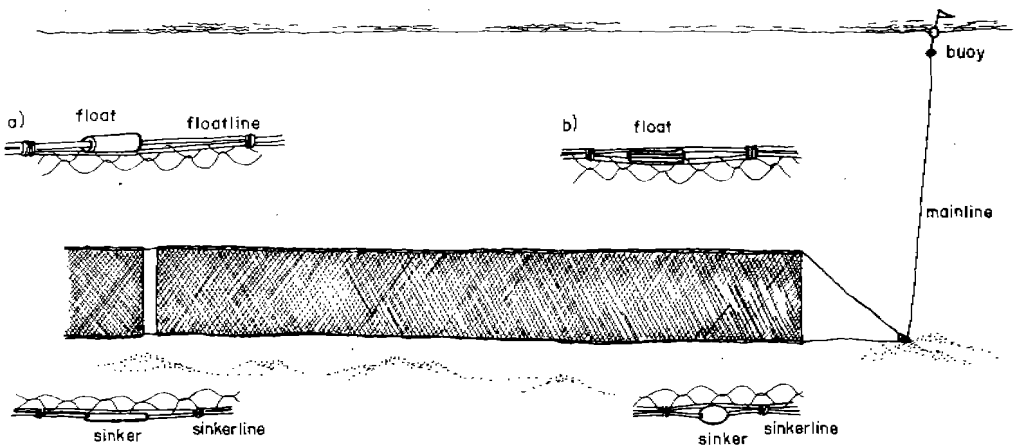
Appendix 1. Typical designs and specifications of artisanal fishing gears used in Lingayen Gulf.

Bottom set gill net



Specifications : (per unit; 15-30 units per setting)

Net

Material	:	Polyamide (PA) monofilament
Mesh size	:	7-12 knots (2.8-5.1 cm)
Twine diameter	:	#020
Stretched length	:	100-200 m
Actual length	:	40-80 m
Hanging ratio	:	35-45%
Stretched depth	:	2-3 m
Actual depth	:	1.5-2.5 m
Floatline	:	#4 PE
Sinker line	:	#4 PE

Floats

a) Hard rubber "sausage"

Length	:	5-7 cm
Diameter	:	1.5-2.0 cm
Number	:	70-120 pcs

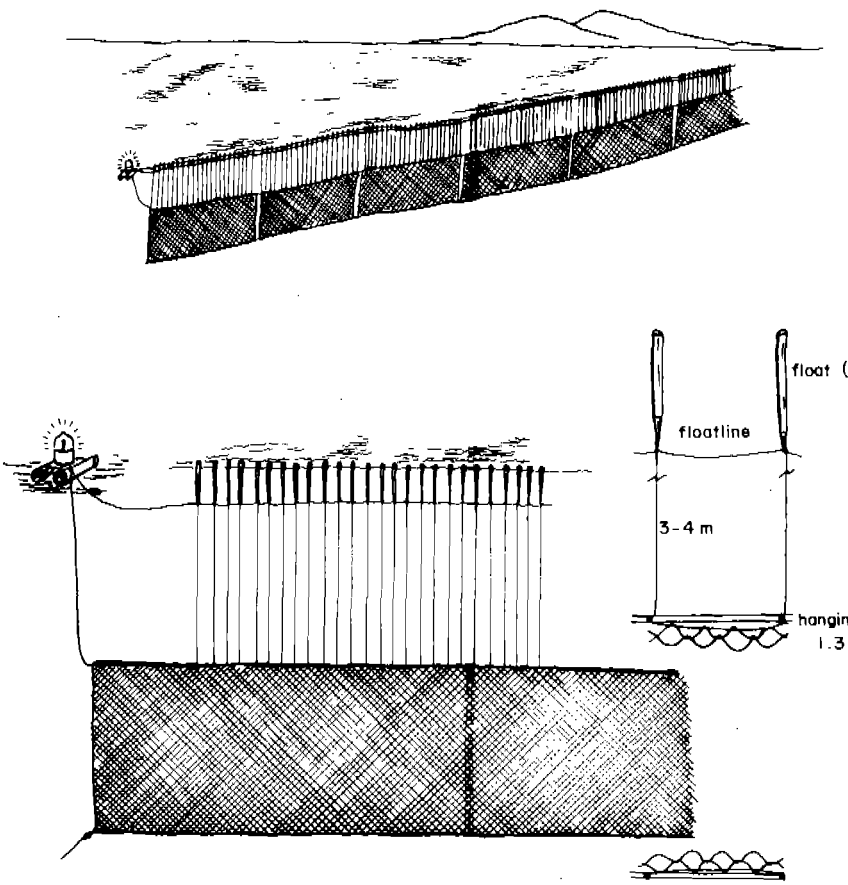
b) Soft rubber "chinelas"

Length	:	6-10 cm
Width	:	2.0-2.5 cm
Thickness	:	1.0-2.0 cm
Number	:	70-120 pcs
Total buoyancy	:	Approx. 120-800 g

Sinkers

Material	:	lead
Length	:	1.2-4.0 cm
Diameter	:	0.6-1.2 cm
Number	:	100-200 pcs
Total sinking force	:	Approx. 600-2,000 g

Midwater gill net



Specifications : (per unit; 10-15 units per setting)

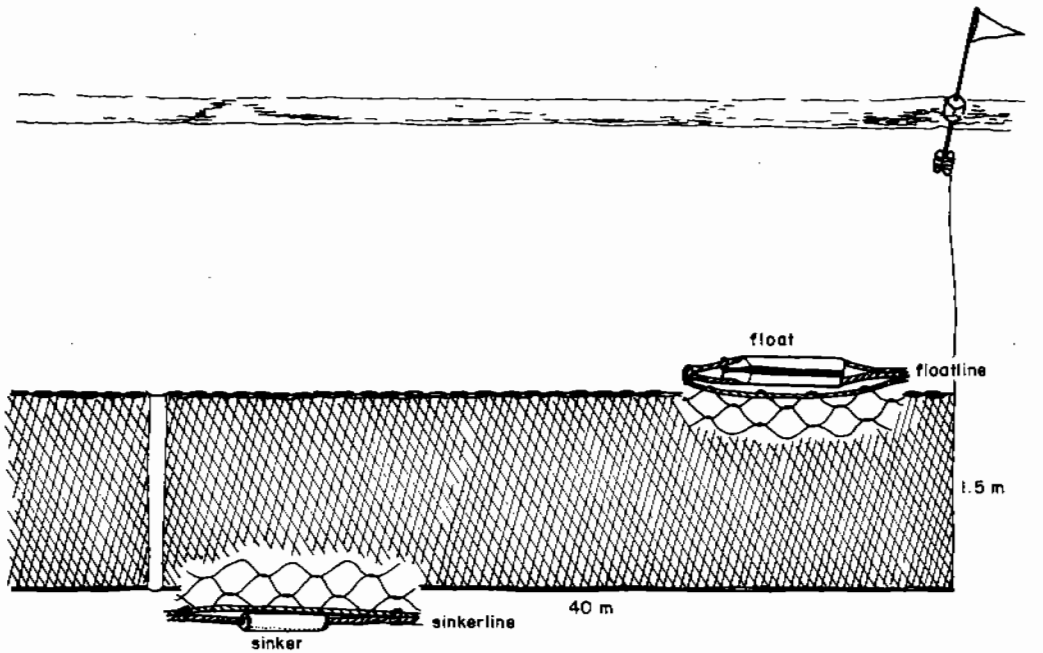
Netting

Material	:	PA multifilament #20
Mesh size	:	8.5-11 knots (3.0-4.0 cm)
Stretched length	:	125 m
Actual length	:	50 m
Stretched depth	:	3.5-5.0 m
Actual depth	:	3.2-4.0 m
Hanging ratio	:	40%
Hanging line	:	PE #5

Floats

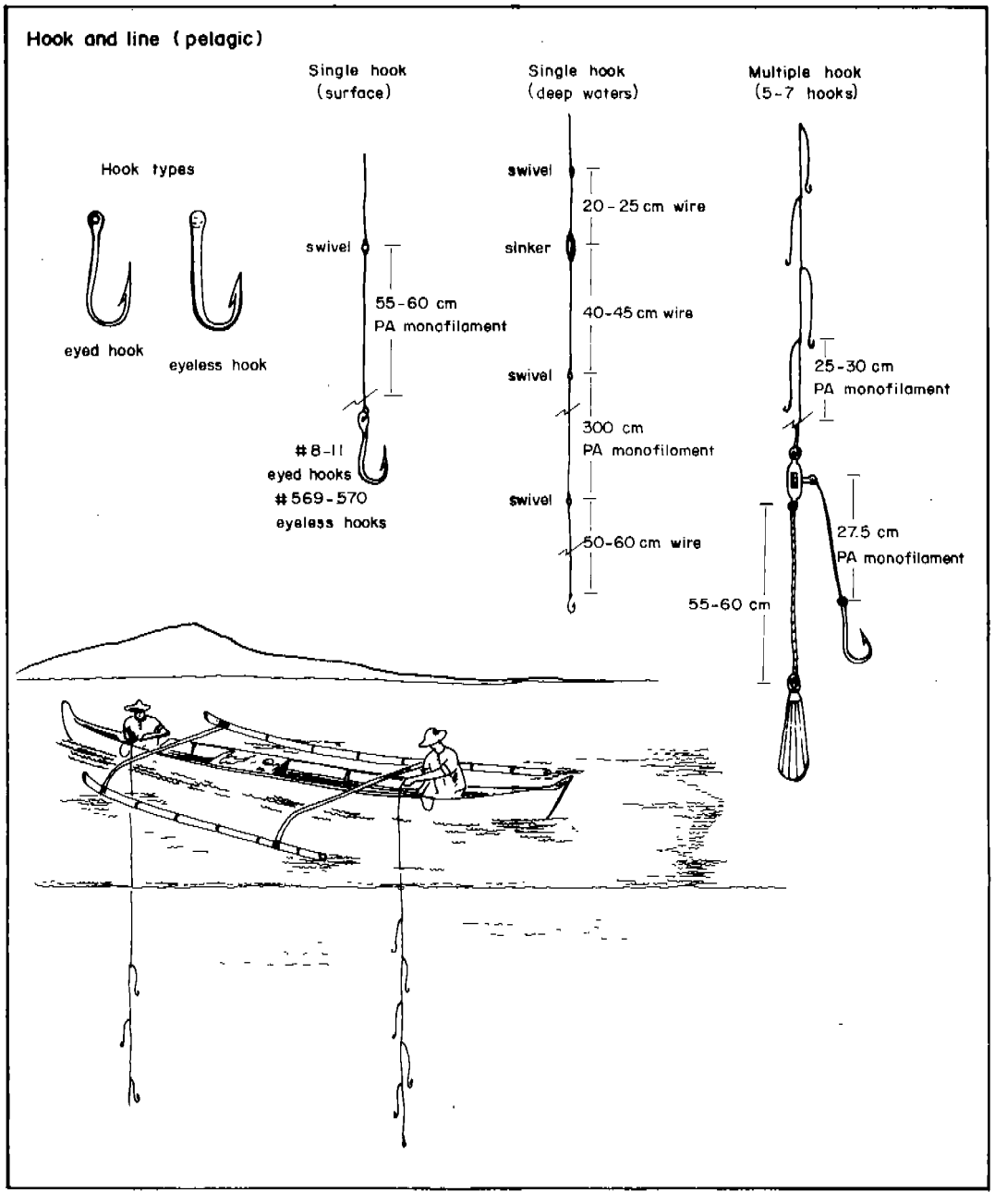
Material	:	balsa
Length	:	40 cm
Diameter	:	2 cm
Number	:	40 pcs
Floatline	:	PE #4
Sinkers	:	None

Tuna drift gill net

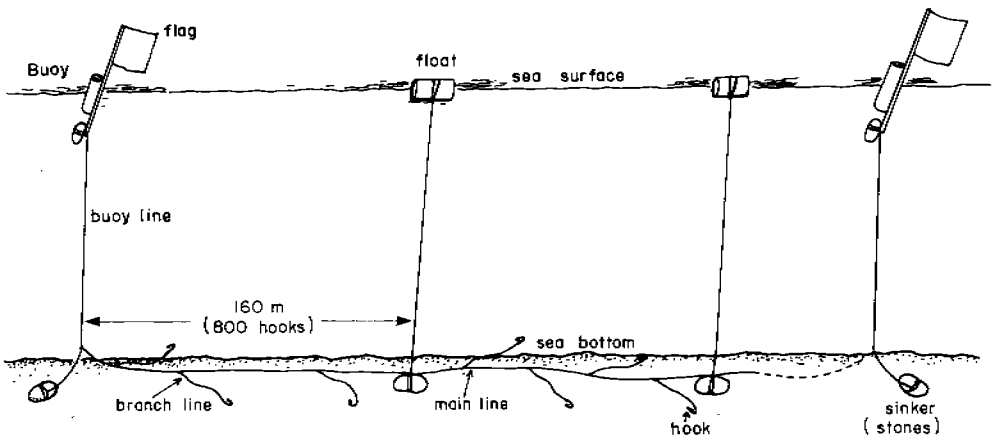


Specifications : (per unit; 8-15 units per setting)

Netting			Floats			Sinkers		
Material	:	PA multifilament #20	Material	:	rubber	Material	:	lead
Mesh size	:	15 cm	Length	:	6.35 cm	Length	:	1.27 cm
Stretched length	:	100-160 m	Width	:	2.54 cm	Diameter	:	0.85
Actual length	:	40-100 m	Thickness	:	1.27 cm	Number	:	50-55 pcs
Stretched depth	:	3.0-7.5 m	Number	:	25-30 pcs	Sinkerline	:	PE #4
Actual depth	:	1.5-3.75 m	Floatline	:	PE #4	Total sinking force	:	195-200 g
Hanging ratio	:	40%	Total bouyant force	:	55-60 g			

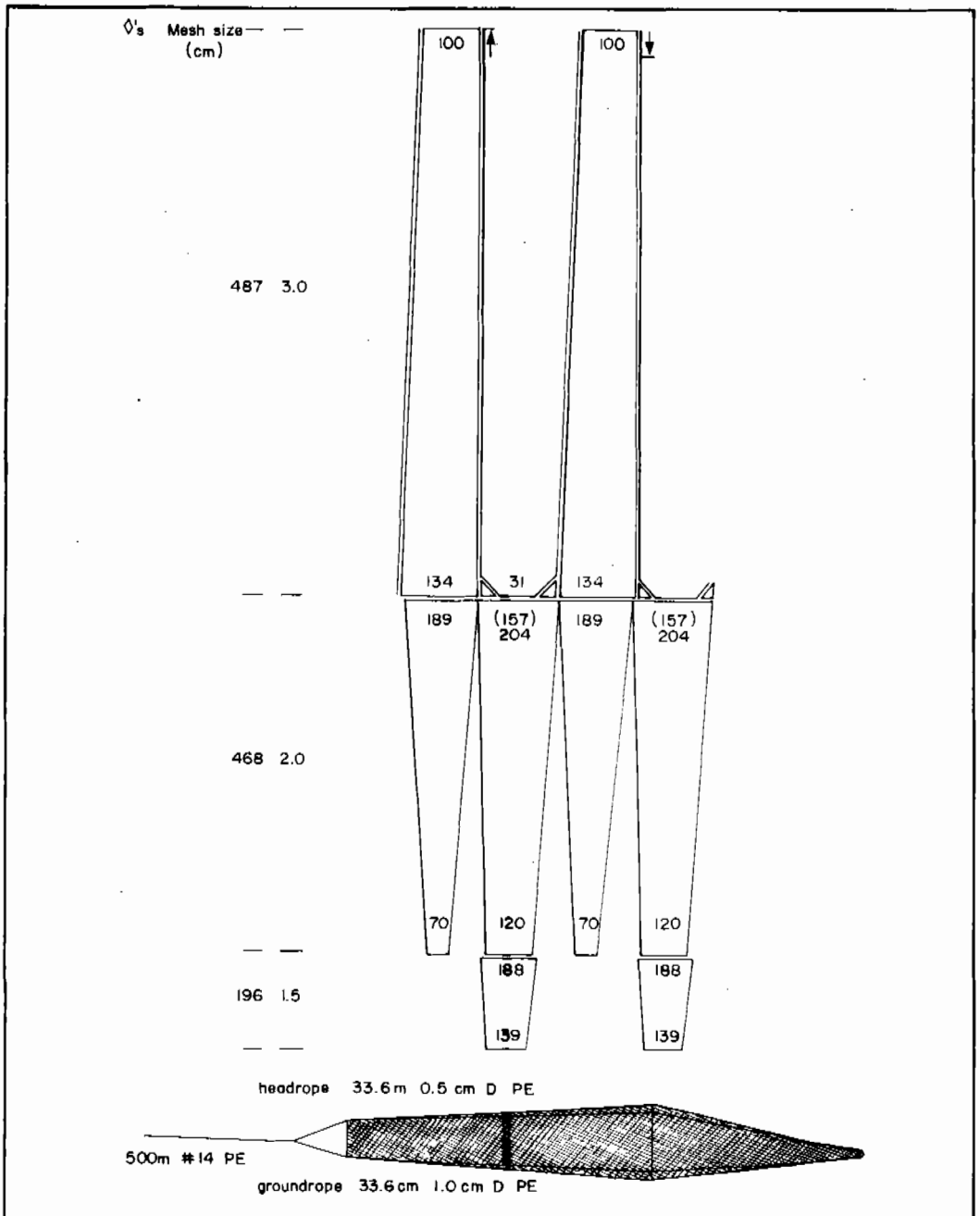

Hook and line (pelagic)
Single hook (surface)
Single hook (deep waters)
Multiple hook (5-7 hooks)
Hook types
eyed hook
eyeless hook
swivel
55-60 cm PA monofilament
#8-11 eyed hooks
#569-570 eyeless hooks
swivel
20-25 cm wire
sinker
40-45 cm wire
swivel
300 cm PA monofilament
swivel
50-60 cm wire
25-30 cm PA monofilament
27.5 cm PA monofilament
55-60 cm

Long line (bottom set)



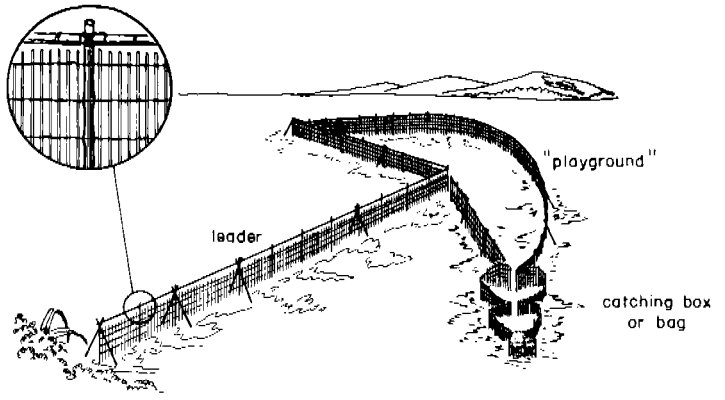
Specifications

Buoy line	:	4 mm diameter PA monofilament
Main line	:	3.5 mm diameter PA monofilament
Floats	:	Balsa; 12 cm x 4.5 cm diameter
Hooks	:	#560-568
Vessel	:	Outrigger banca, 10-16 hp



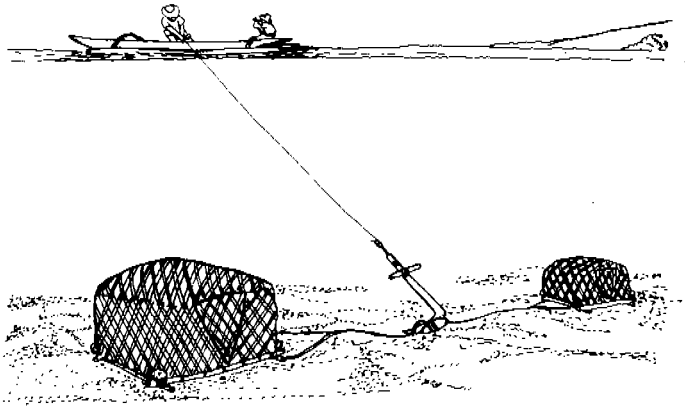
Gear	Floats (hard rubber)	Sinkers (lead) #345	Vessel
Four-seam Danish seine	7.5 cm x 2 cm D 207 pcs	2.5 cm x 1.5 cm D	Outrigger banca 16-25 hp

Fish corral



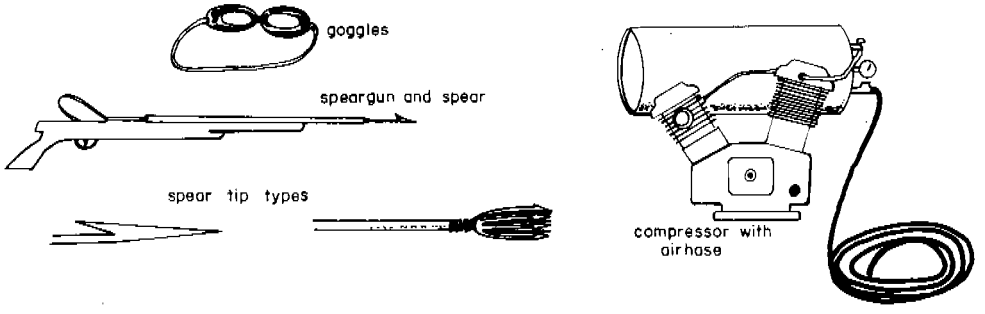
Source: Umali 1950

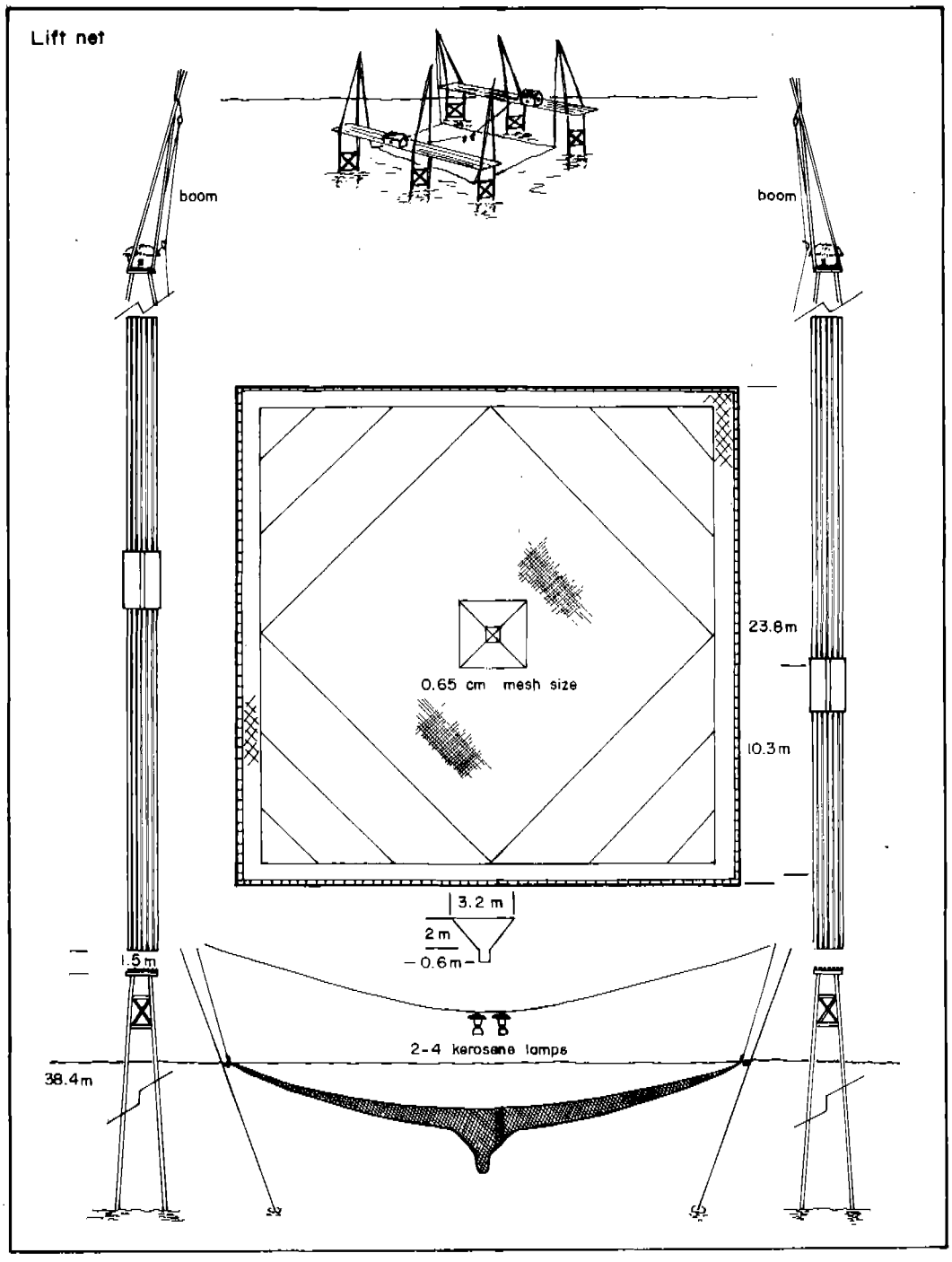
Crab pots



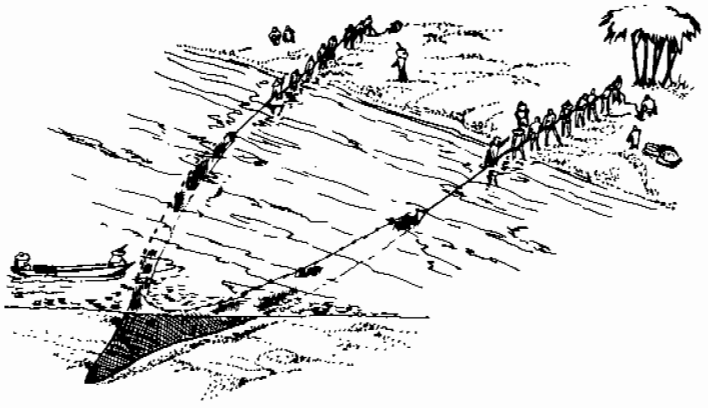
Source: Umali 1950

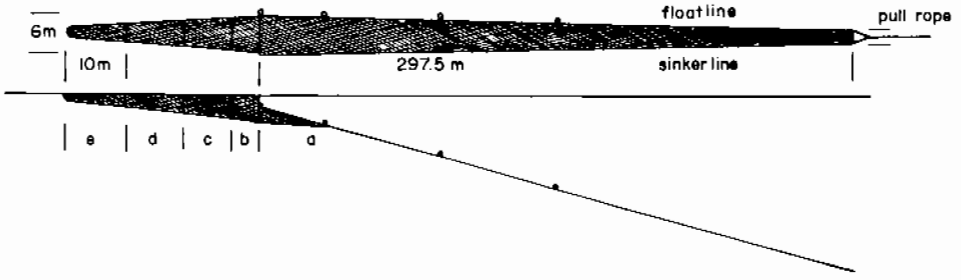
Spear/hookah




Lift net
boom
boom
23.8m
10.3m
0.65 cm mesh size
3.2 m
2 m
0.6m
1.5m
2-4 kerosene lamps
38.4m

Beach seine





Specifications

Float line	:	600 m #18 PE
Sinker line	:	600 m #18 PE
Pull rope	:	700 m #22 PE
Floats	:	8 (7B-22)

Mesh sizes

Wing	:	6.0 cm	a	-	wing
Shoulder	:	4.0 cm	b	-	shoulder
Body	:	3.5 cm	c	-	body
Intermediate tail	:	2.5 cm	d	-	intermediate tail
Cod-end	:	1.5 cm	e	-	cod-end

Appendix 2. Mean catch rate and composition for selected municipal fishing gears used in Lingayen Gulf.

Motorized bottom gill nets
Dulao, Aringay; May 1987 to April 1988
Mean CPUE: 6.8 kg/trip

Species	Relative abundance (%)
Megalaspis cordyla	39.1
Scomberomorus commersonii	22.8
Euthynnus affinis	22.3
Selar crumenopthalmus	2.1
Saurida tumbil	2.1
Gazza minuta	1.3
Rastrelliger brachysoma	1.2
Alepes djedaba	1.1
Atule mate	0.7
Leiognathus splendens	0.7
Others	6.6

Nonmotorized bottom gill nets
Dulao Aringay; May 87 to March 1988
Mean CPUE: 1.7 kg/trip

Species	Relative abundance (%)
Rastrelliger kanagurta	14.2
Gazza minuta	12.7
Leiognathus splendens	9.7
Trichiurus haumela	6.0
Upeneus sulphureus	5.8
Rastrelliger brachysoma	5.8
Alepes djedaba	4.7
Atule mate	4.1
Leiognathus brevirostris	4.1
Leiognathus bindus	3.9
Others	29.0

Bani, Rosario; June 1987 to March 1988
Mean CPUE: 4.2 kg/trip

Megalaspis cordyla	33.2
Euthynnus affinis	10.3
Anadontostoma chacunda	8.9
Alepes djedaba	8.8
Scomberomorus commersonii	6.7
Rastrelliger brachysoma	6.3
Atule mate	3.0
Nemipterus japonicus	3.0
Selar boops	2.5
Leiognathus splendens	1.8
Others	15.5

Bani, Rosario; June 1987 to March 1988
Mean CPUE: 1.5 kg/trip

Alepes djedaba	9.3
Rastrelliger brachysoma	8.9
Anadontostoma chacunda	8.6
Gerres filamentosus	7.6
Leiognathus splendens	8.4
Atule mate	4.9
Nemipterus japonicus	4.8
Crabs	4.5
Leiognathus brevirostris	3.2
Chirocentrus dorab	2.7
Others	37.1

Surface drift gill nets
Tobuan, Labrador; May 1987 to April 1988
Mean CPUE: 15.2 kg/trip

Rastrelliger brachysoma	52.2
Chirocentrus dorab	11.4
Selar crumenopthalmus	11.3
Megalaspis cordyla	6.6
Rastrelliger faughni	4.3
Alepes djedaba	3.4
Selar boops	2.9
Rastrelliger kanagurta	2.3
Scomberomorus commersonii	1.3
Trichiurus haumela	0.7
Others	3.6

Hooks and lines
Tobuan, Labrador, May 1987 to April 1988
Mean CPUE: 5.9 kg/trip

Selar crumenopthalmus	43.3
Scomberomorus commersonii	24.0
Rastrelliger kanagurta	8.7
Sphyraena barracuda	5.6
Rastrelliger faughni	4.4
Atule mate	2.6
Caranx sp.	2.3
Rastrelliger brachysoma	2.0
Leiognathus equulus	1.2
Lethrinus lentjan	0.8
Others	5.1

Danish seines
Masamirey, Sual; May 1987 to April 1988
Mean CPUE: 28.3 kg/trip

Species	Relative abundance (%)
Priacanthus tayenus	33.8
Nemipterus nematophorus	21.3
Nemipterus japonicus	11.9
Pentaprion longimanus	9.0
Nemipterus hexodon	5.8
Nemipterus marginatus	3.7
Atule mate	2.3
Gerres filamentosus	2.1
Saurida undosquamis	1.8
Upeneus sulphureus	1.8
Others	6.5

Lift nets
Sual; June 1987 to March 1988
Mean CPUE: 43.3 kg/boat-trip

Stolephorus sp.	69.0
Acetes sp.	30.4
Trichiurus haumela	0.4
Others	0.2

Drive-in nets
Agoo; January to April 1988
Mean CPUE: 62.6 kg/trip

Decapterus sp.	92.2
Rastrelliger faughni	1.7
Megalaspis cordyla	1.4
Selar boops	0.1
Others	4.6

Shrimp trawls
Balawarte, Agoo; January to April 1988
Mean CPUE: 14.6 kg/trip

Shrimp	93.1
Portunus sanguinolentus	5.3
Trichiurus haumela	1.6

Spearguns
Lucap, Alaminos; July 1987 to April 1988
Mean CPUE: 6.8 kg/trip

Species	Relative abundance (%)
Siganus canaliculatus	55.8
Sepia spp.	23.0
Octopus	9.9
Siganus guttatus	2.1
Loligo spp.	2.0
Panulirus sp.	1.7
Alepes djedaba	1.3
Lethrinus spp.	0.8
Epinephelus tauvina	0.7
Labridae	0.7
Others	2.0

Fish corrals
Lucap, Alaminos; July 1987 to April 1988
Mean CPUE: 4.4 kg/boat-trip

Siganus canaliculatus	38.3
Shrimp	25.7
Portunus pelagicus	7.7
Gobiidae	7.1
Pelates quadrilineatus	3.2
Siganus guttatus	2.3
Gerres oyena	2.0
Loligo spp.	2.0
Octopus	1.4
Leiognathus splendens	1.3
Others	9.0

Beach seines
San Isidro, Agoo; May 1987 to April 1988
Mean CPUE: 19.7 kg/set

Atule mate	28.0
Trichiurus haumela	16.2
Leiognathus bindus	11.1
Megalaspis cordyla	9.0
Selaroides leptolepis	6.9
Gazza minuta	4.8
Selar boops	3.9
Alepes djedaba	2.9
Chirocentrus dorab	2.6
Stolephorus indicus	1.5
Others	13.1

Preliminary Results of a Study of the Commercial Trawl Fisheries in Lingayen Gulf

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Ochavillo, D., H. Hernandez, S. Resma and G. Silvestre. 1989. Preliminary results of a study of the commercial trawl fisheries in Lingayen Gulf, p. 31-42. *In* G. Silvestre, E. Miclat and T.-E. Chua (eds.) Towards sustainable development of the coastal resources of Lingayen Gulf, Philippines. ICLARM Conference Proceedings 17, 200 p. Philippine Council for Aquatic and Marine Research and Development, Los Baños, Laguna, and International Center for Living Aquatic Resources Management, Makati, Metro Manila, Philippines.

Abstract

This paper presents preliminary results of an ongoing survey of the commercial trawl fisheries of Lingayen Gulf covering the period June 1987 to April 1988. A total of 102 hauls from 24 trawl-trips were sampled during the 11-month period. Mean catch rate was 31.8 kg/hour for medium trawlers (10-20 GT) and the catch consisted of 158 species/groups distributed among 58 families/groups. Mean stock density (D) and biomass (B) were estimated (via the swept area method) to be 0.570 t/km^2 and 1,190 t, respectively. Landings (Y) by the trawl fleet averaged 280 t/month, or an aggregate of 3,070 t for the 11-month period. These imply considerable fishing pressure from the trawl fleet comprising 24 medium and 2 large (20-40 GT) trawlers, representing fishing mortalities (F = Y/B) of 0.23 per month and 2.58 for the 11-month period. The faunal composition of trawl catches indicates that the optimum mesh size for trawlers in the area is 3.5-4.0 cm, and that the current mesh size of 2.0 cm being used results into considerable losses in aggregate yield from the multispecies mix. The length composition data generated thus far indicate that more accurate species-specific assessments are plausible after the data collection phase is completed.

Introduction

The term "commercial fisheries" refers to an arbitrary grouping of fishing operations utilizing vessels over 3 GT. In Lingayen Gulf, trawling represents the only form of commercial fishing activity.[c] Landings by commercial vessels using other gears (e.g., purse seine) reported for the Lingayen Gulf statistical area are taken outside the geographical limits of the gulf. Trawling is considered one of the most efficient fishing methods used in the area and, together with a number of other factors (e.g., blast fishing), is blamed for the low catches of other gears. Assessment, therefore, of the trawl fishery is essential in clarifying options toward optimum utilization of the gulf's fisheries resources.

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[c] About three commercial vessels using Danish seines, and based in Dagupan City, began operating in Lingayen Gulf in April 1988. Initial interviews indicate that these vessels relocated operations in the gulf from the Samar Sea area, attracted by the more favorable fish prices in the Pangasinan-La Union region.

The ongoing study of the commercial trawl fisheries of Lingayen Gulf, a component of the Resource Assessment sub-task of the ASEAN-US CRMP is being undertaken to:

- estimate the trawlable biomass of the gulf;
- quantify the contribution of commercial trawlers to fish production from the gulf, and
- assess the level of exploitation and yield of the trawlable fish resources.

Background information dealing with Lingayen Gulf fisheries, in general, and trawl fisheries, in particular, is summarized in McManus and Chua (in press). These include detailed treatments (utilizing extant information prior to commencement of CRMP) dealing with, among others, faunal composition of the resources, catch and fishing effort records, and exploitation levels. This paper provides a summary of data collected during the course of the study between June 1987 and April 1988, as well as preliminary inferences relevant to the three above-named objectives.

Materials and Methods

The data utilized and presented below were collected from commercial medium trawlers (10-20 GT) on a monthly period, wherein four members of the research staff (divided into two teams) boarded a minimum of one trawl-trip. Each trawl-trip consisted of two-day trawling operations, unless shortened by engine trouble or inclement weather. The vessel and gear specifications of the trawler were obtained by each team upon boarding while the following haul-specific information were recorded during the course of the trawl-trip: (1) weight of the catch; (2) towing time; (3) species composition; (4) length composition of the more abundant species; and (5) approximate area of operation/trawling. This information was utilized to estimate catch rates, relative abundance of species/families comprising the catch, range of operations, length composition of major species comprising the catch, and representative vessel and gear dimensions.

As a preliminary assessment of fishing pressure resulting from the operations of the trawl fleet, estimates of aggregate trawl catches/landings (Y) and trawlable biomass (B) were used to calculate overall fishing mortality ($F = Y/B$). The values of Y for each month, Y_i, and for the entire 11-month period, Y_T, were computed from

$$Y_i = (C_i \times n \times d \times h \times hr) + (2 \times C_i \times N \times D \times H \times HR) \quad \ldots (1)$$

$$Y_T = (Y_1 + Y_2 + \ldots\ldots + Y_{11})/11 \quad \ldots (2)$$

where C_i is the mean CPUE (kg/hour) of medium trawlers for month i; n and N, the number of medium and large trawlers, respectively; d and D, the mean number of days spent fishing each month by medium and large trawlers, respectively; h and H, the mean number of hauls each day made by medium and large trawlers, respectively; and hr and HR, the mean number of hours per haul spent trawling by medium and large trawlers, respectively. The mean trawlable biomass for each month, B_i, and for the whole 11-month period, B_T, were estimated via the swept area method (Pauly 1984; Gulland 1983), i.e.,

$$D_i = C_i/(X1 \times X2 \times L \times HL) \quad \ldots (3)$$

$$D_T = (D_1 + D_2 + \ldots + D_{11})/11 \quad \ldots (4)$$

$$B_i = D_i \times A \quad \ldots (5)$$

$$B_T = D_T \times A \quad \ldots (6)$$

where D_i and D_T are the mean stock densities for month i and the 11-month period, respectively; X1, the escapement factor (0.5); X2, a ratio (0.5) expressing the proportion of the headrope length (HL) comprising the effective width of the area swept; L, the distance swept by the trawl in one hour; A, the area of the gulf (2,085 km^2); and the rest as previously defined. The mean monthly fishing mortality, F_i, and the aggregate fishing mortality for the 11-month period, F_T, were then subsequently estimated via the following expressions:

$$F_T = Y_T/B_T \quad \ldots (7)$$

$$F_i = F_T/11 \quad \ldots (8)$$

An attempt to estimate the magnitude of losses due to growth overfishing (resulting from the use of 2 cm cod-end mesh sizes by trawlers in the gulf) was made using the

method described by Silvestre and Soriano (1988). The basic equation is of the form:

$$Y''(Ms, F) = \sum_{i=1}^{n} Y/R\,(Ms, F)_i \times R_i \times W_i \times P_i \quad \ldots (9)$$

where Y"(Ms, F) is the aggregate yield index at mesh size Ms and fishing mortality F; n, the number of species/groups; $Y/R(Ms, F)_i$, the yield-per-recruit for species i at Ms and F; R_i, an index of relative recruitment; W_i, the asymptotic weight of species i; and P_i, an index of relative socioeconomic desirability (i.e., prices obtained from Signey 1987) for species i. The procedure used here utilizes the mean trawl landings by species/groups for the 1980-1984 period published by the Bureau of Fisheries and Aquatic Resources (BFAR), together with population parameters of "representative" species/groups obtained from the literature.

Results and Discussion

Table 1 provides a summary of the trawl-trips monitored, number of day-hauls and mean CPUE, for the 11-month period from June 1987 to April 1988. The study monitored an average of 2.2 trawl-trips per month during the period. A total of 24 trawl-trips were monitored, and an aggregate of 102 hauls sampled during the entire 11-month period. Mean catch rate was 31.8 kg/hour, being highest in June 1987 (50.8 kg/hour) and lowest in January 1988 (22.0 kg/hour) (Fig. 1).

The catch consisted of 158 species/groups distributed among 58 families/groups during the period. Table 2 gives a summary of the relative abundance of the 30 most important families/groups which made up the catch of trawlers from June 1987 to April 1988. Leiognathids made up almost a third of trawl catches (i.e., 31.4%), and together with carangids, hairtails, scombrids, and lizardfish, made up two-thirds of the catch. Table 3 gives the relative abundance of the 30 most important species/groups which made up the trawl catch for the same period. The orange-fin ponyfish, *Leiognathus bindus*, made up 18% of the catch, followed by *Trichiurus haumela* (9.0%), *Gazza minuta* (7.1%), *Saurida tumbil* (5.6%), and *Atule mate* (5.5%). The top 10 species/groups made up over 60% of the trawl catch during the period. Fig. 2 illustrates graphically the rela-

Table 1. Summary of boat/trawl-trips monitored, day-hauls sampled, day-hauls/trip and CPUE for the period June 1987 to April 1988.

Month	Boat-trips monitored	Day-hauls sampled	Day-hauls/trip	CPUE (kg/hr)	Standard deviation
June	2	11	5.5	50.8	20.4
July	2	13	6.5	24.0	9.0
August	2	16	8.0	27.0	11.9
September	4	15	3.8	32.9	13.4
October	2	6	3.0	31.2	15.8
November	4	17	4.2	32.1	13.2
December	1	3	3.0	29.5	5.3
January	2	5	2.5	22.0	15.2
February	1	3	3	33.2	2.7
March	2	7	3.5	24.9	13.4
April	2	6	3.0	41.2	10.5
Total	24	102	46.0	-	15.0
Mean	2.2	9.3	4.2	31.8	-
Standard deviation	1.0	5.3	1.8	8.3	-

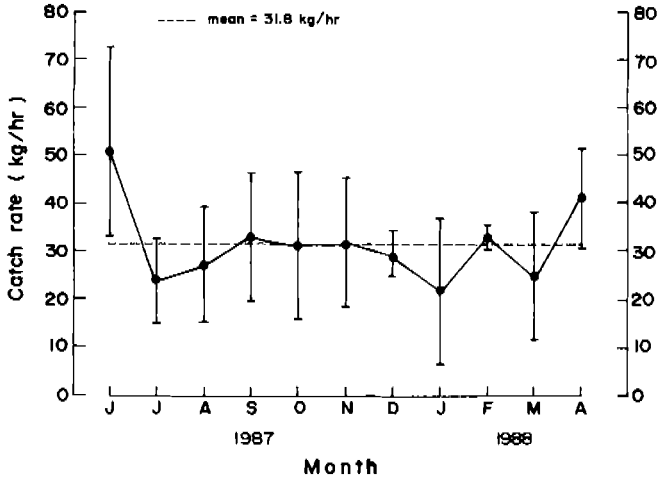

Fig. 1. Mean CPUE (kg/hr) of medium trawlers in Lingayen Gulf, Philippines, from June 1987 to April 1988.

tive abundance data generated during the 11-month period compared with those from other trawl surveys (i.e., Mines 1986, Warfel and Manacop 1950) and the trawler landing statistics published by BFAR. Leiognathids consistently made up the greatest bulk of the catches, although such dominance was in varying degrees. The data from Warfel and Manacop (1950) included larger, longer-lived species (e.g., Dasyatidae, Lactariidae) in greater abundance compared to the more recent data. The CRMP and BFAR data included more pelagic species (e.g., scombrids, carangids) compared to the others. The low abundance of pelagics in Warfel and Manacop's (1950) data, may be due to their survey employing a low opening trawl towed at lesser speed and, hence, making pelagics less vulnerable to their sampling gear.

The 11-month monitoring of trawlers in the gulf also generated information on the composition and operational details of the trawl fisheries. The trawl fleet in 1987 was composed of 24 medium and 2 large (20-30 GT) operational trawlers. There were 17 (i.e., 16 medium and 1 large) and 8 (i.e., 7 medium and 1 large) trawlers based (and which landed their catches) in Damortis and Dagupan City, respectively. One medium trawler was based in Sual, Pangasinan. Large trawlers made trips lasting 10 days and landed their catches with the help of carrier vessels. Medium trawlers, on the other hand, operated at sea for two days and were back in port for a day before the next trip. Vessel and gear dimensions did not vary much. Figs. 3 and 4 illustrate typical vessel and gear dimensions of medium trawlers operating in Lingayen Gulf. Medium trawlers, generally 13 m in length by 3 m width, used two-seam bottom trawls with headrope and groundrope lengths of 40 m and 45 m, respectively. Cod-end mesh sizes varied between 1.5 cm and 2.5 cm with a cover of about 3 cm to 4 cm. The towing warps were operated down to 50 m depth; their length was usually 275 m and adjusted with depth. Fig. 5 illustrates the range of operations of trawlers in Lingayen Gulf (i.e., between Lucap and San Fernando from about 0-50 m depth).

Length composition data for the more abundant species, were obtained during the

Table 2. Relative abundance (%) of the 30 most important families/groups in the catch of trawlers in Lingayen Gulf, Philippines, from June 1987 to April 1988.

No.	Family/ group	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Mean	Weighted mean
1	Leiognathidae	25.5	14.0	30.6	25.0	33.8	22.0	26.0	38.7	16.0	36.0	69.8	30.7	31.4
2	Carangidae	22.1	14.0	23.1	14.2	8.6	16.4	7.5	6.5	6.5	13.0	6.1	12.5	12.9
3	Trichiuridae	1.3	2.5	1.7	4.7	2.3	17.8	39.3	1.4	14.0	18.2	4.2	9.8	9.3
4	Scombridae	4.7	6.9	9.0	12.2	13.0	6.7	2.6	5.4	14.0	3.0	0.4	7.1	6.9
5	Synodontidae	11.2	12.1	3.1	3.0	10.6	6.7	0.3	4.6	8.0	6.0	0.2	6.0	6.1
6	Mullidae	6.5	4.7	2.4	5.0	0.0	3.5	1.1	1.1	4.5	4.0	3.6	3.3	3.6
7	Cephalopods	5.4	7.2	4.1	4.0	2.0	3.5	1.1	0.7	4.1	3.0	2.3	3.4	3.5
8	Nemipteridae	2.5	7.1	6.1	5.0	4.4	3.0	1.0	3.3	4.8	3.3	0.0	3.7	3.4
9	Engraulidae	5.0	7.4	1.3	1.0	0.6	2.6	2.0	2.0	3.0	0.5	2.0	2.5	2.6
10	Apogonidae	1.5	3.1	2.4	2.0	0.4	0.6	3.6	14.0	2.1	2.1	0.1	2.9	2.4
11	Priacanthidae	1.7	3.7	2.2	4.0	2.4	1.3	0.3	2.2	6.1	1.3	0.2	2.3	2.2
12	Gerreidae	1.5	2.5	2.1	2.8	1.1	1.4	0.0	5.4	3.3	1.0	2.1	2.1	2.0
13	Sphyraenidae	0.2	1.6	0.3	1.2	2.7	3.0	0.8	1.4	2.1	0.0	2.4	1.4	1.4
14	Meneidae	0.3	0.0	0.5	3.2	3.0	2.0	4.0	0.1	0.0	0.2	0.7	1.3	1.3
15	Scorpaenidae	0.4	0.1	0.2	0.6	1.0	2.1	0.0	3.6	3.6	0.3	0.0	1.1	1.0
16	Dussumieriidae	1.6	2.4	1.3	1.0	2.0	0.4	0.0	1.3	0.5	0.3	0.6	1.0	1.0
17	Mugilidae	0.1	0.0	1.3	0.6	3.6	1.1	3.0	0.1	0.3	0.0	0.7	1.0	1.0
18	Chirocentridae	0.5	2.6	1.6	1.1	1.0	1.4	0.0	0.0	0.0	0.0	1.0	0.8	0.8
19	Fistularidae	0.3	0.2	0.1	2.3	4.1	0.4	0.0	0.1	0.5	0.6	0.1	0.8	0.8
20	Dorosomatidae	0.4	1.0	1.0	0.2	1.0	0.5	0.8	0.6	1.0	1.5	0.0	0.7	0.7
21	Shrimp	0.6	1.3	0.4	1.0	0.0	0.4	1.0	2.4	1.0	0.0	0.0	0.7	0.7
22	Uranoscopidae	0.3	2.0	0.2	1.0	0.2	0.3	0.0	0.1	0.3	0.3	2.0	0.6	0.6
23	Theraponidae	0.0	0.0	0.5	0.7	0.0	0.2	0.4	1.0	3.5	0.0	0.1	0.6	0.6
24	Tetraodontidae	0.1	0.0	1.4	1.0	0.8	1.0	1.2	0.8	0.0	0.4	0.0	0.6	0.6
25	Shell	0.0	0.7	1.0	0.2	0.0	0.1	1.3	0.5	0.0	0.0	1.0	0.4	0.4
26	Megalopidae	1.0	0.2	1.0	0.2	0.1	0.5	0.0	0.3	0.2	0.3	0.2	0.4	0.4
27	Pomadasyidae	0.6	0.6	0.1	0.5	0.0	0.0	1.8	0.1	0.0	0.0	0.0	0.3	0.4
28	Clupeidae	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4
29	Platycephalidae	0.1	0.4	0.2	0.1	0.2	0.2	0.3	1.0	0.6	0.0	0.0	0.3	0.2
30	Bothidae	0.5	1.0	0.3	0.1	0.0	0.2	0.2	0.6	0.0	0.0	0.0	0.3	0.2
31	Others	1.0	0.7	0.5	2.1	1.1	0.7	0.4	0.7	0.1	4.7	0.2	1.1	1.0
	CPUE (kg/hr)	50.8	24.0	27.0	32.9	31.2	32.1	29.5	22.0	33.2	24.9	41.2	31.8	31.8

Table 3. Relative abundance (%) of the 30 most important species/groups in the catch of trawlers in Lingayen Gulf, Philippines, from June 1987 to April 1988.

No.	Family/group	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Mean	Weighted mean
1	*Leiognathus bindus*	16.6	5.0	15.1	12.8	33.6	12.5	4.3	28.0	10.0	24.6	33.0	17.8	18.0
2	*Trichiurus haumela*	1.3	2.5	1.7	4.7	2.4	18.0	39.7	1.4	14.0	13.4	4.2	9.4	9.0
3	*Gazza minuta*	4.0	2.2	9.1	8.2	0.0	6.1	15.0	6.4	5.0	1.5	17.5	6.8	7.1
4	*Saurida tumbil*	11.1	11.3	3.1	2.7	9.6	6.0	0.2	3.7	8.1	3.2	0.2	5.4	5.6
5	*Atule mate*	15.2	7.2	9.2	3.6	0.7	6.7	0.0	2.0	4.6	0.3	4.0	4.9	5.5
6	*Rastrelliger brachysoma*	2.2	2.5	3.5	5.6	12.2	5.7	0.5	4.7	13.8	0.0	0.2	4.6	4.6
7	*Loligo* spp.	5.4	7.1	4.0	3.5	1.6	3.2	1.1	0.7	4.1	2.0	2.3	3.2	3.3
8	*Upeneus sulphureus*	6.4	4.4	2.1	4.0	2.2	2.2	0.1	1.2	4.5	0.3	3.6	2.8	3.1
9	*Apogon* spp.	1.5	3.1	2.4	2.0	0.4	0.6	3.6	14.0	2.1	1.5	0.1	2.8	2.4
10	*Priacanthus tayenus*	1.7	3.6	2.2	4.1	2.0	1.3	0.3	2.2	6.1	1.0	0.1	2.2	2.2
11	*Gazza acclamys*	1.4	0.7	0.7	1.6	0.0	1.3	5.2	3.2	0.0	0.3	7.4	2.0	2.1
12	*Selaroides leptolepis*	1.3	0.7	7.0	3.4	1.4	2.3	1.3	0.1	2.0	0.0	0.6	1.8	1.8
13	*Sardinella gibbosa*	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	24.3	0.0	2.2	1.7
14	*Nemipterus nematophorus*	1.0	5.0	0.4	2.0	4.4	1.1	0.0	3.1	0.4	1.7	0.0	1.7	1.6
15	*Stolephorus* sp.	4.5	6.3	1.2	0.4	0.4	1.1	0.0	1.6	0.0	0.3	0.3	1.5	1.5
16	*Leiognathus equulus*	1.7	2.6	2.5	1.4	0.6	1.3	1.0	0.2	0.5	0.0	4.0	1.4	1.5
17	*Mene maculata*	0.3	0.0	0.5	3.2	3.0	2.0	4.0	0.0	0.0	0.2	0.6	1.2	1.3
18	*Pentaprion longimanus*	1.3	1.3	0.3	2.0	1.1	1.0	0.0	5.1	0.7	0.7	0.6	1.3	1.2
19	*Sphyraena obtusata*	0.2	1.5	0.3	1.1	2.0	1.0	0.8	1.3	2.1	0.0	2.3	1.1	1.2
20	*Rastrelliger faughni*	0.0	1.6	0.4	6.1	0.5	0.4	2.1	0.1	0.0	2.0	0.1	1.2	1.1
21	*Nemipterus japonicus*	1.2	1.3	5.0	2.3	0.0	0.2	0.0	0.0	2.1	0.5	0.0	1.1	1.1
22	*Selar crumenopthalmus*	0.1	2.6	0.3	0.3	6.0	1.8	0.0	0.0	0.0	1.6	0.0	1.2	1.1
23	*Rastrelliger kanagurta*	2.3	2.3	4.7	0.5	0.4	0.7	0.0	0.5	0.0	0.3	0.1	1.1	1.1
24	*Dussumieria acuta*	1.6	2.3	1.3	1.0	2.0	0.5	0.0	1.3	0.5	0.3	0.6	1.0	1.0
25	*Selar boops*	0.4	0.0	1.2	2.0	0.4	2.0	2.4	3.6	0.0	0.0	0.0	1.1	1.0
26	*Leiognathus splendens*	0.0	1.5	1.0	0.3	0.0	0.4	0.2	0.6	0.4	0.0	4.7	0.8	0.9
27	*Megalaspis cordyla*	0.8	0.5	0.7	1.7	0.0	2.0	3.2	0.6	0.0	0.0	0.0	0.9	0.9
28	*Chirocentrus dorab*	0.5	2.5	1.6	1.1	1.0	1.4	0.0	0.0	0.0	0.0	0.8	0.8	0.8
29	*Fistularia petimba*	0.3	0.2	0.1	2.4	4.1	0.4	0.0	0.1	0.5	0.3	0.1	0.8	0.8
30	*Decapterus macrosoma*	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	7.8	0.0	0.7	0.6
31	Others	15.7	18.2	18.3	16.0	8.0	16.6	15.0	14.3	18.5	11.9	12.6	15.0	15.0
	CPUE (kg/hr)	50.8	24.0	27.0	32.9	31.2	32.1	29.5	22.0	33.2	24.9	41.2	31.8	31.8

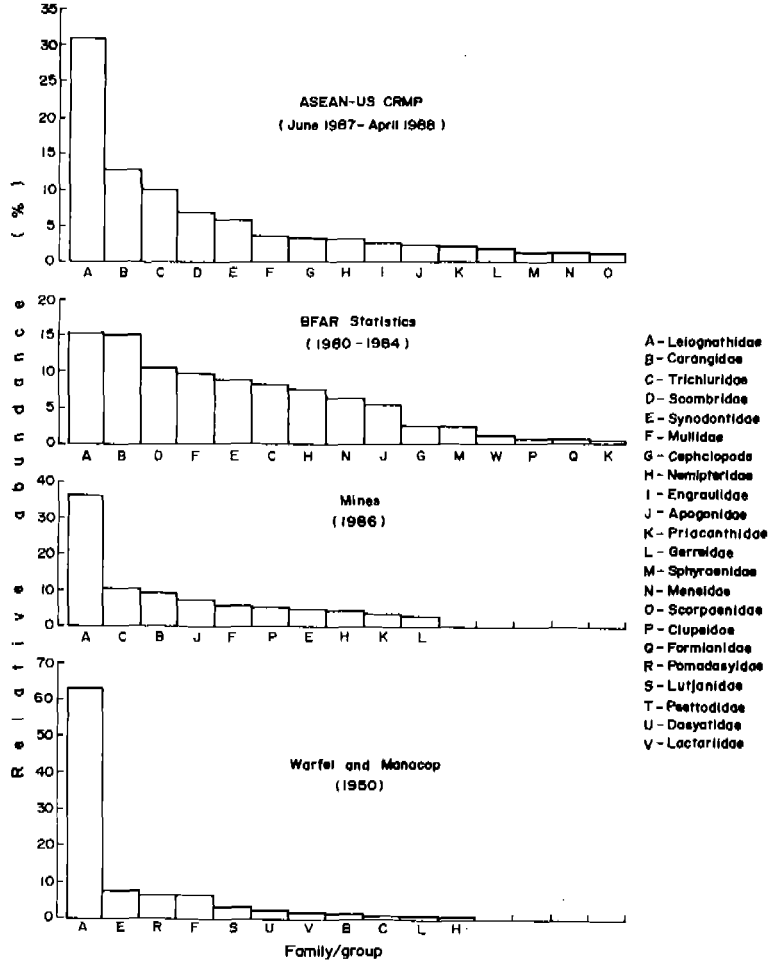

Fig. 2. Comparison of the relative abundance data by family/group generated in this study with those from BFAR statistics and other surveys in the literature.

period from June 1987 to April 1988. They indicate that the catch of medium trawlers predominantly consisted of the smaller-sized individuals for each species. Incoming cohorts were clearly seen, yet the larger-sized individuals were quite rare. The older individuals may be in the deeper areas, and emphasize the need for more representative samples covering the full range of depths. This represents the most pressing information gap identified thus far, aside from that concerning both pelagic and demersal resources outside the gulf boundaries.

Table 4 gives a summary of the estimated magnitude of landings/catches by the trawl fleet in the Lingayen Gulf area, together with estimates of stock density and biomass, for the period from June 1987 to April 1988. Mean monthly landings by the trawl fleet were 280 t/month, varying between 440 t in June 1987 and 190 t in January 1988. Total trawl landings for the 11-month period were

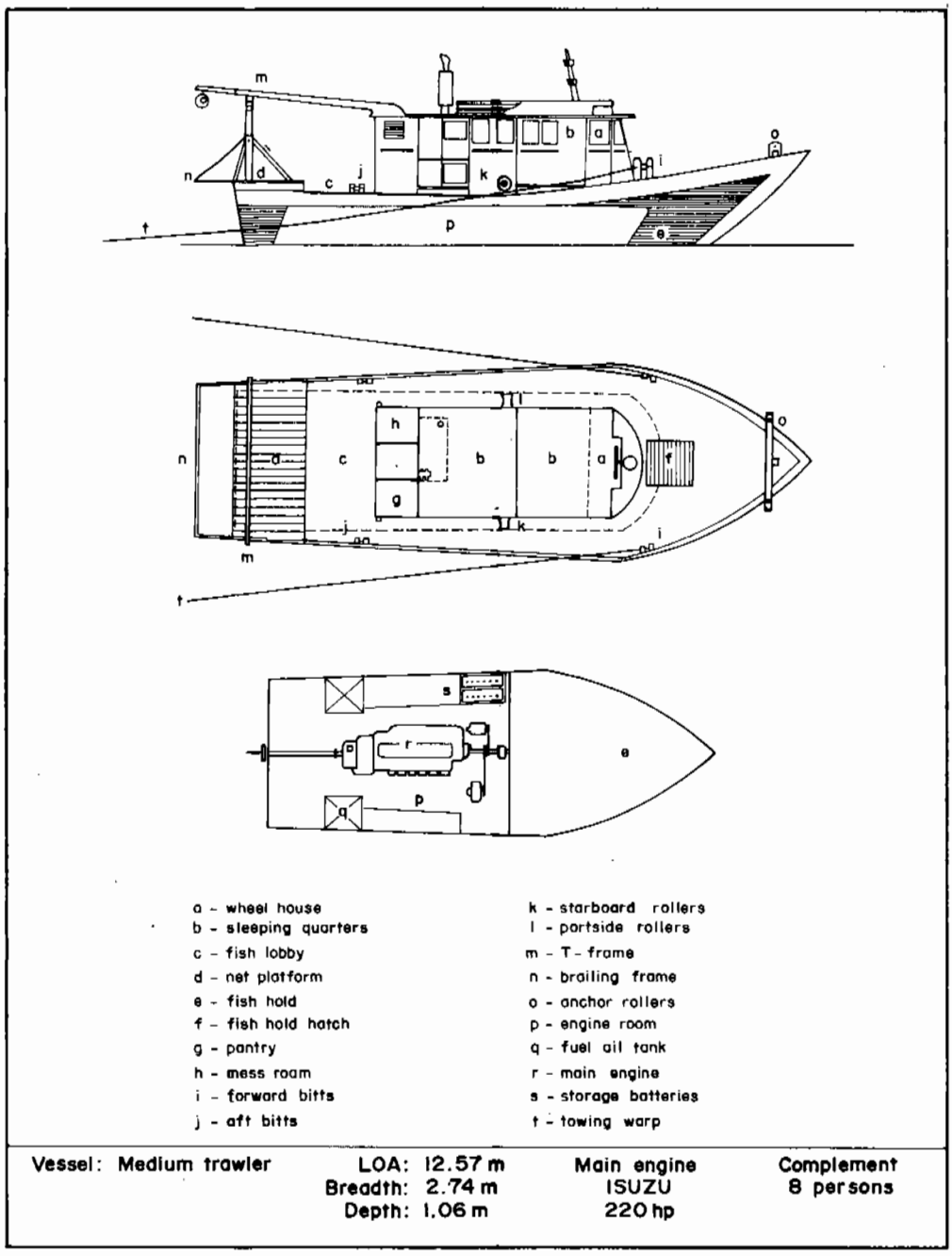

Fig. 3. Diagram of a typical medium trawler operating in Lingayen Gulf, Philippines.

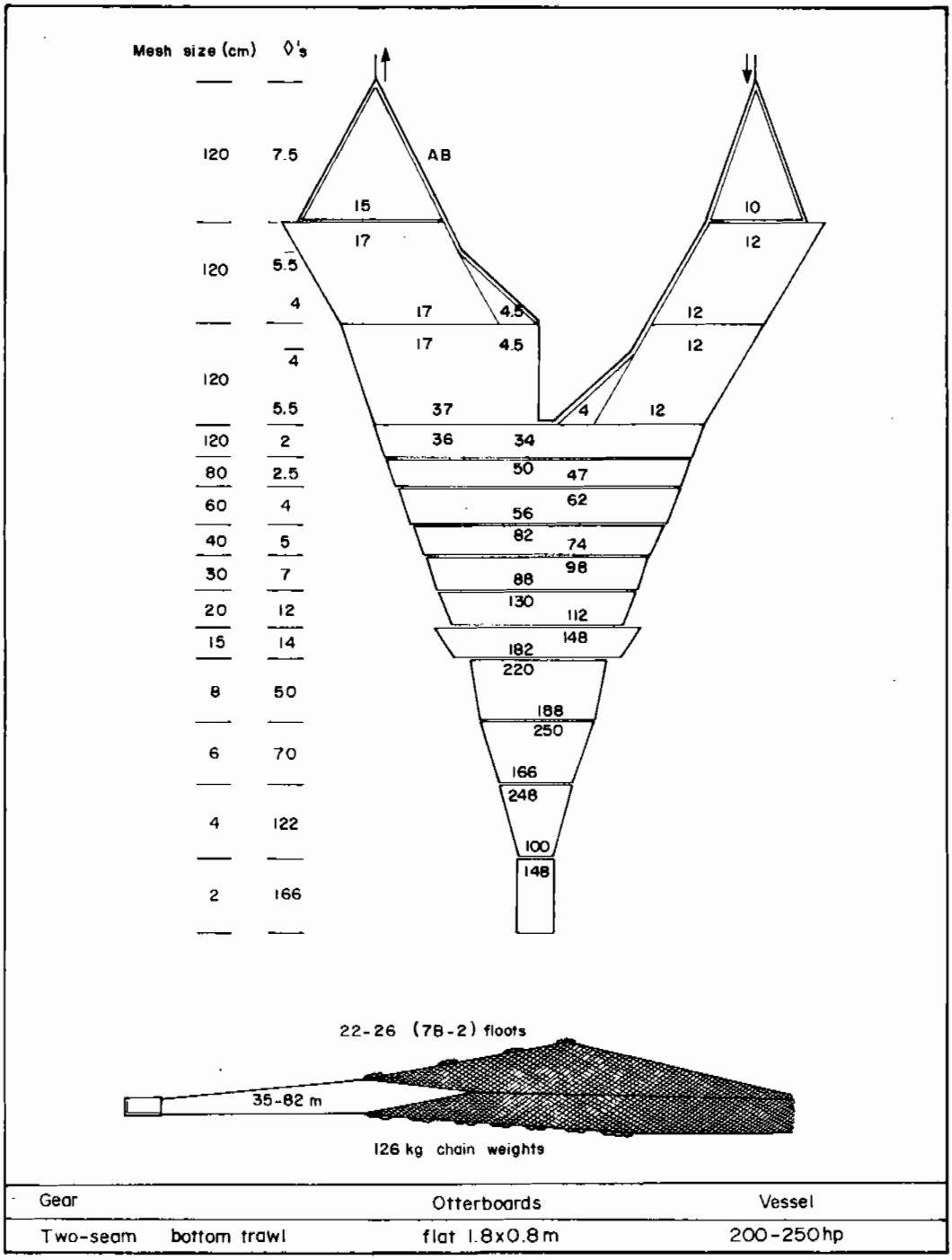

Fig. 4. Typical design of bottom trawl used by medium trawlers in Lingayen Gulf, Philippines.

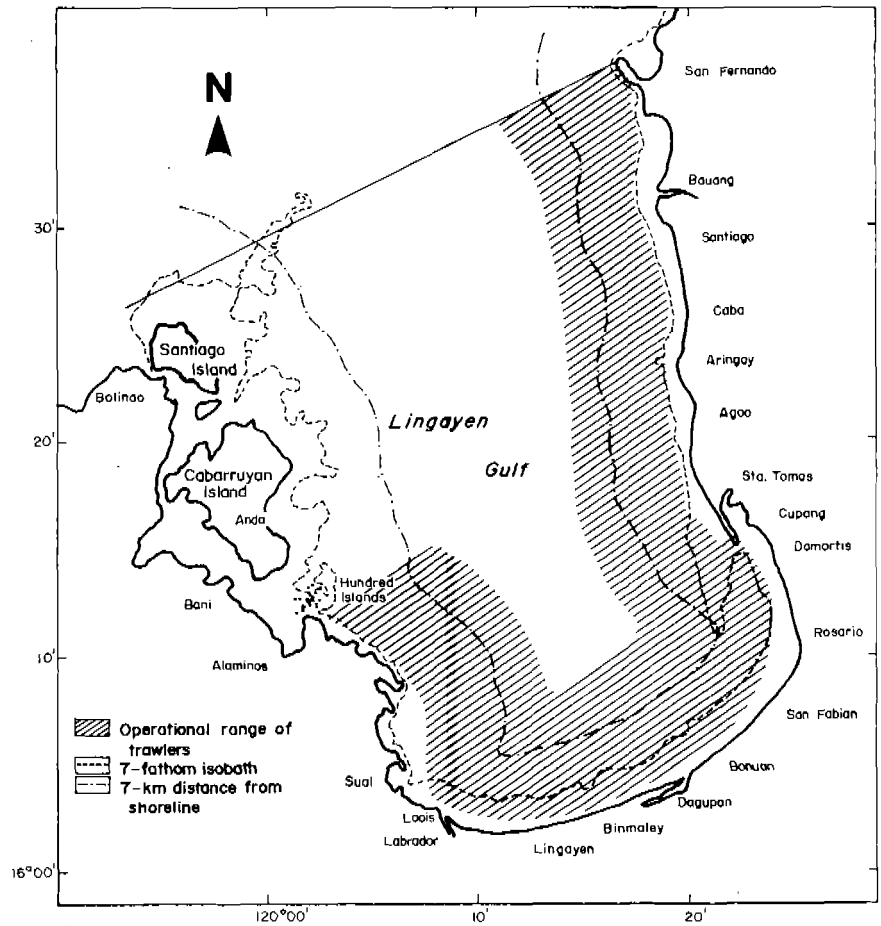

Fig. 5. Lingayen Gulf showing the 7-km distance from the shoreline and the 7-fathom depth isobath.

3,070 t. Mean stock density and biomass for the period were 0.572 t/km^2 and 1,192 t, respectively. These imply considerable fishing pressure, giving fishing mortality (F = Y/B) values of 0.23 per month and 2.58 for the 11-month period.

Fig. 6 gives the values of the aggregate yield index for the species/groups comprising the mean 1980-1984 trawl landings in Lingayen Gulf, between mesh sizes of 2.0 cm and 7.0 cm at 0.5 cm mesh size intervals and F values between 0-4. Aggregate yield increases with mesh size throughout the range of F up to 3.5 cm, but declines beyond this value. The figure emphasizes the inappropriateness of the 2.0 cm mesh size common among trawlers in the Lingayen Gulf area, and points to 3.5 cm as the more appropriate mesh size in maximizing gross value of the landings. The difference between the maximum aggregate yield values obtained at 2.0 cm mesh size (5.25 x 10^7) and 3.5 cm mesh size (5.85 x 10^7) indicates a loss of about 10% in harvestable gross value from the exploited multispecies mix. Apparently, the present levels of trawl effort (F =

Table 4. Estimated catch of the trawl fleet and standing stock density and biomass in Lingayen Gulf, Philippines, from June 1987 to April 1988.

Month	Trawl catch (t)			Stock density	
	Medium[a]	Large[b]	Total	(t/km^2)	Biomass (t)
June	366	76	442	0.914	1,906
July	173	36	209	0.432	901
August	199	42	241	0.498	1,040
September	237	49	286	0.592	1,235
October	225	47	272	0.561	1,171
November	231	48	279	0.578	1,204
December	212	44	256	0.531	1,107
January	158	33	191	0.396	826
February	239	50	289	0.596	1,246
March	179	37	216	0.448	934
April	297	93	390	0.742	1,546
Total	2,516	555	3,071	-	-
Mean	229	50	279	0.572	1,192[c]

[a]Based on 24 medium trawlers operating 20 days/mo.: 5 day-hauls each lasting 3 hr for every day out at sea.
[b]Based on 2 large trawlers operating 25 days/mo.: 5 day-hauls each lasting 3 hr for every day out at sea; catch rates double those given for medium trawlers.
[c]For an area of 2,085 km^2.

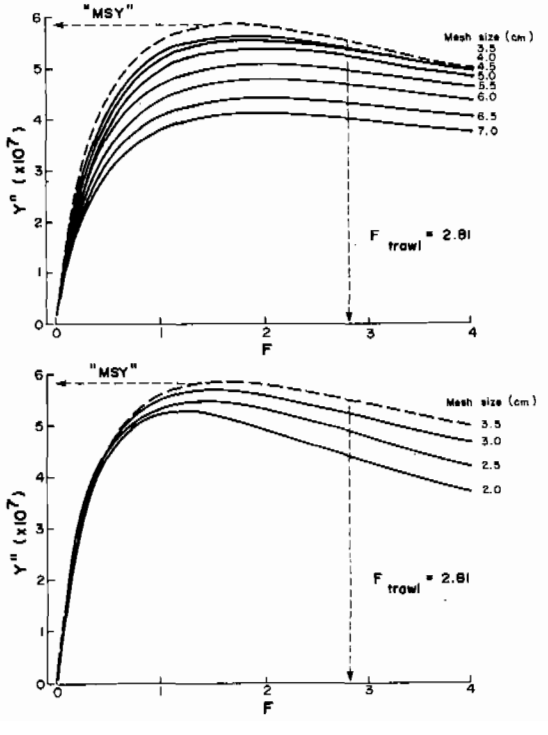

Fig. 6. Aggregate yield index (Y") for the Lingayen Gulf multispecies trawl fisheries as inferred from mean landings for 1980-1984 given in BFAR statistics. The Y" values are given through the range of F between 0 and 4 and mesh sizes between 2.0 cm and 7.0 cm at 0.5 cm intervals. Note that Y" is maximized when mesh size is about 3.5 cm.

2.81/year) and mesh size (2.0 cm) are inappropriate for the mix of species being exploited and lead to losses of about 20%.

The results presented above are still in the process of refinement as the data collection and analysis phases are being completed. More reliable species-specific assessments will be made available as the data for the 12th month of sampling (i.e., May 1988) are obtained. These assessments will be used to increase the accuracy and check the credibility of the assumptions made above.

Albeit preliminary, the results generated thus far indicate considerable fishing pressure on the trawlable biomass by the commercial fleet. Thus, it appears reasonable to stop licensing of new commercial trawlers as well as other commercial boats (e.g., Danish seiners) that may put additional pressure on the same stocks. This measure assumes greater urgency given the high level of municipal fishing effort in the gulf (see Calud et al., this volume). Subsequent reduction of commercial trawlers by accretion of older vessels may be desirable. Other measures toward sustainable utilization of the fisheries resources that need immediate attention include: (1) better enforcement of the 7 fathom-7 km ban on commercial trawlers; (2) increase of cod-end mesh sizes to 3.5 cm; and (3) establishment of a fisheries management council to be composed of representatives from both commercial and municipal sectors, to be placed under the regional development council, which can oversee/address resources allocation and management. The rationale and elements for the establishment of such fisheries councils, in the context of the national fisheries situation, are discussed in Silvestre (1987).

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Sociocultural Dynamics of Blast Fishing and Sodium Cyanide Fishing in Two Fishing Villages in the Lingayen Gulf Area

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Abstract

The use of explosives and poisons in fishing is illegal and punishable with stiff fines and prison terms. Nevertheless, the use persists in a number of coastal villages in the Lingayen Gulf area. This paper gives the results of ethnographic studies in two fishing villages in the gulf area based on data/interviews covering the period May 1987 to April 1988. It describes: (1) how blast fishing and sodium cyanide fishing are practised in the villages; (2) the factors which affect their continued use; (3) the level of perception of village residents regarding these illegal practices; and (4) the need for education campaigns to increase awareness of the destructive effects of these illegal practices.

Introduction

Both blast fishing and sodium cyanide fishing are illegal. Nevertheless, they are widely practised in the two communities studied. Community residents tolerate these practices despite the legal sanctions, the danger they pose to people's health and the damage they inflict on the coastal resources. For many of those who resort to blast fishing and the use of sodium cyanide, it is one of their livelihood options amidst increasing poverty. For many scientists and conservationists, however, these practices need to be stopped to avert destruction of the environment.

One of the concerns of the Legal and Institutional Division of ASEAN-US CRMP is to investigate the sociocultural dynamics of blast fishing and sodium cyanide fishing in two selected fishing villages in the Lingayen Gulf area. The project has the following specific objectives:

- to describe how blast fishing and cyanide fishing are practised in the communities;
- to identify major factors which affect their continued use;
- to assess the people's level of perception regarding illegal fishing practices; and

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- to suggest alternative measures to check its widespread use.

Data gathering for cyanide fishing started in February 1988, thus, rendering current information on this preliminary and limited compared to the blast fishing study (which started in May 1987).

Due to the sensitive and critical data involved, the real names of the study areas and people involved are not used. The criteria for selection of the study areas are as follows:

1. They are among eight pilot areas where baseline surveys were conducted;
2. Blast fishing and/or cyanide fishing are widely practised;
3. Key informants are willing to provide the necessary information; and
4. Researchers have gained adequate rapport and trust among community residents.

Based on earlier community studies, the two areas selected are both characterized by poverty and limited social services and facilities. Fishing is the main source of income, while farming comes as secondary. The study area for blast fishing is located in La Union at the northern part of Lingayen Gulf, and that for cyanide fishing in southwestern Pangasinan.

Methodology

One of the most effective methods for studying sociocultural systems is to directly observe, or be part of, a given community. Thus, the research methods used in this study combine tools used in sociology, anthropology and psychology, and elements associated with community organizing (i.e., contact building and integration methods).

The field researchers lived in the fishing villages since April 1987--initially conducting the baseline survey, subsequently doing ethnographic studies on legal and cultural aspects, and gradually focusing on case studies of illegal fishing practices (particularly blast and cyanide fishing). The researchers interacted with the people in their daily activities. Mutual trust and rapport between the researchers and community residents were considered vital to the nature of the data required.

To gather information for the case studies, the researchers interviewed key informants, observed and participated in various community activities and analyzed existing documents/records. They also utilized information gathered by co-researchers who stayed in other coastal communities in Lingayen Gulf. The bulk of the data are qualitative in nature. Thus it is necessary that these be validated using several informants. Among those interviewed were fishermen, local government officials, members of civic/religious organizations, other community residents and representatives of government agencies such as the Philippine Coast Guard (PCG), the Constabulary Offshore Anti-Crime Unit (COSAC), the local police and BFAR.

The main research technique adopted was *panunuluyan* as described by San Juan and Soriaga (1985). This is an indigenous research method which has many parallels with the participant observation techniques of anthropologists. Its main strength, however, is that it utilizes and observes aspects in Filipino human relations.

The kind of information gathered in social research depends largely on the level of relationship forged between researcher and respondent (Santiago and Enriquez 1976).

The researchers had to reach the *hindi ibang tao* (one of us) level of relationship in order to ensure the accuracy and validity of data gathered. At this level, the researchers are regarded as people with whom the respondents can be themselves as persons, or to whom they can present both their bad as well as good points. The researchers had to go through the *pakikipagpalagayang loob* level, which is winning the trust and confidence of the respondents to enable them to disclose information about their illegal activities.

The methodology adopted other indigenous methods of integration such as *pakikilahok* (participation in people's activities, e.g.,

fishing), *pakikibagay* (doing things the way they are done in the community), and *pakikisama* (friendship and going along with what they want to do). But most important of all is the skill in *pakikiramdam* which roughly translates into "sensitivity". This includes perceptiveness to what the respondent wants to express through actions, indirect remarks and metaphors (San Juan and Soriaga 1985).

Along with the above-mentioned techniques, the researchers also adopted other indigenous methods such as *pagtatanongtanong* (Pe-pua 1985) which is similar to the anthropologists' method of interviewing key informants. This entails directing the same question to several persons for purposes of crossvalidating information.

Results and Discussion

Blast Fishing: a Case Study

Profile of the study area

San Roque is one of the most depressed villages at the northeastern side of Lingayen Gulf. Of the 200 families in the village, about 160 (80%) are directly dependent on fishing. Of the latter, about 60 own boats.

During lean periods, the monthly net income is ₱200 for fishermen who do not own boats and ₱400 for those who do. These income levels are doubled (sometimes tripled) during the peak season which is considerably short in span (i.e., from October to December, when shrimp are the primary catch).

Only about 90% of the fishermen attained elementary education. The options open to them are limited. Their views about their future are also constricted by available resources. As reflected in the way they handle and control their resources, they live on a day-to-day basis. They go out and fish on each calm day to feed their families. The little surplus they produce during peak seasons is absorbed by merrymaking practices that represent a form of coping with the harshness of life.

Origins of blast fishing in San Roque

According to some old fishermen in San Roque, blast fishing was introduced in the gulf after World War I. A pound of gunpowder at the time sold for ₱0.10[b] and blasting caps for ₱0.06 each. Its use intensified in the years before martial law was declared in 1972. The declaration of martial law strictly curtailed the sale of dynamite and gunpowder, and blast fishing was completely stopped. The use of beach seine *(karukod)* for catching anchovies returned in fashion. However, in 1975, enforcement of laws on possession of dynamite and its use in blast fishing became lax. Dynamite fishing reemerged and reached its peak in the 1980s.

Production of bumbong

Blast fishermen claim that the gunpowder they used in the past for production of *bumbong* (local term for the homemade explosive used in blast fishing) came from World War II bombs which were dug up by the fishermen. This has some degree of truth in it since the Japanese made a stand in Lingayen Gulf against the Americans during World War II. The bombs were recovered after the war and were opened using chisels and hammers.

Interviews reveal that the gunpowder used at present partly comes from Zambales (i.e., from inside the naval reservation in Subic), from the unexploded bombs used by pilots in their training exercises. Called "bogey" bombs by the fishermen, these are dug up by the Aetas (tribal people) and then sold to dealers. Through the use of telegram codes, dealers are able to communicate with local suppliers who sell the gunpowder to blast fishers. As of July 1987, a kilogram cost ₱130[c]. By March 1988, however, the cost has

[b] At the time: ₱1.00 = US$1.00

[c] 1987: ₱20.50 = US$1.00

risen to ₱150[d] per kg. Thus, most of the blast fishers have resorted to mixing the gunpowder with potassium nitrate (KNO_3). Although the chemical compound is generally used as fertilizer, it can also be used as explosive. The blast fishermen claim that although it emits a louder explosion, the potassium nitrate compound has weaker killing effect on the fish.

In a later interview, officers of COSAC and PCG confirmed that some of the gunpowder indeed comes from Zambales, but did not elaborate as to whether this is from within the military reservation or the mining companies operating in the province. The military officers also pointed to Bataan and Baguio as other sources of gunpowder. They explained that miners use only half of the supply allotted to them by their permits, and sell the rest. The military officers said that even as procedural safeguards have been instituted, unscrupulous dealers still manage to obtain supplies illegally.

There are two kinds of *bumbong*: one is used for catching surface fish, and the other for bottom fish. The principle behind making both types, however, remains the same. The main components of a *bumbong* are the container, blasting cap, wick, newspaper strips, gunpowder, matchsticks, and sand if the *bumbong* is for bottom fish.

The gunpowder, when newly bought, assumes a solid form like crystal stones. The stones are powdered using an iron grill as pestle; then they are filtered through a fine-meshed screen. Although preparation is not done in the open, it is done openly enough for one to conclude that the process is common knowledge among the residents. And as in any other fishing gear preparation and the entire fish production system, the woman in the house is actively involved.

The process of making *bumbong* is done inside the huts of fishermen. The two huts wherein one researcher observed the process on separate occasions are small. A 10-year old child did the pouring of sand and gunpowder inside bottle containers. From this, it can be concluded that knowledge about the use of *bumbong* is imparted to fishermen's children at a very early age. This also makes the "illegal activity" a family affair. There is reason to believe that the perceptions, values and attitudes of the blast fishermen towards blast fishing are shared by the rest of the members of their families. This is further substantiated by other data presented below.

The most delicate steps in making *bumbong*, however, are done by the blast fishermen themselves. These include the placing of the blasting cap, wick and matchstick.

For surface fish, fishermen make *bumbong* using a sardine can, with one end completely open, as container. Small medicine bottles are also sometimes used. For bottom fish, a smaller container is needed since sand is not utilized. A kilogram of gunpowder makes up to five sardine cans of *bumbong*. The fishermen simply place the gunpowder in the can and close the open side with a hammer. A small hole is made at the other side where the wick and blasting cap are placed. A matchstick is tied to the end of the wick. The matchstick used must be of superior quality to ensure that it immediately lights up when struck to the matchbox. The blasting cap which costs ₱10 each, is held in place with newspaper strips. The blast fishermen estimate each sardine can type of *bumbong* to cost about ₱25.

For bottom fish, fishermen make *bumbong* using softdrink, beer and/or gin bottles as containers. Half of the bottle is first filled with sand and the other half with gunpowder. The sand is necessary to make *bumbong* sink before exploding.

After making *bumbong*, the bottles and cans are placed in a big gasoline container (which is cut in two, one part of which is used as cover). Several bottles or cans are brought per fishing trip.

Fishing schedule

The blast fishermen go out to sea only when the weather is calm. Fish are believed

[d]1988: ₱21.00 = US$1.00

to be abundant after a storm since fishermen have not been able to fish for a time. During the lean season (March to May), there are many occasions when the blast fishermen come home empty-handed.

During February and March, blast fishermen set up FADs (locally called *rama* or *pulohan*) which are made of bamboo poles, coconut leaves (*bulong*) or branches of a tree (*garatiles*). Each bamboo pole costs from ₱15 to ₱25, while each *bulong* costs ₱1. A FAD uses up to 30 *bulong*. With the high cost of coconut leaves, tree branches are more popular among blast fishermen. The branches are commonly obtained for free from neighboring villages.

It is the large-scale blast fishing operation involving large boats and drive-in nets (*taksayan*) which commonly makes use of the coconut leaves. A roll of rope used to tie *bulong* to the pole costs ₱35 each and is used to make 10 FADs. Rocks weighing about 50 kg are used as anchors for the bamboo poles. These rocks are bought at ₱5 each. Some blast fishers, however, use sacks filled with sand as sinkers. The cost of transporting these materials from a nearby town to San Roque must also be included in the computation of expenses. Thus, the overall cost of FAD is about ₱100. Only those who have set up the FAD can utilize it for blast fishing.

Blast fishermen go out to sea at about 5:30 a.m. If they make a good catch, they bring their catch to shore to be sold to the fish vendors. This has to be done immediately because dynamite-caught fish stale faster than those caught with other gears. If they have no catch, they return to shore at about 9:30 a.m., and then go back to sea at about 12 noon. They come back at about 3 p.m. When the wind is strong, or if they have reasons to believe that there are no schools of fish (e.g., the catch was very poor in previous days), they wait for better sea conditions or other indications that schools are available (e.g., the sound of other fishermen blasting).

Compared to fishermen using other kinds of fishing gear, the blast fishers have shorter working hours. At most, they spend only eight hours at sea. Compare this to the bottom set gill net (*sigay*) fishermen who work from 6 a.m. to 6 p.m. Those who use dredge net (*kadkad*) work from 5 p.m. to 5:30 a.m., or for more than 12 hours, aside from being sleepless the whole night. Some fishermen comment that those who use explosives "want to earn money the easy way."

Pulling the *sigay* or *kadkad* is more difficult than pulling the net used in blast fishing. The *sigay* and *kadkad* need to be in water for a longer time to catch fish, thus, straining the boat's motor. The net used in blast fishing is thrown only when the fish are already stunned and easy to catch. It is also pulled immediately.

Nets like *kadkad* are used only seasonally. Thus, the fishermen need bigger capital to own other kinds of nets for use in other seasons. In comparison, the net in blast fishing can be used throughout the year, thus, requiring a lower capital input.

Crew roles

A fishing team consists of a pilot (*timonero*) who also acts as the dynamite thrower *(tirador)*, and a diver. Both perform specialized functions, and neither is considered less important than the other. The role of the thrower, however, can be seen as more dangerous. He has to be good at throwing the dynamite into the center of the school of fish at the right time. He has to ensure that when the matchstick strikes the matchbox, it lights immediately or else it will be of no use when thrown into the sea. Some of the blast fishers meet accidents because they check whether the wick was lighted or not prior to throwing the charge. Successful throwers merely listen to the sound of the burning wick to avoid accidents at this point of the operation.

A blast fisherman was asked if he is not afraid that accidents might happen. He answered, "You should not think of accidents. You will meet accidents only if the Lord has forgotten you."

The role of the diver (sometimes 10-year old children) is also strenuous. He dives in every FAD to see whether any fish school is

available. Many fishermen in the village say that those who appear to age faster are the divers. They are more vulnerable to the elements and their hair are mostly golden in color due to prolonged stay in the sea. The dynamite is sometimes thrown while the diver is still in the water. Although far from the area where the dynamite is thrown and explodes, the diver feels a thud on his body.

Fishing operation

Once a school of fish is spotted, the diver informs the thrower, who waits for the diver to swim away from the target area or climb onboard the boat before throwing the *bumbong*. The target usually ranges from 10 to 30 m from the boat. After about 30 to 60 seconds, the dynamite explodes. There are times, however, when the dynamite does not explode, during which another is thrown.

The team members immediately set their net to catch the dead and half-dead fish. If there are many fish affected by the dynamite, the net is again thrown overboard for the remaining fish to be caught. At times, other blast fishermen who hear the explosion get to the site and start throwing their net and making a catch. This is not resented by the blast fishers because a reciprocal relationship exists. Participating in this "cleaning" operation are about 10 boats of fishermen aside from some diving for the stunned/dead fish. Thus, only a small number of fish are wasted.

What is more striking, however, is that other fishermen who do not use dynamite, but have a baby trawl net (*karkar*), are also allowed to "trawl" the dynamited fish. Such is the high degree of sharing in the area studied, which is not practised in other fishing communities in Lingayen Gulf. In those areas, the blast fishers get half of the fish trawled by the other fishermen from the fish they dynamited.

Seasonality in catch and income

The summer months are generally considered lean season, although there are fish which abound that can be caught through blast fishing. Roundscads (*mataan*) frequently make up the catch. There are many instances during this season when blast fishermen go home empty-handed and incur debts. Net income, however, could be as much as ₱25 per day. It is noted that the catch of blast fishers during lean season is still higher than those of fishermen using other gears (like hook and line) with similar target species.

During times of peak catches, the blast fishermen become instantly awash with cash. The catch can go up to four to seven baskets (*kaing*) a day, each basket containing about 40 kg of fish (mostly anchovies). Individual net incomes could be as much as ₱1,300 per day. Periods of such peak catches can last for four days at a time, depending on the kind of fish. The peak season occurs at different times for the different target species. We note that the catch of artisanal fishermen using other gears does not reach the level of net profits that blast fishers get (see Añonuevo, this vol.).

The catch is normally sold to fish vendors who come to the beach. They bring the catch to the town market. When the catch is small (less than 15 kg), the wives or daughters of the blast fishermen sell the catch themselves at the market. The catch of the blast fishermen is not usually purchased by the "big" fish dealers *(compradors)* because they stale more quickly.

Blast fishers' perception of their resource

According to blast fishers and nonblast fishers alike, the harmful effects of blast fishing are limited, compared to trawl fishing. They say that blast fishing affects only a very small area, confined to where the dynamite is thrown. Trawl fishing, on the other hand, "destroys the seabed and kills all the small fish that cross its path."

The informants say that only a radius of 5 m is affected by the blast. Moreover, they believe that the small fish and fish eggs are not affected, let alone killed, by the blast.

When asked, however, if the eggs that are attached to the *rama* are killed or not, informants generally become more evasive and unsure of their answers.

Relationship with the community

Why is blast fishing generally tolerated, if not encouraged, by the community? Some analysts opine that there has been a breakdown in community norms and values giving rise to a tolerant attitude to the fishing technique. However, this is difficult to prove, considering that the practice has existed even before World War II. Present blast fishermen have learned the skills from their parents or from elder members of the community. However, blast fishing was not as prevalent before as now, as confirmed by elder members.

We believe that the main reason for the tolerance and acceptance of the practice is that almost all members of the community benefit from it. Whenever the blast fisherman comes home with his catch, other fishermen, men, women and children (who are either friends or relatives) ask for a handful of fish. Some of them even ask from two to three blast fishers. When the catch is really good, almost all members of the community ask for a share, sometimes as much as half a kilogram from each blast fisherman. The blast fisherman can give away as much as 10 kg of fish to his villagers after a trip. There are also times when neighboring villagers come to San Roque during peak catches to ask for fish. Since there are only about 10 clans in San Roque, (five of which compose the biggest clans whose members have intermarried), almost anyone can ask from a blast fisherman some share in the catch.

Although this practice of fishing extends to all kinds of fishing operations, it is in blast fishing in which the amount shared is the biggest. This extensive "benefit" to the community members is further illustrated by the fact that whenever the catch reaches a peak, a fiesta atmosphere immediately pervades. The fiesta celebration is attended by members of the town police, the constabulary, and the coast guard, as well as other visitors of the community.

According to the *barangay* captain, dynamite fishing not only benefits the immediate community but also ensures the steady supply of low-priced fish because of the low capital inputs involved.

Extent of Community Participation. Estimates of the number of fishermen in San Roque who resort to blast fishing vary. According to the blast fishermen, almost every fisherman in San Roque engages in blast fishing at one time or another within the period of a year. A nonblast fisher said that there are 10 boats in San Roque which regularly blast fish. These figures were validated by cross interviews with other blast and nonblast fishermen and by the research team's observations.

Of the 200 families in San Roque, 170 are directly dependent on fishing. Of the latter, about 60, or more than one-third of the number of families, own boats. Thus, those who regularly depend on blast fishing are a minority, i.e., only about one-sixth of the boat owners. However, this percentage creates an important impact in the lives and minds of the community members.

The seasonality in the number of blast fishermen should be emphasized. When the catch from blast fishing reaches its peak, other boats also resort to this illegal activity or at least participate in gathering the fish. During these times, baby trawl nets are attached to some boats which normally use other methods and tail the blast fishing boats. In March-April 1988, the research team's count of blast fishers reached 20, or twice the previous number. This increase was due to the very poor catches by fishermen of San Roque who use other gears.

The number of fishermen who regularly use blast fishing techniques does not include San Roque residents employed by the large-scale blast fishers. The *taksay* employs at least 30 San Roque fishermen in their operations. They use up to 40 dynamite sticks a day in their fishing operations to catch round-scad (*galunggong*). One of the informants

said that there was a time, about two years ago, when a scarcity of nonboat-owning fishermen who join fishing trips occurred as many of them were employed on board the *taksayan*. Thus, the number of blast fishers can easily reach up to half the number of fishermen during peak times.

In March-April 1988, many fishermen of San Roque joined the crew of the several *taksayan* near the *barangay* due to their very low individual catches.

Blast fishing seems to employ all types of small fishermen which include:

1. The crewmen who serve in the *taksayan*;
2. The nonboat owners who join the blast fishing operations of those who have boats;
3. Those who own boats but only have the *karkar* type of net;
4. Those who own multiple fishing gears (e.g., *kadkad* and even the expensive *sigay*); and
5. Those who have other means of livelihood aside from fishing (e.g., variety store and piggery).

Almost all of these types of fishermen engage in blast fishing apparently because even those who own gears and vessels still live at subsistence level. But it is equally true that other fishermen in the same economic condition do not resort to blast fishing.

The trade also cuts across family clans. There are blast fishers as well as nonblast fishers in the five main clans of San Roque.

Some of those who do not engage in blast fishing regard those who engage in it as "wanting to earn money the easy way." This view is understandable considering that these fishermen stay at sea for about twelve hours but earn less than the blast fishermen who work for less hours. Nonblast fishers fear the threat of being arrested more than the possibility of accidents. To a certain degree, we can say that those who engage in blast fishing have bolder personalities.

San Roque fishermen who resort to blast fishing do so for various reasons. For one, San Roque is a depressed village and a fifth class municipality. Fishermen's income is very low. About 90% of the fishermen attained only elementary school education. The options open to them are thus very limited.

Aside from their limited options, their view of their future and their lives is also limited. They exist on a daily basis, with hardly the capability to chart a meaningful future. The prime need and desire is to exist for that day. This is translated into the way they handle and control their resources. The very little surplus many fishermen get is spent in other "get-rich-quick" schemes similar to blast fishing, such as *hueteng* (an illegal form of small-town lottery), *ending* (a form of lottery where the winning combination depends on the results of the national basketball games), and other kinds of gambling activities. The surplus during peak seasons is absorbed by the merrymaking sprees necessary for them to cope with the harshness of life.

All the blast fishermen queried replied that it is because of poverty that they resort to blast fishing. It presents a relatively faster and cheaper way of earning money. A Philippine Constabulary (PC) officer related that a fisherman asked him these during one of their information drives, "If we ever stop blast fishing, what would be our source of livelihood? We have not finished (any course). How would our children live?" The officer further said, "The number one problem is unemployment. If we are able to solve it, I think that blast fishing will stop."

The municipality's Chief of Police claims that the people of San Roque are not poor. They will become poor only if blast fishing is fully stopped.

The fishermen also believe that there is no other effective way of catching certain types of fish, such as anchovies (*monamon*). Thus, it is accepted in San Roque that all anchovies are caught through blast fishing.

Blast fishermen also justify their action by saying that blast fishing is better than stealing or other kinds of crimes, claiming that they are not committing crimes against other persons or private property.

Relationship with authorities

Based on a Memorandum of Agreement among national agencies (dated 13 October 1975), five government entities were tasked to coordinate in the implementation of laws and policies regarding illegal fishing methods. These are the PCG under the Philippine Navy; COSAC which is attached to the Philippine Constabulary-Integrated National Police forces; BFAR through its Conservation and Law Enforcement Section (CLES); and the Department of Local Government (DLG) through the provincial, municipal and *barangay* administrations.

The PCG maintains five detachments in the Lingayen Gulf area (i.e., at Damortis, Dagupan, Sual, Lucap and Bolinao, all in Pangasinan). It maintains its regional headquarters at Poro Point, San Fernando, La Union. COSAC, on the other hand, has three detachments in Pangasinan (i.e., at Bolinao, Lingayen and San Fabian) and two more in La Union (i.e., at Agoo and Bauang). BFAR also has some suboffices along Lingayen Gulf.

The relationship of the blast fishers with the civilian and military authorities must be seen in the context that while blast fishing is considered an illegal activity, it is at the same time widely practised and tolerated under certain conditions. This section will discuss why this phenomenon occurs and specifically, what steps/precautions the blast fisher takes in order to continue this illegal activity.

Avoidance. In order not to get caught, the most common precaution cited is to avoid the law enforcement authorities. Whenever blast fishers learn from fellow fishermen that there are PCG/COSAC authorities near the area, they immediately speed away. It must be pointed out that the fishermen know where PCG/COSAC personnel usually pass in their patrols. According to the PCG and COSAC commanders interviewed, blast fishermen maintain a system of look-outs who inform the rest about the presence of authorities. The PCG motorized *banca* is readily noticeable because of its black and grey color.

If the fishermen believe that law enforcement personnel are going to catch up with them, they drop their dredge net into the water. The net is especially designed for catching blasted fish and has an iron pole as sinker. The fishermen will rather lose the net than suffer the "fine" when caught.

Aside from the net, the fishermen also dispose of all the remaining *bumbong*. If the risk of getting caught is high, he also drops the fish he caught from blast fishing. Blasted fish have softer flesh and broken backs which bleed. They are passed off as having been caught through multiple pole and line, and yet the lips of the fish have no hook marks.

The different law enforcement agencies, however, are inadequately equipped to apprehend the blast fishermen. Both COSAC and PCG have only one motorized *banca* for use in each of their five detachments, thus preventing them from maximizing their seaborne patrols. BFAR-CLES, on the other hand, does not have a single seacraft of its own. This is ironic considering that BFAR is primarily tasked with overseeing the implementation of fisheries laws.

Furthermore, BFAR gives only a monthly ₱500 allowance per fisheries officer who conducts seaborne shore patrols, as well as inspection of markets, landing sites and bus terminals. The officer draws from the ₱500 allowance his per diem of ₱60 per day in the field; the amount for hiring a boat (usually about ₱100 per operation); his transportation to and from the field; his fare when he attends hearings; expenses for photocopying court records; and others. Fisheries officers estimate that the allowance is immediately depleted after three days of field operations. Thus, law enforcement is heavily affected.

The authorities use a type of motorized *banca* (with a 16 hp engine) similar to those used by blast fishers. Their boat, however, is sometimes heavier because of the design. The blast fisher's motorized *banca* is usually lighter and swifter. Thus, it can easily outrun and outmaneuver the *banca* of military authorities. Most of the blast fishers' engines

are also well conditioned, if not of later make/model.

The problem is aggravated during joint operations of BFAR and military authorities. Five people usually ride the boat in pursuing the blast fishermen, thus, making the boat heavier and slower.

The point, however, is that blast fishermen immediately speed away before they are sighted by the military authorities. If they try to escape, then the authorities might shoot at them. When sighted, they generally give themselves up. In one instance, the blast fishermen were ordered to dive for the *bumbong* they have thrown overboard. A blast fisherman was fired upon (allegedly for resisting arrest) and hit in the knee. The PCG personnel, however, were not able to find any evidence in the *banca*. This illustrates the difficulty of law enforcement.

Bribery. Although the fishermen have the constant fear of being caught, it is not primarily from being imprisoned. Their fear stems from the fact that they would have to shell out a considerable amount of money to bribe law enforcers to release them. Even if they are released, they are already branded by the law enforcers as blast fishermen. From time to time, these law enforcers would return and visit their homes to ask for more bribes. Bribery is claimed to be the most detested action that the blast fishermen would be forced to do.

The fact that officers can be bribed makes the severe penalties provided by law an ineffective mechanism to stop blast fishing. It is instead reinforced since the benefit from blast fishing is more immediate and regular than the punishment (which is intermittent and can be minimized through bribery). Under PD 704, as amended by PD 1058, mere possession of explosives intended for blast fishing is punishable by 12 to 25 years of imprisonment, and if such explosive is actually used and results in injury, the penalty is from 20 years to life imprisonment.

When caught, the usual amount to bail them out ranges from ₱1,000 to ₱5,000. For this amount, the blast fisher still cannot get back his boat. Additional fines have to be paid for this. However, the sum involved is definitely easier for him to bear than imprisonment. The law, not being widely implemented, tends to encourage bribery. Besides, law enforcement authorities themselves find the punishment too harsh for fishermen. There is, thus, an ambivalence in enforcing the law to its full extent.

The research team believes that in spite of whatever cognitive dissonance might develop from the corrupt activities of law enforcement officers, they even think that they are doing the fishermen a favor, instead of viewing it as extortion.

Military officers interviewed denied the alleged cases of bribery. According to one, their conscience cannot bear the thought that the money with which they feed their families come from bribes. Another argued that the blast fishermen live at subsistence levels, and thus could not afford to bribe the authorities. He raised the possibility of explosives dealers being the ones attempting to bribe the law enforcers.

Perhaps, the law enforcers are right in claiming that corruption does not happen that much. In 1987, PCG filed 32 cases in court against illegal fishing methods. COSAC, on the other hand, filed some 33 cases.

Bribery is not limited to the military authorities. The temptation to become corrupt is also high among BFAR agents because of their low salaries. Based on interviews with blast fishermen, however, BFAR agents come out generally "clean" compared to certain military units.

Based on observation, the law enforcers generally tolerate the blast fishing activities, provided these are done far from their headquarters. In return, they "expect" minimal favors. This shall be discussed in the section "friendly relations" (*pakikisama*) below. The PCG personnel are generally seen as more "repressive" because they *seem to be less lenient* in making arrests.

The small blast fishermen complain that while the authorities "put the heat on them", the "big time" blast fishers or *taksayan-*

owners are not "touched". *Taksayan* operations earn a gross profit of ₱30,000 a week, half of which go to the owner. According to the blast fishermen interviewed, the dynamite used in *taksayan* operations come from soldiers. The military men reportedly ask ₱1,000 every month from each *taksayan* in the municipality. Since there are about 36 of these in the municipality, the military men collect considerable sums from the municipality alone.

During an interview, a lieutenant admitted that their investigations revealed that some military men indeed supply the *taksayan* with dynamite. They have reported this to the superiors of the said military men and passed it for proper action.

Pakikisama. Another way in which the blast fishermen create a "better atmosphere" for blast fishing is by establishing "friendly relations" with the law enforcers. This is mainly done through free drinking sessions and dinners for these authorities whenever they are in the *barangay*. This is an established pattern borne not out of the natural generosity of the fishermen, but for the primary purpose of keeping the law enforcers in a bind. This "game" is generally understood and accepted by the wives of the blast fishermen.

The fishermen also sympathize, however, with the situation of the soldiers who earn very low salaries. Until November 1987, noncommissioned officers received a monthly salary of only about ₱2,000. This was raised by 60% in December 1987.

Social Godparents. Another way of circumventing the legal entanglements is by maintaining social links with the higher military and civilian authorities. If worse comes to worst, the blast fishers turn to these social godparents (*padrino*) in order to be released from prison. Next to poverty, the intervention of politicians in the cases filed against blast fishermen is perhaps the most decisive among the factors that perpetuate blast fishing in the area.

Under the previous administration, it is claimed that the most powerful of these *padrino* was a politician from the region. The blast fishermen of San Roque served as his ward leaders and personal bodyguards. Thus, if the common political term "warlord" is used to describe this politician, the blast fishermen of San Roque served as his "goons".

Many of the previously caught blast fishermen interviewed said that they were released through the intercession of the said official or his immediate relatives. Field reports from other sites also mention his role in interceding for the blast fishermen. The following illustrates this point.

The municipal Chief of Police strictly implemented the law against blast fishing in 1984. He posted foot patrols at the shore as early as 2 a.m. to check the boats and paraphernalia of the fishermen before they were allowed to fish. However, he was told by his superiors to loosen his grip in the area. So he stopped the foot patrols and made only occasional arrests. When the researcher related this to the blast fishers, a smile appeared on their faces. They claimed that one of the higher military officers received a car to protect the blast fishers. It is apparent that the intervention occurred at the level of high civilian officials. The intervention of politicians was also aired by the law enforcement and BFAR officials.

Because of the above-mentioned factors, the 1975 Memorandum of Agreement between the different government entities had been largely ineffective. Recent successes in minimizing blast fishing in two coastal municipalities have been largely due to the determined efforts of the newly elected municipal officials of the said towns. Pleas of their own kins were set aside in the interest of implementing the laws.

Legal Loopholes. According to a BFAR personnel, one of the bureau's problems in the drive against blast fishing are the loopholes in existing laws, especially PD 704, in which Sec. 33 states thus: "It shall likewise be unlawful for any person *knowingly to possess*, deal or sell or in any manner dispose of, *for profit*, any fish or fishery/aquatic products

which have been illegally caught, taken or granted." (Italics supplied).

The BFAR personnel believed that by mounting a campaign against those who buy and sell illegally caught fish, they would be able to deprive blast fishers of a market for their products. In their recent court cases, however, BFAR personnel lamented the dismissal of charges against the said fish dealers because of their claim of not knowing that the fish they bought were caught through illegal fishing methods. The BFAR personnel also complained about the court accepting at face value the statements of the suspected dealers that the fish were bought for personal consumption, and not for disposal to gain profit.

Lack of Legal Assistance. BFAR personnel complained that they lack a full-time legal officer who could follow-up their cases and advise their fisheries officers. It has been years since the regional office has had a full-time legal officer. The personnel explained that they could not rely solely on government fiscals to prosecute their cases.

Slow Grind of Justice. Both BFAR and law enforcement personnel cite the slow resolution of cases as one of the reasons for the ineffectivity of laws against illegal fishing.

An examination of the status of cases against various offenses under illegal fishing (dealing in illegally caught fish, dynamite fishing, trawl fishing below 7 fathoms, illegal possession of explosives, possession of sodium cyanide, etc.) as of December 1987 shows that most of the cases have been pending for three to five years. One case (dealing in illegally caught fish) has been pending for nine years.

Because of the slow resolution of cases, some of them were dismissed due to lack of witnesses. This is because many law enforcement personnel are reassigned after a few years, thus making it difficult for the court subpoena to reach them, and for them to attend court hearings.

Nonimplementation of the 7-km Ban Against Trawl Fishing. As mentioned, the perceived nonimplementation of the laws against trawl fishing contributes to a sense of injustice among the blast fishermen. Thus, they have more reasons to rationalize their resorting to illegal fishing methods. Trawl fishing is generally seen as a competitor for the limited resources nearshore. Blast fishermen feel that law enforcement officers look at commercial trawlers with favor.

According to one officer, "The 7-km (ban) was meant particularly for some areas like Manila Bay and Laguna de Bay. But in Lingayen Gulf, it is different. We are not practising the 7-km ban. It is only by depth that we implement." He said that what they are observing is the original PD 704 prohibition against trawling less than 7 fathoms. He added, "I have very good coordination with owners of these fishing boats, including the ship captains, (instructing them) not to go beyond 7 fathoms." He admitted, however, "Sometimes, the trawl fishers operate near the shoreline. But we are not filing in court these violations because they cannot even be considered illegal since as they say it is an error in navigation on the part of the quartermaster especially at night time."

The officer also maintained that they follow "normally the 7 fathoms" limitation of PD 704, instead of the 7-km ban. "That distance (the former) is already far from the shore, you cannot see it anymore," he explained. "Personally, I think the law should go more by depth rather than distance."

Regarding the lack of cases filed against trawl fishing, the officer explained, "That is not necessarily the truth. We don't spare anybody. It just so happened they are the ones at sea when we were patrolling, which is why they (the blast fishers) are the ones being caught."

The BFAR personnel disputed the officers' statements that the 7-km ban does not cover Lingayen Gulf. BFAR itself has filed four cases against illegal trawling about two years ago. They, however, admitted their limitations in the implementation of the ban.

First of all, they said that the commercial trawls used to be owned by influential people, especially politicians. Second, the ban could not be implemented due to BFAR's

lack of equipment to determine whether the trawls have indeed violated the 7-km ban. Their estimates could not stand in court. Third, the trawl owners would file countercharges of financial damages against the fisheries officers for having impounded their vessels. Earning only a measly salary, with no full-time legal officer to consult with, the fisheries officers are intimidated into not implementing the prohibition.

Past and present attempts to solve blast fishing

Perhaps, before embarking on another attempt to formulate solutions, it is best to look at past and present attempts to confront the problem of blast fishing. In this regard, lessons would be learned and energies prevented from being wasted. Most of these attempts were efforts of BFAR-CLES.

One such attempt was the 1975 Memorandum of Agreement which was largely ineffective. Another attempt is the deployment of detachments in areas where illegal fishing is rampant. Both PCG/COSAC and BFAR stated that they have chosen to establish their detachments in their present areas because these are supposedly where illegal fishing is rampant. Despite the presence of these detachments, however, blast fishing still prevails in these areas.

To solicit the cooperation of community members in the campaign against illegal fishing, BFAR decided to train *barangay* captains on the laws on illegal fishing. Under Letter of Instructions (LOI) 550, *barangay* captains were deputized as fish wardens. Training programs were conducted in Ilocos Norte, Ilocos Sur and some towns of Pangasinan. After the training, they were asked to monitor blast fishing and other illegal fishing practices in their areas. The BFAR fisheries officers, in turn, were asked to monitor the reports of the *barangay* captains. No report, however, came in. The plan turned out to be a failure in all three provinces.

Apparently the *barangay* captains were under very strong pressure to tolerate the acts of the villagers. There were also cases in which they themselves were blast fishermen or distributors of explosives. A PC officer stressed that if only the cooperation of these local officials at the grass roots level could be obtained, the campaign against blast fishing could succeed. The *barangay* captains are very much aware of who among the villagers engage in blast fishing.

What must be stressed, however, is that in interviews, authorities, by employing plainclothesmen and other intelligence personnel, have identified the areas where blast fishing is rampant. Gathering evidence to prosecute violators, however, is another matter.

The BFAR personnel also related that they have trained military men in the examination of fish caught by illegal fishing methods. This, too, did not have any positive effect in their campaign against blast fishing. Anecdotes have been told that military men who used to carry small fish baskets *(bayong)* now carry bigger ones after the training. Thus, BFAR has evaded and discouraged requests for training in fish examination.

Learning from their experience of choosing *barangay* captains as fish wardens, BFAR now plans to conduct a new set of trainings for fish wardens. This time, those to be named fish wardens will come from civic organizations in the community. The nominees will be screened by BFAR for their leadership capabilities, character and standing in the community. A background investigation will also be conducted. The nominees are to be recommended by the mayor for him to be accountable for the performance of the fish wardens. In this way, the local government officials would be discouraged from intervening in behalf of their constituents who engage in blast fishing.

A BFAR personnel explained that the blast fishing activity is perpetrated by a triad: the financier who supplies the dynamite, blasting caps and capital to the blast fishermen; the blast fishermen who catch fish; and the fish dealers who buy fish from the blast fishermen.

He described the law enforcement authorities as almost helpless against the financiers who are usually influential people and are able to evade prosecution. Thus, BFAR personnel are now concentrating their campaign against fish dealers to discourage them from disposing the catches of blast fishermen. BFAR-CLES now conducts market inspections and spot checks in fish landings and bus terminals. Thus, the blast fishermen would be deprived of a market and would be discouraged from continuing their illegal activity. However, this campaign is affected by loopholes in PD 704. But regular confiscation of illegally caught fish would make the fish dealers incur losses.

The Use of Sodium Cyanide in Fishing: a Case Study

History of the use of fish poison in the study area

The use of poisons to catch fish has been a practice in San Jose even before the introduction and use of sodium cyanide. The common fish poisons used then were the *bawot* and *bayating*, both derived from plants. The *bawot* is a shrub with its root sap used to poison the sea catfish (*hitong dagat*). The *bayating* are raisin-like nuts brought to the area by other fishermen from Zambales or La Union. These nuts are roasted and mixed with fish or squid flesh that are fed to the fish. Both were effective fish poisons and facilitated the catching of various types of fish. Eventually, the use of sodium cyanide replaced these traditional fish poisoning activities.

Aquarium fish collection as well as the use of commercial poisons for the purpose were introduced in San Jose by two migrant fishers from the Visayas but who both learned these in Mauban, Quezon. Initially, they did not have the necessary capital to buy a motorized *banca* and air compressor. Fish gathering was done by hand, diving without the aid of a compressor and air line (*mano-mano*). Despite the absence of these equipment, aquarium fish collection was relatively easy. Aquarium fish were then abundant in shallow reef areas and collection was further facilitated by the use of sodium cyanide. The aquarium collection venture of the two migrants was successful.

A number of local fishermen from San Jose and neighboring barrios joined the two in their trade, and their efforts were rewarded with large profits. Soon, other groups ventured into the activity. The large profits they earned enabled them to buy their own compressors and motorized *banca*. Thus, aquarium fishermen could stay submerged for as long as two hours and could venture to depth levels of 40 m. This facilitated the job of aquarium fish gathering and so increased the number of fish gathered as well as the fishermen's income. The use of these equipment became so widely accepted in the area that even other fishermen have adopted the use of the compressor and poison in other fishing activities.

By 1975, all aquarium fish collectors in San Jose were using sodium cyanide. In 1983, an expatriate conservationist came to San Jose advocating marine conservation and discontinuation of sodium cyanide use. He was able to invite six cyanide users to join a project which trained aquarium fish collectors on the use of fine-meshed nets instead of cyanide. The project also taught better fish handling methods and safe diving courses.

The use of sodium cyanide

At present, two groups of aquarium fish gatherers still depend on the use of cyanide. One group is composed of gatherers operating in deeper waters utilizing the aid of air compressors to fish at depths of no less than 10 m. The other group is composed of gatherers operating in shallow water. Members of this latter group are notoriously known as "sodium cyanide boys". They fish at depths of no more than 10 m and dive and collect fish by hand.

About 8-12 collectors comprise a work group, majority of whom are boys between 12 and 18 years old.

The use of sodium cyanide is widespread among aquarium fish collectors and other fishermen who use compressor machines. Sodium cyanide is often locally referred to as *gamot* or *tableta*. It comes in small cubes or marble-sized balls made of fine, white grains. It is readily available at farm supply or drug stores. A special permit form, however, is required to purchase them. Fish suppliers claim that the use of sodium cyanide for gathering fish is encouraged by exporters. Thus, they supply their collectors with the poison.

A number of aquarium fish gatherers using sodium cyanide seem unaware of the detrimental effects of the chemical compound on the fish and the marine environment. They claim innocence regarding the toxic effects of cyanide on human beings and ignorance of laws against the use of the compound.

A kilogram of sodium cyanide, which presently costs ₱100-120, is consumed within a maximum of four days of aquarium fish collection by a work group of two divers.

A plastic squeeze bottle made from recycled one-liter motor oil plastic container is used to squirt sodium cyanide. Between one to two cubes of cyanide are dissolved in one liter of seawater.

The following equipment are brought along by each deepsea or shallow water work group: an improvised basket (*sambirga*) attached to a float (*pataw*) where fish are placed while at sea; plastic bags (about 35 cm diameter); oxygen tanks; and a scoop net (*singapong*).

Most aquarium fish collectors use a motorized *banca* (8 m long by 0.7 m wide) equipped with a 10-16 hp engine. The deepsea collectors use a compressor motor attached to the boat's engine. The motor is connected to an air tank which supplies air through two air lines measuring 50 m each.

Aquarium fish gathering is not a seasonal fishing activity. Except on Sundays and stormy days, the gatherers work from 8 a.m. to 4 p.m.

Crew composition and crew roles

The deepsea work group consists of three members, one lineman and two divers. One of the latter is usually the owner of the fishing boat. In cases when the boat owner is not a crew member, he appoints a diver who acts as captain (*timonero*) of the vessel and who decides where they would gather aquarium fish. In one fishing trip, they may gather different types of fish at different depths/locations. The captain selects areas where he believes there are abundant aquarium fish.

Upon reaching the fishing area, the vessel is anchored. The lineman attaches one end of the compressor belt to the *banca* motor and the other end to the compressor motor. He then fills up the compressor machine's cooling system with water. He is responsible for preventing compressor overheating and sees to it that the two air lines properly extend to the two divers and do not get entangled. The lineman is paid on a daily wage basis of ₱20-30/day. In rare cases where the lineman is a qualified diver, the three crew members alternate to act as lineman.

While the lineman performs his task, the two divers prepare to dive. Each wears a belt with weights, and slips in the belt a scoop net on one side and ties the cyanide squeeze bottle on the other. Each also carries a plastic bag tucked into the belt. Each diver then takes one air line, winds it around the waist three times and loosely around the neck once and then bites the end of the air line. Each one wears improvised wooden flippers and a diving mask before diving. In the absence of a compressor, fish gathering by the shallow water work group is basically an individual activity.

Fishing operations

Aquarium fish gatherers have a cognitive map of the habitats of various aquarium fish. The fishing ground and depth level for a specific day would often be determined by the type of fish they wish to collect.

Most aquarium fish collectors (either deepsea or shallow water) use sodium cyanide. They squirt cyanide directly on the fish or into crevices in corals where fish are hiding. Once affected by the poison, the fish are scooped and put inside the plastic bag.

Some cyanide users claim that they primarily use nets when gathering aquarium fish. They say that they only use sodium cyanide on rare and expensive species to prevent such from acquiring scratches. Fish with scratch marks are often rejected by the exporters. They explain that there are fish species which cannot be caught without the use of sodium cyanide. As one fisherman related, "We are not actually killing the fish. Would we allow ourselves not to be able to sell anything to exporters and not to earn for our family's meal?"

Also, they claim to use only very small quantities of the chemical compound on the fish, enough to make these fish feel dizzy. Once they transfer the fish to uncontaminated water, the fish regain their balance. From such experience, the fishermen have deduced that the effect of sodium cyanide is only temporary.

Apart from using cyanide on fish, aquarium fish collectors do not practise proper decompression of fish which lessens the possibility of their damage or death. Nondecompressed cyanide-caught fish have either bloated or raptured abdomens. Others have popped-out eyes. As a remedy for fish with raptured abdomens, the fishermen pierce the exposed intestine and push it back into the abdomen.

At the end of the fishing trip, fish are packed into plastic bags. The fish which excrete toxins are packed in separate plastic bags. The fish are later transferred to the vessel owner's aquarium or fishpens. Less expensive aquarium fish are stored in fishpens until they are packed for shipment to Manila. The more expensive species are individually packed in oxygenated bags and stored in sheds.

Sharing and marketing arrangements

In the case of shallow water aquarium collectors, the manager or vessel owner buys the aquarium fish from his gatherers at a much lower price than in Manila. He claims that his relatively low buying price is justifiable due to other capital inputs he shoulders before the fish are shipped to Manila and sold to exporters. Beside the weekly, monthly and yearly fees he pays as aquarium supplier, he shoulders the costs of materials (e.g., plastic bags, oxygen, etc.) as well as of operating and maintaining the vessels.

The deepsea aquarium collectors have a totally different sharing arrangement. The operating costs and the daily wage of the lineman are subtracted from the gross income. The net income is then divided among the owner of the vessel and compressor and the two divers.

Relationship with exporters

Amo is the term used by suppliers to address exporters to whom they regularly supply ornamental fish. These *amo* extend assistance in many ways to their regular fish suppliers. They extend loans used to buy gear, equipment and new fishing boats. They also shoulder part of the transportation expenses of fish brought to Manila. The exporters also give incentives to their regular suppliers (i.e., 10% commission for every shipment) for referring other suppliers to them.

Perception of cyanide users of their resource

The blast fishers and other fishermen in the community believe that the main cause for the declining fish catch and deteriorating status of other marine resources is the rampant use of sodium cyanide by the aquarium fish gatherers. They claim that the effects of cyanide could last up to 30-35 years. They think that all corals exposed to sodium cyanide acquire certain foul odors which

keep fish away and that these corals also eventually die. Related one fisherman, "I myself would not want to live in a place with a surrounding that smells, so would the fish. The fish that smell sodium in the stone would not go nearby."

According to fishermen who were interviewed, the shallow reef areas are blasted or are dead due to exposure to sodium cyanide. Hence these areas are said to be unsuitable habitats for the fish, and that as a consequence they have migrated to deeper waters. Thus, fishermen also have to venture to deeper waters.

It is also believed that the effects of sodium cyanide are more permanent compared to the effects of dynamite fishing. Most fishermen claim that *arorocep* (an edible seaweed) can grow in blasted areas and provide sources of income for gleaners. For corals exposed to cyanide, however, no seaweed would grow, nor would any fish dare go near these dead corals. A fisherman related that corals used to be the habitats of baby cuttlefish and lobsters.

Cyanide users believe that sodium cyanide has no harmful effect on corals in San Jose because it mixes with seawater and goes with the current. They maintain that they only use minimal quantities of sodium cyanide for the fish just to lose balance. When fish are transferred to clean seawater, they regain their balance. Deaths of aquarium fish during storage and shipment are attributed to overexposure to sunlight, improper packaging, too much heat and other causes, but never to exposure to sodium cyanide.

Major Management Issues and Recommendations

Preliminary assessment of information on how blast fishing and cyanide fishing are practised and sustained at the community level, as well as consultations with key fishermen-leaders, point to four major issues, namely, the:

1. Level of community perception;
2. Law enforcement measures;
3. Need for alternative livelihood sources; and
4. Possible role of local organizations to check illegal fishing practices.

A community-based approach to CRM entails not only assessing specific area conditions, but most importantly, building local organizations which would play a decisive role in such management. Necessarily, policy and program recommendations must be generated through continuing consultations with fishermen's organizations and community residents, as well as development agencies working in their behalf.

Level of Community Perception

As discussed above, it is perceived that the economic gains derived from blast fishing and cyanide fishing outweigh their negative consequences to people's health, coastal resources and law enforcement. In this regard, it is recommended that a massive educational program be conducted focusing on the short- and long-term effects of both types of fishing. The program should be primarily addressed to all fishermen, fishing communities and other beneficiaries of coastal resources.

It is further recommended that the program incorporate the following:

1. A multimedia approach to reach as many people as possible and create a strong impact on them. The program can include short radio dramas in the vernacular, jingles, comics and short seminars at the village level.
2. Emphasis on the dwindling resources of Lingayen Gulf; the ill effects of trawling, cyanide fishing, pollution, mangrove destruction, fine-meshed nets and blast fishing; and the factors which put stress on coastal resources (e.g., fishing methods, population).
3. Fishermen's organizations and the local government involved in disseminating relevant information.

4. Coordination among different government and nongovernmental agencies.

Law Enforcement Measures

The enforcement of existing laws on illegal fishing practices is ineffective. Law enforcement agencies lack patrol boats and logistics to police the fishermen. Through bribery, the apprehended blast fishermen often evade prosecution. According to the fishermen and law enforcers, the bribes are easier to shell out whereas the punishments are quite harsh.

Although the sale of dynamite and sodium cyanide is regulated, supplies are readily available, given the right connections. Then there are the trawls which continue to operate near the shore in spite of the 7-km ban. Politicians, acting as *padrino*, often intervene in behalf of their constituents in exchange for political support.

Thus, it is recommended that law enforcement be improved. The following deserve immediate attention:

1. The capability of law enforcement agencies, such as BFAR-CLES, must be upgraded through the provision of adequate motorcrafts to increase the number of patrols and enhance the coastal mobility of its agents.
2. Stiff penalties are intended to serve as deterrent to illegal fishing practices. However, excessive harshness may render them impractical and, to some extent, less enforceable. It is recommended that these stiff penalties be reviewed. Fines should approximate the amount of the bribes usually offered/demanded. Since small fishermen are usually the ones involved in blast fishing and cyanide fishing, fines must be "affordable" for them not to resort to bribery. Stiffer fines/penalties, however, must be given to suppliers of dynamite and sodium cyanide. Laws should encourage enforcement equally and constantly, lessening the probability of pitying poor families if they are subjected to such penalties. (It should be noted, however, that graft and corruption pervades all aspects of law enforcement in the country. The problem of illegal fishing is but a small part of this system breakdown.)
3. Enforcement of laws must apply equally to trawlers. The 7-km ban must be strictly enforced.
4. Law enforcement must be consistent and coordinated. This requires mechanisms for continuing cooperation among law enforcement agencies and the local government.
5. Special awareness programs must be instituted for government officials and law enforcers concerning the deteriorating ecological conditions of Lingayen Gulf.

Need for Alternative Livelihood Sources

Many fishermen households live in marginal subsistence levels. There are minimal employment opportunities due to limited education and skills, and inadequate livelihood sources. There is an urgent need, therefore, for alternative socioeconomic programs which will allow fishermen to live above the subsistence level. These programs must have complementary basic characteristics; maximize gains from coastal resources exploitation; and draw fishermen away from fishing. Thus, these programs should:

1. Introduce socioeconomic projects which allow the fishermen to maximize their gains from coastal resources exploitation. It has been documented in many cases (Smith 1979; Acheson 1981; Szanton 1971) that the presence of several levels of middlemen depresses the prices of

fish, enabling them to reap the profits which are due the small fishermen. Using lessons from past efforts in establishing cooperatives, these programs can help alleviate the conditions of the fishermen. It is also necessary to look into the high prices of capital inputs (e.g., engines, fuel, gears).

2. Attract fishermen to jobs outside the fisheries domain. Although programs which provide additional sources of livelihood based on current projects (e.g., pig and cattle dispersal, variety store) are not discouraged, attempts to alleviate the conditions of the fishermen (and totally stop blast fishing) will be futile if they rest principally on these kinds of government socioeconomic programs, as shown by past research. It is believed that national industrialization (dispersed through the countryside) has more capability in attracting the surplus labor in fisheries, and provides more stable sources of employment. These types of programs also prevent further stress on the coastal resources.

The Role of Local Organizations

Although the ill effects of illegal fishing practices concern the communities' livelihood and future, CRM and conservation are often left to the hands and "expertise" of outside agencies. As a result, sustained action at the community level seems inadequate and scattered.

There is a need, therefore, to build/support fishermen's organizations for them to actively take part in coastal management, in general, and exert peer pressure against illegal practices, in particular.

The capability of community organizations to exert strong pressure among their members has been noted in many experiences (see White, this vol.). These organizations are in the best position to monitor the actions of their members and identify the best forms and degree of sanctions against erring members. They can become a forum for fishermen to discuss conservation, among other sectoral interests. They can become conduits for the educational (aimed toward the development of ecological consciousness) and technoeconomic programs (aimed toward the improvement of their members' economic conditions).

Critical Information Gaps

Research on cyanide fishing is well in its middle phase, thus the following data are still to be gathered:

1. Level of community perception. The perceptions of both sodium users and nonusers have already been obtained. However, the perceptions of other community members, such as the religious groups, local leaders (both formal and informal) and other work groups, should also be taken.
2. Role of the community. Members of the community either play an active or passive role in the regulation of cyanide fishing. Research has yet to come up with findings on the roles of community institutions, e.g., family, church, local government, in the regulation of cyanide fishing. Also, the study has yet to delve into the possible conflicts between those who accept and practise, against those who oppose and do not practise, cyanide fishing.
3. Law enforcement practices. Laws pertaining to cyanide fishing are yet to be gathered and analyzed. Are such laws really implemented? What are some of the strengths/weaknesses and capabilities/limitations of law enforcement agencies? How do the cyanide users evade arrest and punishment? What is the level of awareness of the whole fishing community with respect to these laws and sanctions?

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Status of Coralline Resources in Lingayen Gulf

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McManus, L. and L.A. Meñez. 1989. Status of coralline resources in Lingayen Gulf, p. 63-70. *In* G. Silvestre, E. Miclat and T.-E. Chua (eds.) Towards sustainable development of the coastal resources of Lingayen Gulf, Philippines. ICLARM Conference Proceedings 17, 200 p. Philippine Council for Aquatic and Marine Research and Development, Los Baños, Laguna, and International Center for Living Aquatic Resources Management, Makati, Metro Manila, Philippines.

Abstract

Nine sites were surveyed along the western coast of Lingayen Gulf to assess the status of coral reefs in the area. The study showed the reefs to be in relatively poor to fair condition, having 18%-47% living coral cover. Reefs are degraded by both naturally occurring factors and man-induced stresses (such as poor land management, which brings about siltation, and destructive fishing techniques). Blast fishing and the use of sodium cyanide for catching aquarium fish are rampant in the area. The destruction of the reefs could cause a breakdown of their community structure, as well as those of associated coral-dominated communities. Various management schemes designed to forestall the destruction of the reefs and ease the fishing pressure on the resources are presented. Critical information gaps are identified.

Introduction

The coral reefs of Lingayen Gulf are year-round sources of food and income not only for about 6,000 fishermen (Ferrer et al. 1985) from Sector I (Fig. 1 in Calud et al., this vol.), but for the rest of the 13,000 artisanal fishermen in the gulf as well. The reefs represent a heavily exploited coastal habitat that typifies the rocky shorelines of most islands in the Philippines today. Because of the reefs' proximity to land, where a burgeoning population continues to proliferate and whose demand for food and basic needs remains high and unsatisfied, degradation and unsustainable harvest of resources are imminent. Measures to help curb deterioration and to prevent irreparable depletion of reef resources are clearly necessary to ensure their long-term productivity.

This study has as its major objective the biological assessment of the coralline habitats of the gulf, to serve as input for the formulation of a community-based management scheme for Sector I, in particular, and the gulf, in general. Along with the economic and cultural studies of the coral reef fisheries of the gulf, it is hoped that an integrated and holistic management of coral habitats can be ultimately achieved by, and for, the people of the gulf.

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Methods

Detailed habitat surveys in selected sites located in Santiago and Cabarruyan Islands (Fig. 1) were made to determine the abundance of coral reef fish and percentage cover of hard and soft corals, algae, seagrasses and macroinvertebrates associated with the reef. Essentially, the surveys were conducted based on the ecological concept that habitats inhabited by a large number of living organisms are in good condition, and vice-versa. The underwater survey method used was the life-form transect technique adapted from the ASEAN-Australian Manual of Habitat Assessment (AIMS 1986). In each site, three or more 100-m fiberglass transect lines (calibrated in centimeters) were laid along the same depth using scuba. One line was placed on the reef flat at 2-3 m depth of water, while two others were set up on the fore reef slope at 6 and 9 m. A team of two divers proceeded along the transect and recorded the abundance of finfish within a 5 x 10 x 100 m^3 corridor. Size estimates of commercially important fish, here referred to as target species, and their numbers were obtained. Fish which indicate the relative health of the reefs, called indicator species (e.g., butterflyfish), were also counted. Other fish species were grouped according to families and their numbers were estimated.

The fish monitoring team was followed by a second set of three to four divers (spaced 20 m apart along the transect) who recorded the lengths of each life-form and substrate type (e.g., sand, rubble, rock, etc.) found along the line. Organisms recorded were live hard corals of the *Acropora* and non-*Acropora* types, dead corals, macroalgae and other live invertebrates (including soft corals, sponges, etc.). The reefs were then classified (Gomez and Alcala 1984) into excellent (75-100% live coral cover), good (50-74.9%), fair (25-49.9%) and poor (less than 25% cover) condition.

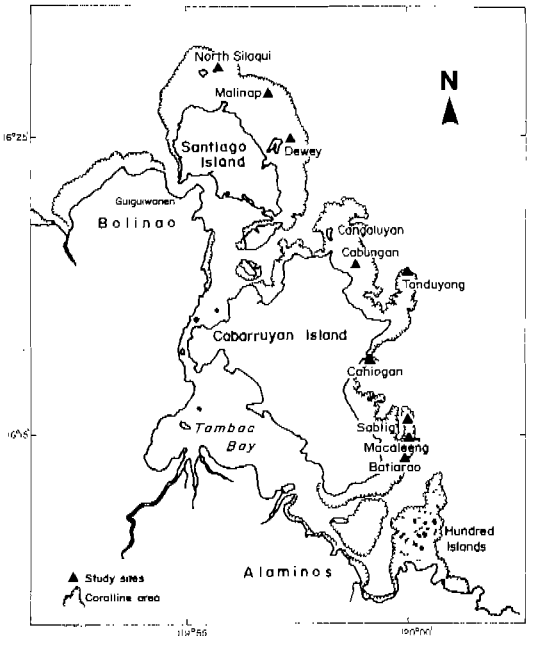

Fig. 1. Western section of Lingayen Gulf showing study sites for coralline resource assessment.

Results and Discussion

The coralline resources of Lingayen Gulf are concentrated on the western section (Sector I). These are located fringing the northwest coast of Bolinao, and the islands of Santiago, Cabarruyan, and the Hundred Islands. Coralline communities are also found in certain islands off Sual. The more extensive reefs, however, are found mainly around the Santiago and Cabarruyan Islands.

Nine sites (Fig. 1) were surveyed for reef condition (i.e., three along Santiago Island and six adjacent to Cabarruyan Island). Santiago Island, the northernmost of the group, has an extensive reef platform reaching up to 2.5 km along the northern and northeastern coast. A luxuriant growth of seagrasses dominates the relatively shallower reef flat from its shoreward margin to depths of about 3.5 m. The reef flat is cut in certain sections, particularly in the north by relatively deep (3-5 m) lagoons/channels with an abundance of dead branching *Acropora* and massive *Porites* and *Pavona*. Rock mounds emergent at low water are likewise dispersed along the north and northeastern sections of the reef. Towards the outer reef margin is a rocky rim consisting of

consolidated rock and/or massive coral mounds, usually followed by a gentle slope to a sandy bottom at 12-15 m. Vertical dropoffs are present in the northeastern section of the reef. In the east, the reef slopes gradually from a rocky-coralline zone (covered by brown algae) to about 9-12 m with coral communities occurring on rock mounds in generally sandy substrate.

The Cabarruyan Island reefs are widest on the northern portions adjacent to Cangaluyan Island and in the south bordering the coast of Batiarao. As in Santiago, the shallower sections (particularly on the north) are fringed by seagrass beds with rock mounds and large banks of coral rubble. The outer reef has an irregular rim. Large mounds of coral and rock predominate the northern section which gradually slopes to 5-9 m. Although not very distinct, the southern reefs have shallow crests (0.1-1 m deep) gently sloping to a sandy bottom at 3-4 m (with large rock/coral mounds and table corals present). The western reefs, on the other hand, slope gradually from a narrow (500-800 m) grass flat to sand/sand-rubble bottoms with coral patches existing on rock mounds.

Percentage cover of the benthic components of the reefs surveyed is given in Tables 1 and 2. Seven of the nine reefs studied are in relatively fair condition. The reefs adjacent to Cabarruyan Island have relatively higher coral cover. Macaleeng has 47% cover (for both hard and soft corals) followed by Sablig,

Table 1. Percentage cover of benthic component of reefs in the nine survey sites.

Site	Live coral		Dead coral	Others		
	Hard coral	Soft coral		Algae	Living	Nonliving
Malinap	30.3	15.4	13.4	3.4	1.3	36.3
Dewey	10.2	14.6	38.0	3.9	1.2	32.1
N. Silaqui	14.1	4.2	8.3	53.9	1.1	18.4
Cabungan	39.9	3.1	16.1	10.1	2.8	28.0
Tanduyong	29.8	6.0	33.0	18.2	1.1	12.0
Caniogan	19.7	8.1	13.6	5.8	3.0	49.9
Sablig	35.6	10.8	17.4	13.4	2.4	20.4
Macaleeng	42.4	4.7	18.5	21.5	2.2	10.7
Batiarao	40.3	1.8	17.9	19.6	1.6	18.7

Table 2. Live coral cover, reef condition and fish density in the nine survey sites.

Site	Live coral cover (%)	Reef condition	Fish density (individuals/1,000 m^2)
Malinap	45.7	fair	334
Dewey	24.8	poor	301
N. Silaqui	18.3	poor	512
Cabungan	43.0	fair	277
Tanduyong	35.8	fair	186
Caniogan	27.8	fair	113
Sablig	46.4	fair	554
Macaleeng	47.1	fair	346
Batiarao	42.1	fair	294

Cabungan and Batiarao with 46%, 43% and 42%, respectively. Of the northern reefs, Malinap had 46% cover, while the other two areas showed relatively poor coral cover (25% and 18%). The surveys showed a dominance of encrusting forms throughout the area, with a number of sites having dead corals of the massive, branching and foliate growth forms. The few branching species are mostly small and frequently found in deeper waters. In areas where large sections of the reef have been destroyed or damaged, there appears to be a shift in the type of growth form (particularly from the branching to the encrusting and submassive species).

Several natural factors (ranging from wave action accompanying tropical storms and monsoons, predators and borers, exposure due to tides, etc.) are responsible for the destruction of large portions of the reefs. These natural stresses are further aggravated by human activities, such as land clearance (which exacerbate siltation), and destructive fishing techniques.

The silty condition of the reefs south of Cabarruyan Island and the Hundred Islands is mainly the result of land clearance or deforestation along the coastal region of Western Pangasinan. This includes the conversion of mangrove areas into fishponds, most of which are located in the Tambac Bay area. A number of rivers with heavy silt load (having tributaries from the deforested areas of the Cordilleras) empty into Tambac Bay, which then flows towards the gulf through this area. Batiarao, the southernmost of the sites, is most turbid with silt covering the substrate including turf algae. Similar conditions were observed on the northeastern passage (Cangaluyan) connecting Tambac Bay to the gulf.

Among the destructive fishing methods, the use of dynamite and sodium cyanide is the most rampant. Observations made (recording blasts while doing underwater transects) indicate an average of four to five explosions per hour during good weather. Other destructive fishing methods include the *karokod* (a drag seine operated in shallow coral reef areas) and *karkar* (a dredge used to gather shells on seagrass beds).

The recovery rate of devastated coral reefs varies according to the degree of destruction. Periods of 10 to 20 years have been recorded for reefs damaged by cyclones in Australia (Endean 1976) given that a sizable population of adult/mature hard corals is still present. For reefs which have been affected by human activities, studies have shown (Endean 1976) that recovery takes the longest, if it recovers at all, considering that the general condition has already been altered. For instance, increased silt load in the water column reduces the amount of light reaching the corals, and smothers the respiratory and feeding mechanism of polyps.

The degradation of coral reefs results in the decline in abundance of fish populations associated with this ecosystem. Preliminary observations indicate that reefs with high fish diversity coincides with those having relatively better coral cover (e.g., Macaleeng and Sablig) and vice-versa. This appears to hold for all sites, except for Dewey which apparently has relatively high fish diversity despite poor coral cover (25%). Final analysis of these observations, however, await completion of the data collection phase. Fish density, on the other hand, could not be clearly correlated with coral cover (Table 2). One reason could be that the reefs are excessively fished and this overrides what possible correlation exists. It is likewise probable that the degree of correlation among sites with relatively the same amount of coral cover would depend on the general growth forms of the species. For instance, branching types which have more surface area compared to the massive/submassive and encrusting species would display higher correlation with fish abundance.

A consequence of the deterioration of reef habitats is the breakdown of its community structure and associated coral-dominated communities. The resulting shift in community structure is characterized by a proliferation of less preferred species, both economically and ecologically.

Management Proposals

The management of coral reefs, especially those which are heavily exploited, involves a

thorough understanding of the fisheries from the biological, economic and cultural perspectives. The following proposals are tentative in that integration of recommendations from other studies has yet to be achieved. Biological findings largely form the basis for the recommendations below.

Policies and Management Strategies

Management is guided by policies which define the rationale and targets of interventions. For the proper utilization of reef resources, the following policies are proposed:

1. Resources management should aim to sustain and enhance the productivity of coralline habitats.
2. Resources management should accrue to the artisanal fishermen the optimal and sustainable benefits that can be derived from coral reefs.

Panayotou (1982) stated that the rejuvenation of traditional community rights over coastal resources may be the best possible management option for small-scale fisheries. Such options can be conceptualized within the existing socioeconomic and biological framework of the fisheries in the gulf. Panayatou suggested the following steps: (1) the explicit allocation of the resources to artisanal fisheries; (2) the division of these resources among fishing communities; (3) the regulation of entry into the fishery; and (4) the gradual encouragement of exit from the artisanal fisheries by creating more attractive alternative employment opportunities.

With respect to resource allocation, PD 704 (1975) provides for the jurisdiction of municipalities over marine waters "... included between two lines drawn perpendicular from the point where the boundary line of the municipality touches the sea at low tide and a third line parallel with the general coastline and three nautical miles." Municipal councils can therefore pass resolutions and ordinances affecting their defined territories, and which become effective upon approval by the duly designated department (currently, the Department of Agriculture to which BFAR is attached). Although PD 704 does not explicitly allocate resources found within municipal waters to artisanal fisheries, this may be adopted as a policy by municipal councils upon democratic consultation with their constituents. PD 704 grants such political bodies the legal rights to do so. In this regard, the municipalities of Bolinao and Anda can pass such resolutions to achieve two things: first, to define the reef areas under their jurisdiction; and second, to allocate such resources to their sustenance fishermen.

With respect to the division of reef resources among the fishing communities, PD 704 helps define the territories of Bolinao and Anda. However, within each are barrios governed by barrio councils, and further division of reef areas at the barrio level seems too limiting and socially counterproductive. Along with the division of resources between municipalities should be the formulation of mechanisms through which territories and resources contained therein are legally recognized, and ownership thereof is enforced.

Establishing community territorial use rights may be best achieved within the bigger context of strengthening and sustaining alternative livelihood. Currently, income-generating activities in the area (aside from fishing) include shellcraft, collection of sea urchin gonads, processing of bêche-de-mer and mat-making. To date, bêche-de-mer processing is very much limited by the severely depleted sea cucumber resources. The activity may not be sustained for long unless mariculture provides for an economically feasible source of raw materials. A major problem which besets these cottage-scale industries is the absence of a good marketing scheme that affords reasonable incomes for labor expended in lieu of fishing, and that ensures a stable market for the goods. These industries are at present dominated by middlemen who pay minimal prices for the goods which they in turn sell at high prices. Perhaps, cooperatives based on co-ownership of capital and equitable sharing of profit, can take the place of middlemen. Initially, aid in community organization and socioeconomic infastructure will have to be made available

before viable cooperatives can be established. Errors which abound from many failures in the establishment of cooperatives need not be repeated.

Management of the Siganid Fisheries

A major reef-based industry in Bolinao is the fishery for siganids. Siganids or rabbitfish are heavily exploited year-round. Mature individuals, known locally as *barangin* are caught mainly by fish corrals *(baklad)*. Juveniles or *padas* are harvested using mobile lift nets *(salambaw)*, bag nets *(basnig)* and seines *(karokod)*. The small siganids are processed into fish sauce (*bagoong*).

The biology and socioeconomics of the fishery are crucial to the formulation of feasible and realistic management measures. The harvest of berried females during their spawning run (from seagrass beds to deeper areas) poses a major biological limit to the long-term viability of both the *barangin* and *padas* industries. Such practice is exacerbated by the deployment of *baklad* end to end along the route of the spawning migration, especially along the eastern fringes of Santiago Island. Although fishermen intuitively understand the repercussions of catching gravid females on the overall abundance of siganids, the lack of formal and informal sanctions easily override an innate sense of ecological propriety.

Social and economic conflicts plague the siganid fishery. Currently, fisheries lots where *baklad* are placed are leased out by public bidding. The highest bidders, naturally, are the prominent and affluent citizens who can raise as much as ₱50,000[b] to pay for a year's lease. Fish corrals built on the lots are protected by policemen. Fishermen who scoop *barangin* from these *baklad* pay 50% of the cash generated to the lessee. During spawner runs (which occur for six days during each new moon from February through June, and from September through December), fishermen are not allowed to catch *barangin* within a certain arbitrary distance from the fish corrals. Although this tacit rule of power play is tolerated, fishermen resent the limitation of their fishing ground and are quick to point out that such rule is not instituted to protect the spawners but to further the interests of the lessee. Furthermore, they note that *baklad* owners are culprits in the decline of the fishery because their corrals indiscriminately capture spawners and non-spawners alike.

The following recommendations for the sustainability of the siganid fishery is in line with the concept of territorial use rights as envisioned to be exercised by a community:

1. The municipality of Bolinao should limit the area where *baklad* can be set up in order to allow a biologically significant number of spawners to reach their breeding grounds and ensure sustenance of the fishery.
2. Fisheries lots should be leased to coastal barrios rather than to individuals. If there are more barrios than lots, the lease can be rotated yearly. Rotation of leaseholds among barrios will promote protection of spawners, as fishermen would like to ensure abundance of catch when their turn comes.
3. Those who own leases can exact a fraction of the catch from fisherfolk of other barrios, the actual sharing scheme for which can be formulated by the appropriate councils.
4. The dimensions of the fish corrals, especially the length of (and angle between) leaders, should be regulated to ensure a certain breeding stock size that can repopulate the area.
5. The mechanisms of profit sharing, law enforcement, and overall management should be thoroughly worked out at the level of the barrio councils (with strong support from the municipal and provincial governments).

No-access Zones

The reef flat and slope areas of the gulf from Bolinao to the Hundred Islands, and

[b] 1988: ₱21.00 = US$1.00

beyond, to the patch coral communities of Telbang and Victoria, are heavily fished. Apart from the Hundred Islands Marine Park, a proposal to establish marine parks in these heavily exploited grounds should embody the desire of coastal communities for self-determination.

In formulating the proposal for no-access zones below, two things were considered. First, the proximity of coastal villages to the no-access zone areas was considered. Without people who can effect management, a marine park cannot be realized. Second, areas which are less fished were identified. In the gulf, such areas include lagoons of the back reef, some of which feature dead corals and very low fish densities. Protection for these areas is therefore rehabilitative rather than preventive in nature.

With these considerations, the lagoonal waters off Barrio Binabalian, Labas and Lucero, encompassing roughly 1 km^2, are proposed as a no-access area, except for research under the supervision of the UP Marine Science Institute (UP-MSI). Research can include rehabilitative experiments such as coral transplantation and enhancement of fish recruitment. Prior to closure of these areas to all forms of harvest, appropriate social preparation and environmental education campaigns should be conducted. These would enable the barrio councils of Lucero and Binabalian to subsequently formulate appropriate management strategies (e.g., police power, punitive measures, fines, etc.). Legal sanction of these management measures by both the municipal and provincial government bodies should be made explicitly.

Long-term Measures

The management of coral reefs should incorporate long-term components. In this regard, the following proposals are worth considering:

1. A nonformal environmental education program (e.g., slide presentations, films, lectures, and on-site underwater nature trails) should be conducted. This will allow for internalization of the desire to safeguard renewable resources, the productivity of which can be short-lived if improperly utilized.
2. Transfer of alternative income-generating skills (such as those taught in vocational schools) can help in the long run in the regulation of total fishing pressure.
3. Acceleration of capital influx to the area to facilitate step 2 through assistance programs.

Data Gaps

The quantitative determination of sustainable yield for some commercial species is at present being undertaken by the field component of the USAID-funded Collaborative Research Support Program (CRSP). However, there remains a need to obtain estimates of sustainable production for the other species of finfish, molluscs and seaweeds. A major constraint is the absence of large individuals which are believed to have been selectively overfished.

Large-scale experiments on rehabilitation of damaged reefs need to be undertaken. These should include research on recruitment of hard coral planulae and fish, as well as methods to enhance recruitment rates.

Information on income derived from coral reefs by fishermen and others involved in the marketing of reef-derived resources (e.g., middlemen, wholesalers, retailers, exporters, etc.) is lacking. These data are essential in assessing the significance of coralline habitats as a source of livelihood. However, it must be emphasized that pure economic valuation neglects the ecological value of reefs. Their contribution to ecological balance throughout their entire life span should be taken into account. Currently, UP-MSI is gathering data on catch from various gears used for harvesting finfish and invertebrates from which estimates of catch rate, income and total harvest can be obtained.

There is a need to ascertain and understand pervading perceptions and attitudes pertaining to reef resources (e.g., their finite nature

and value) for the proposed programs (educational, socioeconomic, etc.) to be accepted by the target audience. This information is also crucial in drafting a management plan for Sector I. Ultimately, coastal villages (through their councils) should be able to make their own recommendations for a feasible resource management scheme. This presupposes that the desire for self-determination has been internalized and that the people's environmental consciousness has achieved a level that can effectively mobilize their political bodies towards effective coastal zone management.

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Patterns and Levels of Aquaculture Practices in the Coastal Municipalities Adjoining Lingayen Gulf

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Palma, A. 1989. Patterns and levels of aquaculture practices in the coastal municipalities adjoining Lingayen Gulf, p. 71-82. *In* G. Silvestre, E. Miclat and T.-E. Chua (eds.) Towards sustainable development of the coastal resources of Lingayen Gulf, Philippines. ICLARM Conference Proceedings 17, 200 p. Philippine Council for Aquatic and Marine Research and Development, Los Baños, Laguna, and International Center for Living Aquatic Resources Management, Makati, Metro Manila, Philippines.

Abstract

A survey of the aquaculture practices in eight coastal municipalities of Pangasinan was conducted from July 1987 to March 1988, covering 499 brackishwater fishponds. The survey revealed that most fish farmers in the eight coastal municipalities in Pangasinan practise milkfish monoculture. Aquaculture practices remain traditional, and management is extensive with heavy input of pesticides. Average production is 900 kg/ha/year. This study focuses on the patterns and levels of the aquafarming practices towards developing management strategies for aquaculture development in the gulf area.

Introduction

Pangasinan is one of the provinces in the country endowed with abundant brackishwater resources. In the past years, most of these have been converted to milkfish ponds. Chong et al. (1984) reported that milkfish ponds in the region were underutilized with an average yield of only 800 kg/ha/year. BFAR (1985), on the other hand, noted that the yield increased to exceed 1,000 kg/ha/year. Despite the reported increase in pond yield, there is obvious need for yield enhancement through appropriate farm management. Before this could be achieved, it is essential to know the current status on the patterns and levels of aquaculture practices as well as better knowledge of coastal land use and development trends.

A series of farm surveys was conducted in eight coastal municipalities extending from San Fabian to Bani (Fig. 1). The surveys covered 499 farms with an aggregate area of 1,628 ha, representing 12% of the total fishpond area in the province (Table 1).

[a]Bureau of Fisheries and Aquatic Resources, Marcelo Bldg., Quezon Avenue, Quezon City, Philippines.

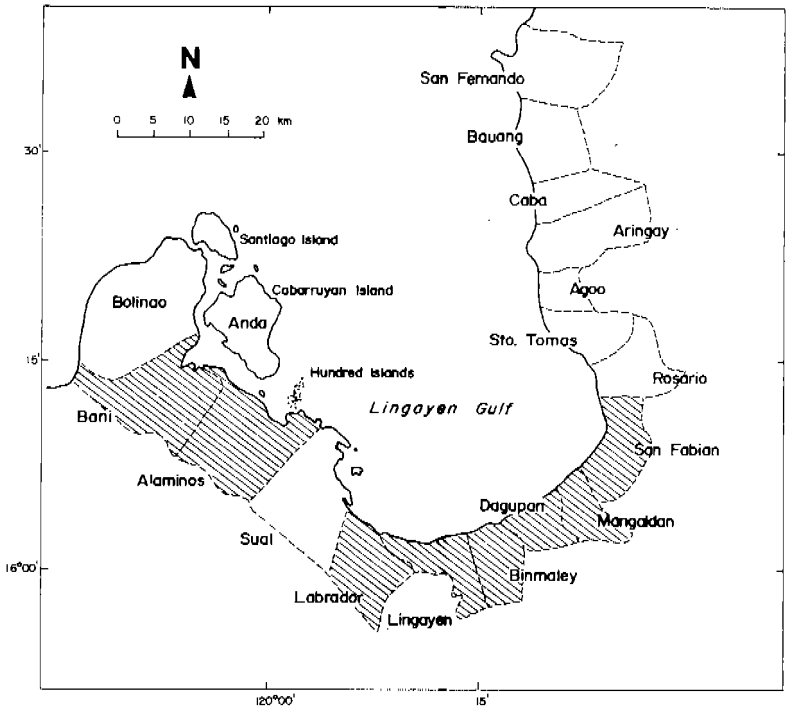

Fig. 1. Lingayen Gulf, showing the eight coastal municipalities covered by the survey.

Table 1. Distribution of privately owned brackishwater fishponds in the coastal municipalities of Pangasinan (fronting Lingayen Gulf) and the area of farms surveyed during the course of the study.

Municipality	Total area (km^2)[a]	Total no. of fishponds	Area (ha) All fishponds	Area (ha) Farms surveyed
San Fabian	81	324	279	33
Mangaldan	41	71	157	45
Dagupan	44	2,693	3,830	243
Binmaley	50	3,721	3,728	258
Lingayen	47	2,337	1,729	310
Labrador	183	138	153	75
Sual	159	61	112	-
Alaminos	167	305	1,200	281
Bani	153	205	1,328	383
Anda	91	137	881	-
Bolinao	236	50	55	-
Total	-	10,042	13,452	1,628

[a] 1 km^2 = 100 ha.

Materials and Methods

Reconnaissance Survey and Site Identification

An ocular survey of the coastal municipalities was conducted to obtain initial information on the general condition of the coastal area and existing fishfarms. The results of the ocular survey together with aerial photographs and the latest provincial land-use maps were used to identify the distribution of fishfarms in the gulf area. The study area was thus delimited to include eight coastal towns, namely: San Fabian, Mangaldan, Dagupan, Binmaley, Lingayen, Labrador, Alaminos and Bani.

The maps of these municipalities were reproduced to a uniform scale of 1:20,000. The northeasternmost point in San Fabian and the northwesternmost point in Bolinao were joined by a straight line. Straight lines perpendicular to this were subsequently drawn at 10 km intervals which were used as reference lines in selecting the sample farms/stations. Sample size per municipality was set at 5% of the total number of fishfarms. Selection of farm samples was made such that 25% were along the road, 25% along the river, 25% remotest from the river and 25% midway between the river and the remotest farms.

Farm Survey

A survey questionnaire was prepared to include data pertaining to farm size, tenure, operator's profile, culture system used, management and operation, and socioeconomics (Appendix 1). These were administered together with personal interviews of the farmers by the research assistants of the ASEAN-US CRMP from July 1987 to March 1988.

Results and Discussion

Farm Size and Ownership

Farm holdings are generally small; 10.6% are below 0.5 ha. The average size range is 1.0 to 2.0 ha. Most of the big farms exceeding 5.0 ha are located in Alaminos and Bani (Table 2).

Aquaculture is basically a family enterprise with 88.6% of the farms privately owned. The remaining are leased either from the government or private individuals. Fishpond operators are predominantly full-time fishfarmers (Fig. 2). Few fishermen, agriculture workers and professionals (i.e., doctors, lawyers, etc.) are engaged in farm operations. Caretakers are employed in most cases.

Fishfarming Practices

A summary of the aquaculture practices in Lingayen Gulf is given in Table 3.

Brackishwater aquaculture consists mainly of the monoculture of milkfish (81.6%) using *lumut*[b], *lablab*[c], or *lumut-lablab* as natural

[b]Filamentous green algae.

[c]Microbenthic complex of algae, zooplankton, detritus, etc.

Table 2. Percentage distribution of the farm samples by size range (ha).

Municipality	<0.2	0.2-0.5	>0.5-1.0	>1.0-2.0	>2.0-5.0	>5.0	Total
San Fabian	0	0	30.0	20.0	30.0	20.0	100.0
Mangaldan	4.8	9.5	23.8	33.3	14.3	14.3	100.0
Dagupan	2.0	9.9	22.8	29.7	31.6	4.0	100.0
Binmaley	0	6.1	27.6	31.6	22.5	12.2	100.0
Lingayen	0	16.3	25.8	28.6	23.8	5.5	100.0
Labrador	10.5	10.5	23.7	28.9	21.1	5.3	100.0
Alaminos	0	0	0	17.2	20.7	62.1	100.0
Bani	0	0	1.8	34.5	25.5	38.2	100.0

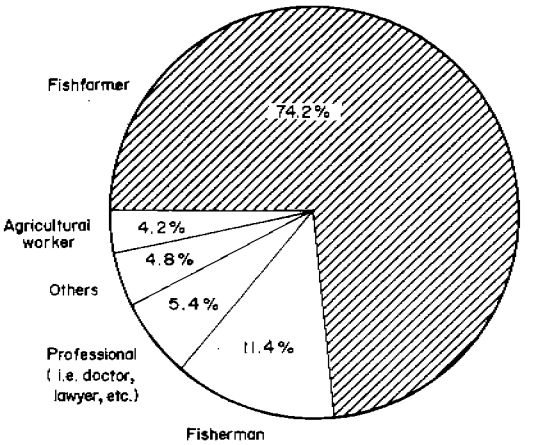

Fig. 2. Distribution of farm operators by principal occupation.

Table 3. Percentage of fishfarms utilizing various aquaculture practices in Lingayen Gulf based on data collected covering the period July 1987 to March 1988.

Municipality	Culture system		Aquaculture practices								Average yield (kg/ha/yr)
			Fertilizer		Pesticide		Supplemental feed		Artificial feed		
	Monoculture	Polyculture	User	Non-user	User	Non-user	User	Non-user	User	Non-user	
San Fabian	90.0	10.0	90.0	10.0	100.0	0	20.0	80.0	0	100.0	744
Mangaldan	100.0	0	95.2	4.8	100.0	0	19.0	81.0	0	100.0	488
Dagupan	95.1	4.9	90.1	9.9	99.0	1.0	23.8	76.2	0	100.0	947
Binmaley	70.4	29.6	73.5	26.5	96.9	3.1	56.1	43.9	9.2	90.8	1,090
Lingayen	98.5	1.5	93.2	6.8	100.0	0	48.3	51.7	1.4	98.6	888
Labrador	97.4	2.6	92.1	7.9	89.5	10.5	60.5	39.5	2.6	97.4	725
Alaminos	100.0	0	100.0	0	100.0	0	75.9	24.1	3.4	96.6	1,122
Bani	98.2	1.8	98.2	1.8	100.0	0	80.0	20.0	1.8	98.2	1,266

food base. Polyculture of species combinations such as milkfish-shrimp, milkfish-siganid, shrimp-siganid and milkfish-shrimp-siganid is practised by few farmers in Binmaley. Management of most of the farms is extensive. There is no standard stocking density. The number of stocks is determined by the immediate availability of fingerlings and the financial capability of the farmer, rather than the optimum carrying capacity of the pond.

Liming is never practised. Farmers believe that lime hardens the pond soil. Since most of the farms are old, there are no problems of soil acidity. However, apart from reclaiming acid-sulfate soils, lime also serves to sanitize the pond. Besides, continuing use of organic manure tends to make ponds acidic. The use of lime should be encouraged especially in shrimp ponds.

Fertilizers and pesticides are among the most common farm inputs. The most common types are chicken manure, and chemical fertilizers such as urea and 16-20-0 (N-P-K ratios) while Brestan, Aquatin and Gusathion are the more frequently used pesticides (with isolated cases of endrine use). However, there is a higher rate of pesticide (98%) than fertilizer use.

In the study conducted by Chong et al. (1984), intensive fertilizer application was found to be directly proportional to increased yield. Comparatively, the role of pesticide in increasing production is rather indirect. It eliminates potential predators and grazers, thereby allowing the natural food to bloom. Organo-chlorine pesticides are persistent, nonbiodegradable and fat-soluble. Organophosphates, on the other hand, are biodegradable but take time to hydrolize and require alkaline pH (Brown 1978). Alkaline pH levels are least expected from the brackishwater ponds since liming is an alien practice. Eventually, persistent and undissolved pesticide residues sink down to the gulf. Apart from their role in production, the impact of pesticides in the environment and the potential danger they pose to the consuming public and the fishfarmer cannot be overlooked.

Supplemental feeding with rice bran and *lumut* is practised by the big farms from Binmaley to Bani (Table 3). Artificial feeds are seldom used. Average production for the eight municipalities is 900 kg/ha/year and falls within the low-level intensity (Chong 1984). Fig. 3 gives a comparison of the production levels of the eight municipalities. Average production is highest in Bani (where high input levels were also observed) and lowest in Mangaldan. The highest production is attained in Dagupan and Binmaley, but low-yielding farms in these two areas were also among the lowest observed. This shows the disparity of management practices among farmers in the same area.

Management Recommendations

Aquaculture development should be geared towards input intensification rather than area expansion. Rather than converting what little is left of the estuarine area into ponds to expand pond aquaculture, mariculture should be developed in order to sustain aquaculture expansion and to preserve the natural state of Lingayen Gulf.

Appropriate aquaculture technology should be field-tested to increase the production of existing fishpond units. Among the identified viable technologies for testing are the modular system of milkfish monoculture and shrimp-milkfish polyculture.

Mariculture should be developed as a supplemental livelihood for fishermen. Oyster culture has a big potential for development. The availability of resources and culture techniques makes cage culture of siganids in the area viable.

Development should be approached at the grass roots level. Inasmuch as the target beneficiaries are the traditional, small-scale fishfarmers and/or low-income fishermen, field testing of the identified technology should be conducted within their own farms/areas where they can be trained more effectively on the technology, while increasing their incomes. This should initially include operators identified during the survey and fishermen-cooperators endorsed by the local government as members of a duly recognized fishermen's association.

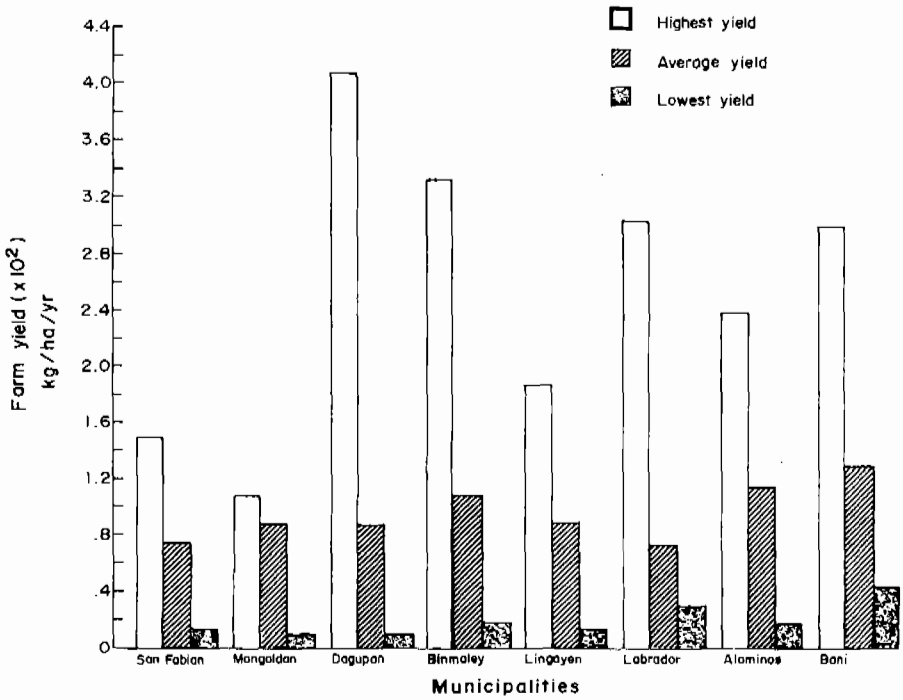

Fig. 3. Comparison of the farm yields of the eight coastal municipalities covered during the survey.

Data Gaps

Intensification of aquaculture calls for levels of higher inputs. The following research needs, among others, must be given priority to bridge the gap between existing technology and increased production rates:

1. Identification of fry grounds and quantification of their potential to meet the demands of the industry;
2. Studies of more efficient techniques in the collection, handling and transportation of fry;
3. Quantification of the extent and effects of pesticide pollution in the gulf; and
4. Formulation of a viable credit scheme for intensified aquaculture production.

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Appendix 1. Survey form used in the evaluation of patterns and levels of aquaculture practices in the Lingayen Gulf area.

I. General Information

A. Type of fishfarm
____Fishpond ____Seaweed farm
____Oyster farm ____Others

B. Site of farm (specify *sitio*, barrio and municipality)
_____ _____ _____
Sitio Barrio Municipality

C. Accessibility of farm (by road, trail, etc.)
_____

D. Tenure status
____Privately owned ____Others (specify)
____Government-leased

E. Form of organization
____Single proprietorship ____Government institution
____Partnership ____Private institution
____Corporation ____Others (specify)
____Cooperative

F. Name of owner (if different from operator)
Address_____

G. Name of operator
Address_____

H. Occupation prior to fishfarming
____Agricultural farmer
____Professional (engineer, lawyer, doctor, etc.)
____Fisherman
____Always been a fisherman
____Others (specify)

II. Fishfarm Complex

A. Fishpond
1. Age of fishpond _____years
2. Total area of fishpond _____ ha
   a. Developed _____ ha
   b. Undeveloped _____ ha
   c. Abandoned _____ ha Why?_____
   d. Have the ponds been idle before? Yes/no.
   If yes, why?_____
   _____
   _____
3. Farm layout (attach farm layout showing number and position of ponds, water control gates, water supply canal, sources of water, roads, etc.)

B. Other types of fishfarm (fish cage, seaweed, oyster, etc.)
1. Age of farm _____ years
2. Total area _____ ha
3. Farm layout (attach farm layout)

III. Fishfarming Practice

1. Mono/polyculture Yes/no (Encircle).
2. Species cultured
3. Total years of experience in:
Milkfish culture _____ years Shrimp culture _____ years
Siganid culture _____ years Others (specify) _____
4. Are you familiar with any of the following fishfarming technique/operation?

	Yes	No	Since when
a. Acclimatization			
b. Stock manipulation			
c. Stock transfer			
d. Water exchange			
e. Water analysis			
f. Natural feeding			
g. Supplemental feeding			
h. Artificial feeding			
i. Pond design			
j. Soil analysis			
k. Pond preparation			
l. Pond liming			
m. Pond fertilization			
n. Pest and predator control			

5. If practicing the following fishfarming techniques, give particulars.
a. Pond fertilization

Kind of fertilizer used	Source	Unit cost	Quantity/ha	Mode of application
1) Organic				

2) Inorganic

3) Is the quantity of each fertilizer applied to the maximum? Yes/no.
If yes, are you already optimizing your operation?

If no, why?

b. Pond liming

Kind used	Source	Unit cost	Quantity/ha	Mode of application

If not using lime, why?

c. Pest and predator control

Pest/predator	Control measures/ pesticides	Unit cost	Quantity applied	Unit	Source

d. Supplemental feeding

Kind of feed	Source	Unit cost	Quantity used	Mode of application

e. Artificial feeding

Kind of feed	Source	Unit cost	Quantity used	Mode of application

f. Water exchange/freshening

Source of water	Mode of exchange	Frequency

g. Soil analysis

Result	When	By whom	Cost

h. Water analysis

Result	When	By whom	Cost

Are you monitoring your pond water regularly? Yes/no.
Do you have problems with your pond water? Yes/no.
If yes, explain

What were the conditions of water in your pond in 1986?

Parameter	High/low	Good/bad
Salinity		
pH		
Others (specify)		

i. Natural feeding

1) What natural feeds do you grow in the ponds?

Type	Period (month to month)
_____ *lumut*	
_____ *lablab*	
_____ plankton	
_____ others	

2) In the absence/shortage of natural food, which of the following do you resort to?

_____ Purchase natural food — Type: _____ ₱_____/kg

_____ Use of supplemental feeds — Type: _____ ₱_____/kg

_____ Others (specify)

6. Fry/fingerling procurement

Source	Mode of transport	Type of container	Price/thousand

7. Stock management and production (1986) of pond fishfarm.

Species and phase of culture	Stock/ha	Total	Food: Natural Kind	Food: Natural Quantity	Food: Supplemental Kind	Food: Supplemental Quantity	Duration of culture	Cropping/yr	Size (pc) (fish/kg)	Production (kg)
a. Milkfish										
Nursery										
Transition										
Rearing										
b. *Siganid*										
Nursery										
Transition										
Rearing										
c. Shrimp										
Nursery										
Transition										
Rearing										
d. Others										
Nursery										
Transition										
Rearing										

8. How do you harvest your products?
   _____ By cast net
   _____ By use of bag net with gradual draining of pondwater
   _____ By seining
   _____ By gill netting
   _____ Others (specify)
9. How often do you harvest within one cropping season?
   _____ Once (total harvest)
   _____ Every 45 days
   _____ Others (specify)
10. What postharvest techniques do you employ?
    _____ Washing
    _____ Washing and icing
    _____ Others (specify)
11. Have you changed your technique over the years of fish farming? Yes/no.
    If yes, when?_____ What sort of change?_____
12. Have you encountered any losses/damage to your fishfarms over the last five years? Yes/no.
    If yes, specify _____
    _____
    What measures have you taken to minimize losses/damage?
    Specify _____
    _____
13. Apart from fishfarming, do you use the ponds for other purposes? Yes/no.
    If yes, specify _____
14. Do you contemplate shifting to culturing other species, or other business ventures? Yes/no.
    If yes, specify
    Species _____ Reason _____
    Business venture _____ Reason _____
15. Production inputs:
    a. Operating cost for fishpond (1986)

Item	Quantity	Cost
Salaries/wages		
Insurance		
Other benefits		
Maintenance and repair		
Fry/fingerling		
Inorganic fertilizer		
Pesticides		
Lime		
Feeds		
Rentals		
Fuel		
Other expenses		

    b.

Input	Quantity	Cost
Stock/seed		
Culture plot cage		
Feed		
Fuel		
Other supplies		
Salaries/wages		

IV. Socioeconomic Information (for pond fishfarming or otherwise)
1. Total number of persons in the family _____

Members	Age	Educational attainment	Occupation	Full-time/part-time/ seasonal in the farm
Husband				
Wife				
Children above 10 years of age helping in the farm				
Relatives				
Others				

2. Would you consider yourself:
   _____ a. Full-time fishpond operator
   _____ b. Part-time fishpond operator
3. If you are a part-time operator:
   _____ Average number of hours/day
   _____ Average number of days/month
4. If you are a part-time operator, what alternative work are you doing?
   _____
   Reason for such work _____

5. For the past three years, what have been your farm yield/ha/year?

a. Fishpond culture

Milkfish

Year	Production area	No. stocked	No. harvested	Pcs /kg	Kg/ha	Good/bad and your reason
1984						
1985						
1986						

b. Shrimp

Year	Production area	No. stocked	No. harvested	Pcs/kg	Kg/ha	Good/bad and your reason
1984						
1985						
1986						

c. Siganid

Year	Production area	No. stocked	No. harvested	Pcs/kg	Kg/ha	Good/bad and your reason
1984						
1985						
1986						

d. To obtain higher yield, do you think you should devote more time to fishfarming? Yes/no.

e. What are the other constraints/restrictions for being unable to achieve higher yields?

6. Other culture systems

a. Fish cage

Year	Size and no. of cage/plot	Species	No. stocked	Quantity	Pcs/kg
1984					
1985					
1986					

b. Oyster culture

1984					
1985					
1986					

c. Seaweed farming

1984					
1985					
1986					

d. Others

1984					
1985					
1986					

7. What is your lowest yield since you started fishfarming?

_____kg/ha/year

Reason for such low yield_____

8. Do you know of any yield differences in output in your locality?

Yes _____ Range _____ kg/ha

No _____

What do you think are the factors that contribute to such yields? _____

9. How do you compare your yield with other ponds within Pangasinan? _____

What about in other provinces? (specify the province)

10. What are the important factors that determine your production decision?

_____ a. Price signal and trends

_____ b. Government subsidies

_____ c. Risks

_____ d. Nonpecuniary factors (recreation)

_____ e. Weather condition

_____ f. Others (specify)

11. Who makes the major decision regarding farm operations?

_____

12. In 1986, what percentage of your income was derived from your fishfarm? Other income sources?

_____% Main crop _____% Secondary crop

_____% Nonfishfarm sources

13. What do you do with part of your income derived from fishfarming?

_____ Improve production operation

_____ Deposit in the bank to earn interest

_____ Others (specify)

14. What is the range of prices you have received in 1986?

Milkfish

Average ₱_____/kg

Lowest ₱_____/kg

Highest ₱_____/kg

Reason for such price variation?_____

15. Is harvest done to coincide with expected higher prices?
Yes/no. If no, why?_____
16. Do you think there is competition with other species? Yes/no.
If yes, why?_____

V. Institutional Parameters

1. Are you a member of any of the following?

Organization	Name	Since when	Benefit derived
Fisheries			
Association			
Cooperative			

2. What do you think about your present fisheries organization/s?
_____
_____
3. Are you willing to borrow money for any of the following:
Farm production purposes? _____
Consumption purposes? _____
Children's educational needs? _____
Others (specify)? _____
4. What are your attitudes/feelings toward credit or borrowing to purchase inputs or make necessary farm renovations?
_____
_____
5. What sort of minimum guarantee/assurance do you look for before investing on improving production or increasing inputs? _____
_____
6. Have you ever borrowed money for farm production? Yes/no.

Year	Source	Amount	Collateral	Amortization	Purpose

7. Have you ever hired the services of consultants or technicians? Yes/no. If yes, what benefits have you gained?
_____
_____
How did you come to hire such consultant/technician? _____
How much did it cost you and for how long? _____
What problems have you encountered? _____
_____
8. Have you ever attended any training course/seminar on fishfarming? Yes/no. If yes:

Training course/seminar	Sponsor	When	Remarks

9. Have you ever discussed your production operation with fellow fishfarmers? Yes/no.
If yes, elaborate_____
_____
10. How do you obtain technical information for improving your production?
_____
_____
11. What costs are involved in obtaining technical information?

Item	Costs

12. Have you ever obtained copies of any fishfarming publication? Yes/no.
If yes, what are these?_____
_____
How did you obtain these?_____
_____
If no, why?_____
_____
13. How do you market your produce?_____
_____
14. What problems have you encountered in marketing your produce?
_____
_____

Reference_____
Date_____
Interviewer_____

Preliminary Results of a Water Quality Baseline Study of Lingayen Gulf

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Maaliw, M.A.L., N. Bermas, R. Mercado and F. Guarin. 1989. Preliminary results of a water quality baseline study of Lingayen Gulf, p. 83-91. *In* G. Silvestre, E. Miclat and T.-E. Chua (eds.) Towards sustainable development of the coastal resources of Lingayen Gulf, Philippines. ICLARM Conference Proceedings 17, 200 p. Philippine Council for Aquatic and Marine Research and Development, Los Baños, Laguna, and International Center for Living Aquatic Resources Management, Makati, Metro Manila, Philippines.

Abstract

A water quality baseline study was conducted in Lingayen Gulf to serve as a basis in formulating a general water quality management plan for the area. This paper presents initial results of the study based on data collected from 21 offshore, estuarine and river stations between March 1987 and March 1988. General water quality parameters were determined, namely, hydrogen ion concentration (pH), temperature, salinity, transparency, suspended solids and dissolved oxygen. Nutrients (nitrite-nitrogen, nitrate-nitrogen and total phosphorus) and heavy metals (lead, zinc, cadmium and mercury) were also analyzed. The results indicate possible issues/problems related to siltation, domestic pollution and eutrophication from increased population/urbanization and various economic activities. Three rivers draining into the gulf (Patalan, Dagupan and Agno) are deemed important in the formulation of a management scheme. Recommendations pertinent to the issues identified are briefly discussed.

Introduction

This baseline study of Lingayen Gulf was initiated in response to concern expressed by several sectors on the deterioration of water quality in the gulf area. Particular attention has been drawn to potential stresses generated by land- and water-based economic activities such as mining, agriculture, logging, aquaculture and industrial operations and increased population density and urbanization in the coastal zone (especially the Agno-Bued Delta). The water quality profile of the gulf area will serve as one of the inputs in the formulation of a general water quality management plan. The study includes examination from selected sites of the following parameters:

- General water quality characteristics such as pH, temperature, salinity, transparency, dissolved oxygen (DO) and suspended solids (ss);
- Nutrient levels in water (i.e., nitrite-nitrogen, NO-N; nitrate-nitrogen, NO3-N; and total phosphorus, PO4-3);

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- Concentration of heavy metals (i.e., zinc, Zn; lead, Pb; cadmium, Cd; and mercury, Hg); and
- Biological oxygen demand (BOD), coliform and pesticide levels.

This paper presents initial results based on data collected from 21 offshore, estuarine and river stations between March 1987 and March 1988, covering general water quality parameters, heavy metals and nutrient levels (Fig. 1).

Materials and Methods

There were 15 stations for offshore aspects (located 1,000-1,500 m from the shore or rivermouth) and six for river characterization. Of the latter, three were located at the mouth (i.e., estuarine) and three, 1,000-2,500 m upstream (i.e., river) of the Patalan-Bued, Dagupan and Agno Rivers. Information on the stations regarding existing land-use, vegetation and marine/estuarine communities in the vicinity were compiled from previous studies and complemented by ocular surveys during the second quarter of 1987.

Quarterly collection of water samples from the 21 stations started in the third quarter of 1987. Water samples were collected at sea surface (1 m below surface) and mid-depth levels. These were stored in well-stoppered polyethylene bottles and packed in dry ice. Samples for DO determination were placed in BOD bottles wrapped in aluminum foil. Sediment samples were also collected in selected stations, stored in glass bottles and immediately frozen. All samples were collected during high tide which was estimated using the tide and water current table of the Bureau of Coast and Geodetic Survey.

Water quality parameters such as pH, temperature, salinity and transparency were measured *in situ*. Methods used to determine the other parameters were as follows:

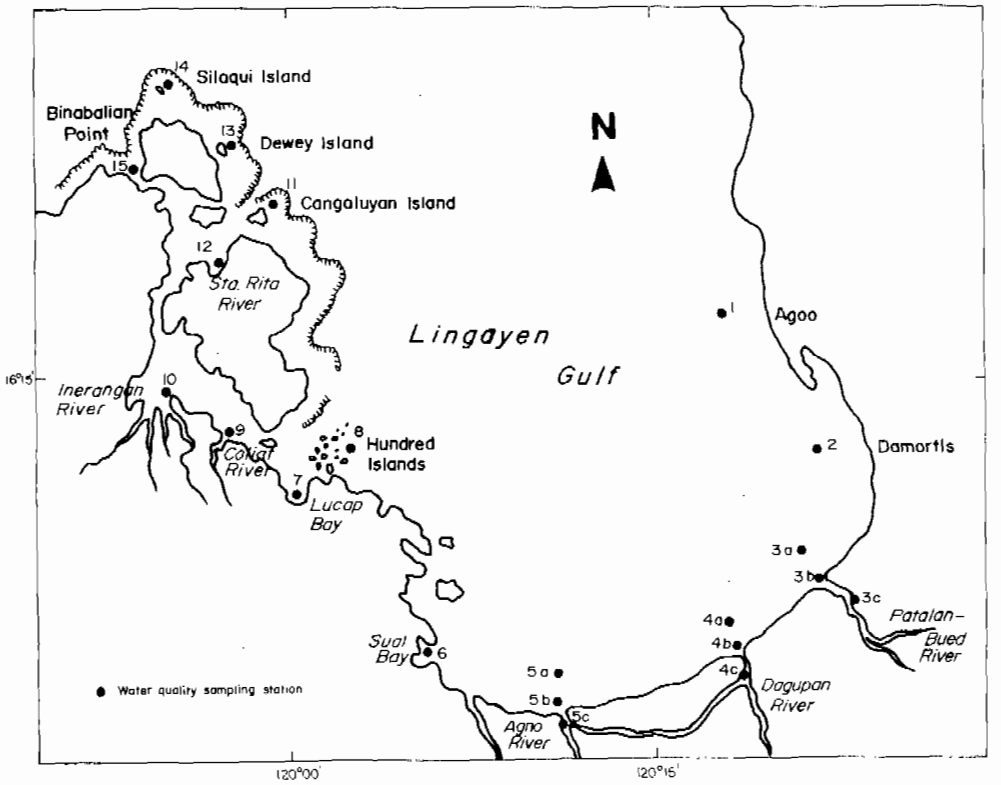

Fig. 1. Location of the 15 water quality sampling stations in Lingayen Gulf.

- Suspended solids were determined using APHA (1976) filtration methods;
- NO_3-N and NO_2-N levels were analyzed based on methods in Strickland and Parsons (1972);
- Total phosphorous (PO_4/PO_3) was determined by digestion and read via a UV-Vis spectrophotometer (EPA 1976);
- DO was determined by the Winkler method (Strickland and Parsons 1972);
- Heavy metals were pretreated following EPA (1979) methods and read via atomic absorption spectrophotometer.

Results and Discussion

Table 1 gives a summary of existing land-use and vegetation features, as well as the marine/estuarine communities in the vicinity of the water quality stations. Previous studies and ocular surveys of the area confirm the high density of human settlements along the coast and rivers. Refuse and sewage disposal into the rivers and coastal waters is a problem, and is especially acute in the Patalan, Dagupan and Agno River areas. Accumulation of solids ranging from biodegradable wastes (e.g., paper, vegetable/meat/fish scraps, plants) to persistent solids (e.g., glass bottles, cans, plastic, rubber) is evident in these places. Heavy deposition of silt in the mouth and certain sections of river systems is apparent.

Table 2 gives a summary of general water quality parameters in the Lingayen Gulf area and the water quality standards of the National Pollution Control Commission (NPCC 1978) for fresh, marine and estuarine waters suitable for contact recreation and fish/shellfish growth and propagation. For the wet season, data collected were during the third quarter of 1987, while for the dry season, both during the fourth quarter of 1987 and first quarter of 1988.

The pH, salinity and temperature values are generally within normal limits for marine, estuarine and river waters, and variations are apparently due to natural causes. Typically, marine waters have pH ranging from 8.1 to 8.3, while estuarine and river pH values range from 7.5 to 8.1 (Reid and Wood 1976). This is because marine waters are relatively strongly buffered and lightly basic. The upper range of pH=9.9 (for Inerangan during the first quarter of 1988) is the only value outside the expected ranges. All other pH values are within NPCC (1978) standards. Salinity values are typical, being higher during the dry season and increasing from river to offshore stations. Temperature trends indicate an increase from offshore to river stations during the dry season, and vice-versa during the wet season.

During the dry season, 85% of the offshore stations had DO levels below the NPCC standard of $\geq$5 mg/l. This improved during the wet season with 50% of the offshore stations meeting the minimum permissible level resulting in a higher mean of 5.27 mg/l. All estuarine and river stations had DO levels below the NPCC standard during the wet season. During the dry season, estuarine stations in Patalan-Bued (3b) and Agno (5b) exceeded 5 mg/l, while Dagupan (4b) consistently showed DO levels below this standard. This led to a mean level of 5.09 mg/l for estuarine stations during the dry season. For river stations (3c, 4c and 5c), only 40% of the dry season samples for two quarters had DO levels above the NPCC standard. The Agno upstream station consistently showed values below 5 mg/l. Average DO level for river/upstream stations during the dry season was 4.0 mg/l. Shallow rivers normally exhibit high DO due to turbulence and mixing, and in uncontaminated conditions, should be near saturation levels. The low levels of DO observed apparently indicate organic pollution where the oxygen demand of oxidizable organic matter is high.

Most of the stations sampled have relatively low transparency values. The highest values were 4.8 m (Binabalian Point) and 3.0 m (Cangaluyan) during the dry and wet seasons, respectively. All river and estuarine stations exhibited transparency readings below the NPCC standard of $\geq$1.0 m during both wet and dry seasons. For offshore stations, 60% had readings below the NPCC

Table 1. Characteristics of water quality sampling stations in Lingayen Gulf.

	Stations	Land use	Vegetation	Marine/estuarine communities	Other physical structure
1.	Agoo	Residential, agricultural	Coconut grove, grass	Soft-bottom	Resort
2.	Damortis	Residential, agricultural, fishpond	Coconut grove, grass	Soft-bottom	None
3.	Patalan River, including offshore	Residential, agricultural fishpond	Coconut grove, grass, sparse mangrove, nipa	Mangrove	Bridge, railroad
4.	Dagupan River, including offshore	Residential, agricultural, industrial, fishpond, commercial center	Coconut grove, mangrove, nipa	Mangrove	Port, dock
5.	Agno River including offshore	Residential, agricultural, fishpond	Coconut grove, grass, mangrove, nipa	Mangrove	Bridge
6.	Sual Bay, including Portugese Point	Residential, agricultural	Coconut grove, grass	Coral reef	Port, dock, tower
7.	Lucap Bay	Residential, fishpond	Coconut grove, grass	Mangrove	Port, dock, tower
8.	Hundred Islands	Residential	Coconut grove, grass	Coral reef	Resort, port
9.	Coliat	Residential, agricultural, fishpond	Coconut grove, mangrove	Mangrove	None
10.	Inerangan	Residential, agricultural, fishpond	Coconut grove, mangrove	Mangrove	None
11.	Cangaluyan Island	Residential	Coconut grove, grass	Coral reef, seagrass	Resort
12.	Sta. Rita	Agricultural, fishpond	Coconut grove, mangrove	Mangrove	Oyster farm, saltbeds
13.	Dewey Island	Residential, fishpond	Coconut grove, grass	Seagrass	Port, dock, tower
14.	Silaqui Island	Residential	Coconut grove, grass	Coral reef, seagrass	None
15.	Binabalian Point	Residential	Coconut grove, grass	Coral reef, seagrass	Port, dock, tower

Table 2. Summary of general water quality parameters in the Lingayen Gulf area as compared to selected water quality standards for fresh, marine and estuarine waters suitable for "contact recreation" and "fish/shellfish growth".

Parameter	Station	Wet season[a] Range	Wet season[a] Mean	Dry season[b] Range	Dry season[b] Mean	Water quality standard[c]
Depth (m)	Offshore	1.5 - 18.0	7.2	0.5 - 9.0	3.6	-
	Estuarine	1.5 - 3.6	2.6	2.0 - 4.0	3.4	
	River	3.0 - 3.6	3.3	1.0 - 7.5	3.9	
pH	Offshore[d]	8.0 - 8.3	8.1	7.6 - 9.9	8.0	6.5 - 8.5
	Estuarine[e]	7.9 - 8.1	8.0	7.5 - 8.3	7.9	
	River	7.9 - 8.1	8.0	7.3 - 8.4	7.9	
Salinity (0/00)	Offshore	12.0 - 36.0	29.6	32.0 - 35.0	33.4	
	Estuarine	3.0 - 26.0	14.5	19.0 - 34.0	29.7	
	River	0 - 25.0	12.8	4.0 - 32.0	19.3	
Temperature (°C)	Offshore	29.0 - 33.0	30.9	27.7 - 32.0	28.7	Not to exceed 3°C
	Estuarine	30.0 - 32.0	30.5	28.0 - 31.2	28.8	from natural
	River	28.0 - 32.0	29.5	27.4 - 31.6	29.5	temperature
Dissolved oxygen (mg/l)	Offshore	2.85 - 6.94	5.27	1.77 - 6.20	4.46	≥ 5.0 mg/l
	Estuarine	3.64 - 4.46	4.20	3.48 - 6.14	5.09	
	River	3.54 - 4.75	4.14	1.36 - 7.67	4.00	
Suspended solid (mg/l)	Offshore	486 - 7219	1828	1312 - 5566	1714	Total solid < 2,000
	Estuarine	217 - 1136	564	629 - 2993	1701	
	River	78 - 1110	362	223 - 1733	1009	
Transparency (m)	Offshore	0.3 - 3.0	0.9	0.2 - 4.8	1.0	≥ 1.0 m measured by
	Estuarine	0.3 - 0.5	0.4	0.2 - 0.5	0.3	Secchi disk
	River	0.3	0.3	0.2 - 0.5	0.3	

[a] Third quarter 1987.
[b] Fourth quarter 1987 and 1st quarter 1988.
[c] From NPCC (1978).
[d] 1,000-1,500 m off the coastline.
[e] Mouth of rivers.
[f] 1,000-2,500 m upstream from river mouth.

standard during the two quarterly samples for the dry season. Transparency values can be correlated with the amount of suspended load carried by the water column, and generally increase from river/estuarine areas to the open sea. Rivers with relatively high current velocity have relatively high turbidity due to scouring and resuspension of bottom sediments. Strong tidal currents have the same effect for coastal areas, especially where substantial inputs of silt and fine-grained particles from erosion-prone areas exist.

The level of suspended solids is relatively high throughout the gulf. Offshore stations near the vicinity of river discharges (e.g., Patalan-Bued, Dagupan, Agno, Sual, Inerangan, Coliat and Sta. Rita) generally exhibited higher suspended solid levels although maximum values were observed in Dewey which supposedly is remote from such discharge point. Possible sources of these solids include particles from erosion-prone areas, chemical and mechanical weathering of rocks and scouring of the substratum during periods of high tidal current velocities. Other possible sources are discharges of domestic sewage as well as effluents from commercial and industrial establishments. The presence of large amounts of suspended solids, as in the case of most of the stations examined, decreases water transparency and reduces DO levels due to decomposition of organic matter.

Table 3 gives the average nutrient levels (NO_2-N, NO_3-N, PO_4-3) in the 21 stations during the three quarterly sampling periods. The ranges in mean values were 0.18-34 µg/l for nitrite, 0.92-26 µg/l for nitrate and 3.27-118 µg/l for phosphate. These levels are relatively high although NPCC has not set definite limits/standards for these nutrients, stating only that these should "not be present in amounts as to cause deleterious or abnormal biotic growth" (NPCC 1978). We note, however, that EPA (1979) standards prescribe a maximum allowable concentration of 0.1 µg/l for total P in coastal waters. Possible sources of high nutrient levels include domestic effluents and leaching from the soil and organic/inorganic fertilizers from farms and fishponds. For most of the stations, nutrient levels were highest during the third quarter which was the rainy or wet season.

Concentration of heavy metals (i.e., Zn, Pb and Cd) in water for selected stations is given in Table 4. The maximum permissible levels based on NPCC (1978) standards are 2.0 mg/l for Zn, 0.05 mg/l for Pb and 0.01 mg/l for Cd. All stations sampled gave zinc levels way below the NPCC limit. For lead, Silaqui (the control station) consistently gave the highest levels which exceeded the NPCC standard. Lead levels also exceeded the standard in the Patalan and Dagupan mouth stations in July 1987 and in the Agno station in April 1987. In the case of cadmium, only the Agno and Dagupan upstream stations in July 1987 showed values below the NPCC limits.

Examination results of mercury concentrations in sediments at selected stations in the Lingayen Gulf area are given in Table 5. At present, mercury is detected in the sediments in Patalan, Dagupan, Agno and even in Silaqui, the control station supposed to be far from river mouths which potentially carry the metal. Since NPCC has not determined permissible limits for mercury in sediments, the data obtained are presented solely for documentation purposes.

The analysis of heavy metals was made because of historical episodic cases of contamination from the mining activities in the upstream areas. Health risks involved in the presence of mercury in living systems are due to the methylation process it undergoes in the marine ecosystem and its potential for biomagnification. Many cases of contamination have been documented where the original source of mercury has ceased for several years and the metal is no longer detected in the water column. However, sediments being good sinks of pollutants may still contain mercury showing its persistence over a long period. In some cases, bioturbation contributes to the resuspension of mercury in water from time to time.

Conclusion and Recommendations

The significance of maintaing good water quality in the area cannot be overemphasized

Table 3. Average nutrient levels (µg/l) at selected stations in Lingayen Gulf (1987-1988).

Station	Station no.	Nitrite (NO_2-N) 1987 3rd Q	Nitrite (NO_2-N) 1987 4th Q	Nitrite (NO_2-N) 1988 1st Q	Nitrate (NO_3-N) 1987 3rd Q	Nitrate (NO_3-N) 1987 4th Q	Nitrate (NO_3-N) 1988 1st Q	Phosphate (PO_4-3) 1987 3rd Q	Phosphate (PO_4-3) 1987 4th Q	Phosphate (PO_4-3) 1988 1st Q
A. Offshore										
Agoo	1	4.56	0.18	0.92	1.81	0.92	2.08	31.85	7.48	15.6
Damortis	2	11.56	0.18	1.34	1.81	0.92	2.32	38.38	17.19	57.62
Patalan Offshore	3a	7.58	0.18	2.27	4.51	0.92	1.39	7.45	13.78	6.93
Dagupan Offshore	4a	8.74	1.44	1.18	7.34	1.01	5.04	7.93	6.29	9.27
Agno Offshore	5a	5.31	2.70	1.59	3.96	0.92	4.29	42.05	10.09	7.98
Sual Bay	6	4.56	0.18	2.52	1.81	0.92	3.81	31.74	4.95	55.52
Lucap Bay	7	22.01	2.70	0.92	16.61	2.70	3.18	48.44	5.90	6.23
Hundred Island	8	7.58	0.18	0.92	6.15	0.92	4.19	117.80	4.30	15.92
Coliat	9	34.20	2.70	2.61	22.28	14.18	5.04	25.39	4.30	31.64
Inerangan	10	15.71	8.27	1.51	9.54	2.70	7.30	13.35	20.04	29.25
Cangaluyan Island	11	6.82	8.27	1.09	4.33	20.30	3.34	7.35	4.11	8.43
Sta. Rita	12	13.26	9.74	1.68	8.40	4.08	7.30	23.83	7.62	23.59
Dewey Island	13	16.70	0.18	1.26	8.39	0.92	2.85	6.49	5.33	4.10
Silaqui Island	14	4.56	0.18	1.09	2.08	0.92	5.13	29.61	3.27	7.23
Binabalian Point	15	6.07	0.18	0.92	3.42	0.92	4.29	32.18	3.55	11.17
B. Estuarine										
Patalan Mouth	3b	6.06	0.18	2.78	12.98	0.92	5.58	15.67	66.92	8.90
Dagupan Mouth	4b	6.75	4.08	2.36	14.21	5.47	4.09	29.74	9.25	6.84
Agno Mouth	5b	-	11.93	2.94	-	2.70	4.76	-	17.06	23.87
C. River										
Patalan Upstream	3c	5.31	0.18	6.73	13.62	0.92	6.15	9.70	37.03	3.54
Dagupan Upstream	4c	15.74	20.02	4.22	16.04	7.29	25.51	63.75	39.43	12.58
Agno Upstream	5c	-	2.71	1.60	-	0.92	3.28	-	10.81	15.73

Table 4. Heavy metal concentrations in water (mg/l) at selected stations in the Lingayen Gulf area.[a]

Sampling data/ heavy metal	Patalan River Mouth (3b)	Patalan River Upstream (3c)	Dagupan River Mouth (4b)	Dagupan River Upstream (4c)	Agno River Mouth (5b)	Agno River Upstream (5c)	Silaqui Island (14)
April 1987							
Zn			<0.010	<0.010	<0.010	<0.010	0.014
Pb			<1.00	<1.00	2.71	2.71	3.33
Cd			0.030	0.014	0.310	0.030	0.060
July 1987							
Zn	<0.010	<0.010	<0.010	<0.010	0.036	0.010	<0.010
Pb	1.77	2.08	2.71	<1.00	<1.00	<1.00	5.21
Cd	0.052	0.040	0.040	<0.010	<0.010	<0.010	0.070

[a]Maximum permissible levels for waters suitable for "fish/shellfish growth and propagation" based on NPCC (1978) standards are 2.0 mg/l for Zn, 0.05 mg/l for Pb and 0.01 mg/l for Cd.

Table 5. Mercury concentrations (mg/l) in sediments at selected stations in the Lingayen Gulf area.

Station	Mercury levels (ppm)
(3a) Patalan River offshore	<0.10
(3c) Patalan-Bued River fork	<0.10
(4a) Dagupan River offshore	<0.22
(4c) Dagupan River-Market area	0.32
(5a) Agno River offshore	<0.10
(14) Silaqui Island	0.24

given that Lingayen Gulf is a major source of fish and other aquatic products in the region. The assurance of safe and uncontaminated food cannot be overlooked from the point of view of both economics and human safety. The initial results of this study generally indicated low water DO levels and transparency and high suspended solids and nutrient load. Lead and cadmium concentrations in water for certain sections of rivers are above the NPCC limits. These results indicated the need for consideration and resolution of issues on siltation from mining activities and denuded upland areas, pollution from domestic refuse and sewage and pollution/eutrophication from agriculture and aquaculture runoff and effluents from commercial operation.

Siltation requires massive efforts to reforest denuded upland areas. Thus, there is a need to: identify priority areas for rehabilitation; conduct information/education campaigns to raise awareness of the problem; mobilize support for reforestation programs; reforest and sustain secondary growth in critically eroded areas; and devise a system for monitoring upland resource uses. For mining activities, there must be continuous and total containment of mine tailings in dams which needs frequent monitoring to prevent spillage or breakdown. Some mining companies have initiated conversion of tailings into hollow blocks which has reduced the amount of tailings and increased livelihood opportunities in the uplands. Encouragement of similar efforts is in order. Mines must also consider increasing the quantity of solids recycled as sandfills and developing/designing chemical treatment procedures for their pondwater tailings.

Pollution from domestic sources emphasizes the need to develop integrated solid waste and sewage disposal systems, particularly for the highly populated areas in the

Agno-Bued Delta. Moreover, the following appear to be in order:

- Information/education campaigns to highlight the necessity of proper waste disposal;
- Creation of buffer zones along rivers and coastal areas where dumping of wastes is prohibited; and
- Formulation and implementation of proper land use, delineating residential and other onshore activities.

The proper use of fertilizers by farmers and fishpond operators needs to be improved further via effective extension services. Ways to reduce direct discharge into waterways of "enriched" effluents need particular attention.

Overall, there is the necessity for intensive and extensive monitoring of potentially hazardous chemicals and environmentally significant physico-chemical parameters on a regular basis. Development of the capabilities of agencies or academic institutions in the region to enable them to conduct these studies deserves proper consideration.

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Land Use Patterns and Physical Characteristics of the Provinces and Municipalities Bordering Lingayen Gulf

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Abstract

This paper presents background information on land use patterns in the coastal provinces and municipalities adjoining Lingayen Gulf. Geographic, climatic, hydrogeologic and related information are also presented, based on unpublished data and studies available in the files of the Ilocos Regional Development Council-National Economic Development Authority (IRDC-NEDA Region I), as collated from the various local units and regional offices of government agencies in the area. Development concerns and relevant recommendations identified center around water quality, conflicting resource use, socioeconomic and cultural and institutional/legal issues.

La Union and Pangasinan

The coastal provinces, La Union and Pangasinan, bordering Lingayen Gulf are situated on the northwestern coast of Luzon or on the southern portion of Region I (Fig. 1). They are bounded by the province of Ilocos Sur in the north; the provinces of Benguet and Nueva Vizcaya in the east; the province of Nueva Ecija in the southeast; the provinces of Tarlac and Zambales in the south; and the South China Sea in the west. These provinces fall within latitudes 15°40' to 16°55' north and longitudes 119°45' to 120°55' east, and are approximately 200 km north of Manila.

Pangasinan and La Union are basically agricultural provinces where rice production and fishing are important economic activities. They are considered relatively advanced compared to other provinces in the region because of facilities or activities like food processing, cold storage, mine warehousing, oil depot, cottage industries and tourism. San Fernando, the provincial capital of La Union, is the administrative center of the region.

Physical Characteristics

Land area

La Union has an area of 1,493 km^2. Of this area, 68% (1,020 km^2) is classified as alienable and disposable, while the remaining

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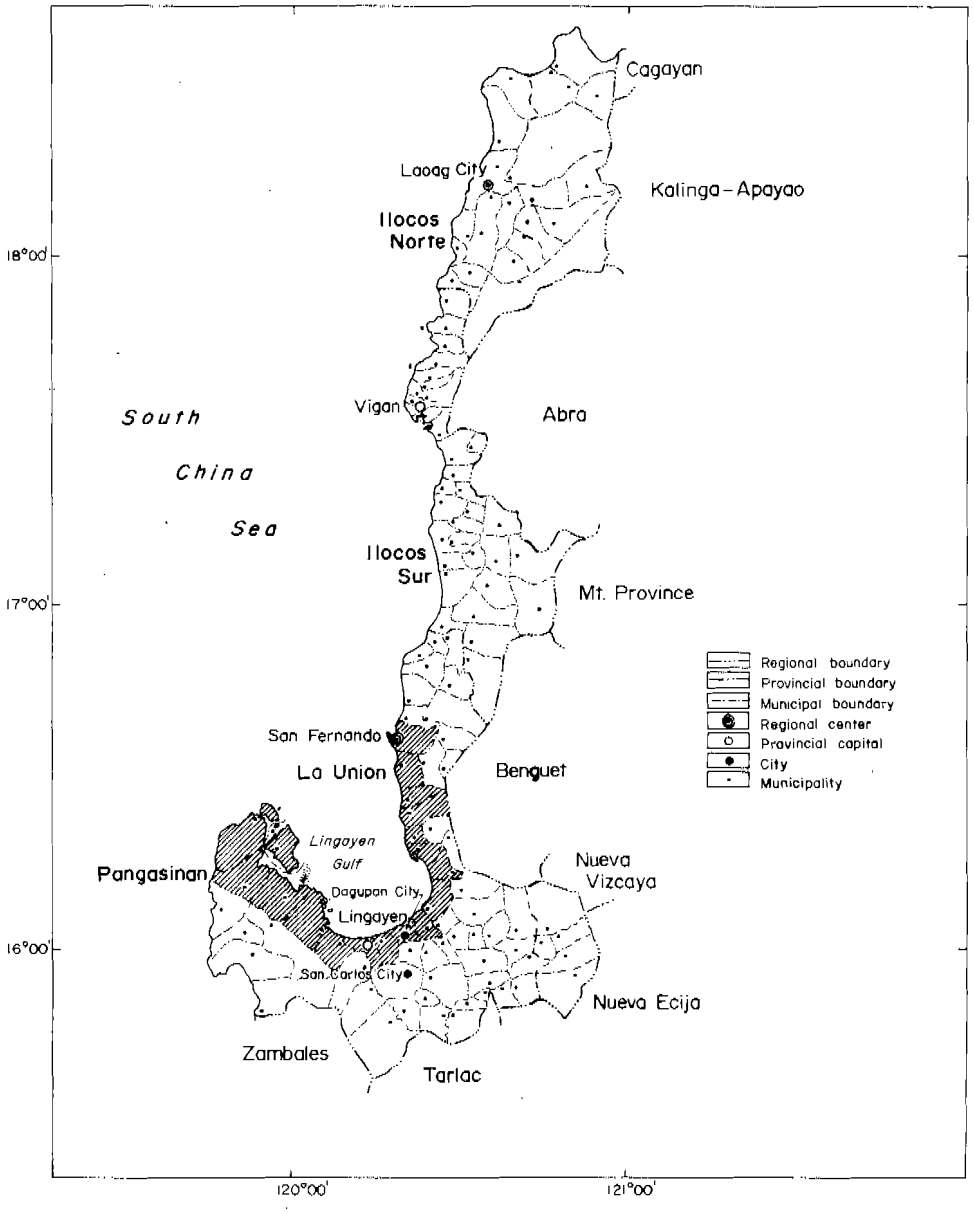

Fig. 1. Region I and the coastal municipalities bordering Lingayen Gulf.

32% (473 km^2) are public forest lands. On the other hand, Pangasinan has an area of 5,368 km^2, with 3,721 km^2 (69%) considered as alienable and disposable and 1,647 km^2 (31%) as public forest lands. The total area of the coastal provinces of Lingayen Gulf is 6,861 km^2 making up 53% of the total area of Region I.

Topography

The topography of Pangasinan is generally flat with some hilly/mountainous areas at the eastern (Cordillera mountain ranges) and western (Zambales mountain) portions with slopes ranging from 18% to more than 30%. An area of 3,998 km^2 or 74% of the area of Pangasinan is covered by 0-18% slope. The remaining 1,370 km^2 have slopes of more than 18%.

The province of La Union consists of lands generally level to undulating and/or rolling with the hilly/mountainous portions concentrated in the intermediate hillsides of the Cordillera mountain ranges. About 51% (763 km^2) of the area has 0-18% slope. The western border is a coastal plain of raised coral and alluvium (sand/clay) deposited by flowing water and overlaying older sediments. This irregular coastal plain is narrowest south of Damortis, Sto. Tomas, and widest in the north at Balaoan, where it extends almost 15 km inland from the South China Sea. The eastern portion is predominantly mountainous (but lower in contour than the Cordillera mountain ranges of Benguet and Mountain Province) with a linear north and south arrangement. The highest peak in the province is in the municipality of Bagulin with an elevation of 366 m above sea level. Other areas with an elevation of more than 240 m are found in San Gabriel and Burgos. The remaining 730 km^2 have slopes ranging from 18% to more than 30%

Climate

The Hernandez climate type classification of the Philippine Astronomical, Geophysical and Atmospheric Sciences Administration defines the climate of the two coastal provinces as arid (type E) and dry (type D). The western portion of La Union is arid, while its eastern portion and the whole province of Pangasinan is dry. The arid climate is best described by the range of the Q values from 1.00 to 1.67, where Q is the ratio of the number of dry months to the number of wet months. Dry climate is characterized by insufficient distribution of rainfall, with Q values ranging from 0.60 to less than 1.00.

Rainfall

The total annual rainfall in Pangasinan is 2,409 mm with a monthly average of 201 mm. Maximum rainfall is observed during August with a rainfall mean of 582 mm, while minimum rainfall occurs in January and February with a mean of 8 mm and 13 mm, respectively.

In La Union, the total annual rainfall is 2,335 mm, with a monthly average of 195 mm. Maximum rainfall is observed in August with a rainfall mean of 643 mm, while minimum rainfall with a mean of 4 mm is observed in January.

Temperature

The mean annual air temperature in Pangasinan is 27.3°C. April and May are the hottest months with mean temperature of 28.9°C. La Union has a mean annual air temperature of 25.8°C. The average maximum temperature is 23°C while the average minimum is 19°C. The coolest months are from August to February. May and April are the hottest months with 29.1°C and 28.6°C, respectively.

Typhoon

The coastal provinces of Lingayen Gulf are shielded from the northeasterly winds by the Cordillera mountain ranges, and to some extent, from the Pacific trade winds by the Sierra Madre mountains. Typhoons or tropical cyclones frequently pass the area during the southwest monsoon period.

Water resources

Precipitation is the source of all surface and subsurface water of the coastal provinces of Lingayen Gulf. These are distributed mainly by the rivers found in the area. Table 1 gives the location, origin and drainage location of the rivers in La Union and Pangasinan.

Regarding ground water, La Union can be divided into two categories, namely: (1) the shallow well areas, where the recommended depths are not greater than 20 m and the static

water levels are generally within 6 m below ground surface; and (2) the deep well areas, where the recommended depths are greater than 20 m and the static water levels usually exceed 6 m below ground surface. On the other hand, Pangasinan can be divided into three ground water categories: the two types of well areas above and the difficult areas, where ground water depths vary considerably and about 25% yield nonproductive boreholes.

Shallow well areas generally consist of recent geologic formations with slopes ranging from 0 to 3%. Most of these areas (such as alluvial and coastal plains and river valleys) are located at elevations within 50 m above mean sea level. Compared to deep wells with the same discharge and location, shallow wells are less susceptible to saltwater intrusion and can easily be safeguarded from bacterial pollution. However, they may not be resistant to the effects of fertilizer and pesticides, particularly when constructed near ricefields.

Deep well areas are generally sedimentary formations, 90% of which are water carriers. These are usually located in slopes reaching up to 10% and at elevations of more than 50 m above mean sea level. The waters from deep wells are generally good. However, care must be exercised in limestone formations where calcium carbonates are the major constituents. The aquifers are susceptible to pollution caused by activities of human beings, animals and others because the geologic formation normally has solution channels/caves where water flows as underground creeks/rivers. Such formation, therefore, has no considerable filtration and/or purifying properties.

Difficult areas have varying slopes, elevations and water depths. The water supply sources are mainly replenished by way of sheared rocks (i.e., through fissures, cracks and crevices). The basic grains of geologic formations in this category are so arranged and sized that only a negligible amount of water can move (i.e., their primary permeabilities are near zero). Springs are generally found in these difficult areas. Although springs may have a minimal yield, they may be the only viable source in such areas.

Shallow well areas are found along the coastal towns of La Union, while the deep well areas are found in the hilly/mountainous towns of the province. The static water level in La Union ranges from 0.3 to 20.7 m below ground surface, while the average provincial static water level is 5.6 m below ground surface. The average discharge of the wells in La Union is 0.58 l/second and the average well depth is 21.2 m. About 500 km^2 or 33% of the provincial area is shallow well areas. Deep well areas occupy 993 km^2 or 67%. The static water level for deep well areas in La Union is greater than 6 m.

Shallow well areas occupy the central portion of Pangasinan, while deep well areas are found in the eastern and western tips of the province. The difficult areas are found in the southwestern portion (Zambales mountain). The static water level ranges from 0.3 to 26 m below ground surface, while the provincial static water level average is 6.6 m below ground surface. The average well discharge in Pangasinan is 1.41 l/second. About 48% (2,580 km^2) of the provincial area are shallow well areas while 39% (2,100 km^2) are deep well areas. The remaining 13% (688 km^2) are difficult areas.

Natural drainage, which refers to the frequency and duration when the soil is free of saturation, is a required factor in evaluating soil suitability for both agricultural and urban development.

Table 1 gives the 11 rivers which drain into the coastal provinces of Lingayen Gulf.

Internal drainage is moderate (due to good seepage) in areas of sandy soils. However, in clayey areas, drainage is poor causing the soil to have poor permeability and infiltration. Occasionally, because of flat topography in some parts of the area, external drainage problems occur such as surface runoff accumulation, river flooding and seasonal/ tidal flooding during heavy rains and typhoons.

Land Capability Classification

Land capability classification for crop production, human settlements, forestry and wildlife conservation, and fishfarming is an

Table 1. Rivers in La Union and Pangasinan.

Name of river	Location	Origin	Drainage location
Maragayap	Bacnotan, La Union	Santol, La Union	South China Sea
Baroro	Bacnotan, La Union	San Gabriel, La Union	South China Sea
Naguilian/Bauang	Bauang, La Union	Benguet Province	Lingayen Gulf
Aringay	Aringay, La Union	Tuba, Benguet Province	Lingayen Gulf
Bued	San Fabian, Pangasinan	Benguet Province	Lingayen Gulf
Mitura	Dagupan City	Benguet Province	Lingayen Gulf
Agno	Lingayen, Pangasinan	Benguet Province	Lingayen Gulf
Alaminos	Alaminos, Pangasinan	Sual, Pangasinan	Tambac Bay
Balingasay	Bolinao, Pangasinan	Bani, Pangasinan	South China Sea
Balincaguin	Agno, Pangasinan	Mabini, Pangasinan	South China Sea
Dasol	Dasol, Pangasinan	Burgos, Pangasinan	Dasol Bay

important guide for development planners and farmers in the area. The land capability classes are as follows:

1. Classes A, B and C - areas suitable for intensive crop production and human settlements with 0-15% slope;
2. Class D - areas suitable for limited cultivation and human settlements with slopes ranging from 0-8% and 15-25%;
3. Classes L and M - areas suitable for forest production and limited grazing with slopes 0-3% and 25-40%;
4. Classes N and Y - areas suitable for forestry/watershed and wildlife conservation with slopes of 20% and above; and
5. Class X - areas suitable for fish-farming, salt production and wildlife conservation with 0-1% slope.

In Pangasinan, classes L and M occupy the largest area with 3,082 km^2; followed by classes A, B and C, 2,059 km^2; class D, 154 km^2; and class X, 74 km^2.

In La Union, classes L and M occupy the largest area with 1,152 km^2; followed by classes A, B and C, 308 km^2; class D, 21 Km^2; classes N and Y, 9 km^2; and class X, 3 km^2.

Environmentally Critical Areas

The area of severely erodable portions in Pangasinan consists of 958 km^2 or 18% of the area of the province; in La Union, 392 km^2 or 26% of the province's area.

On the other hand, severely floodable areas in Pangasinan cover 297 km^2 or 6% of the total area of the province and in La Union, 103 km^2 or 7% of the area of the province (Fig. 2).

The water quality in the coastal provinces of Lingayen Gulf, specifically in the coastal part of Pangasinan (Fig. 3), is affected by siltation from the mining operations within the upper reaches of the Agno and Bued Rivers (Fig. 4). The river bottoms are made shallow due to silt deposits. This ultimately causes banks to overflow resulting in destructive floods. Siltation in the paddies has caused cementing action on the soil layers within the root zone of plants. The complete cessation of soil aeration enhances the formation and accumulation of toxic compounds. This causes the death of soil microorganisms that are beneficial to plant life and the stunted growth and eventual death of paddy rice in areas with thick sediments.

Another factor which creates siltation in the area is soil erosion. Soil erosion does not only occur within the two coastal provinces, but also within the province of Benguet where the upper reaches of the river basins of Agno, Bued, Aringay and Naguilian/Bauang are located. It is commonly caused by forest denudation and land-use abuses like illegal forest occupancy, illegal and legal logging and fuel wood production.

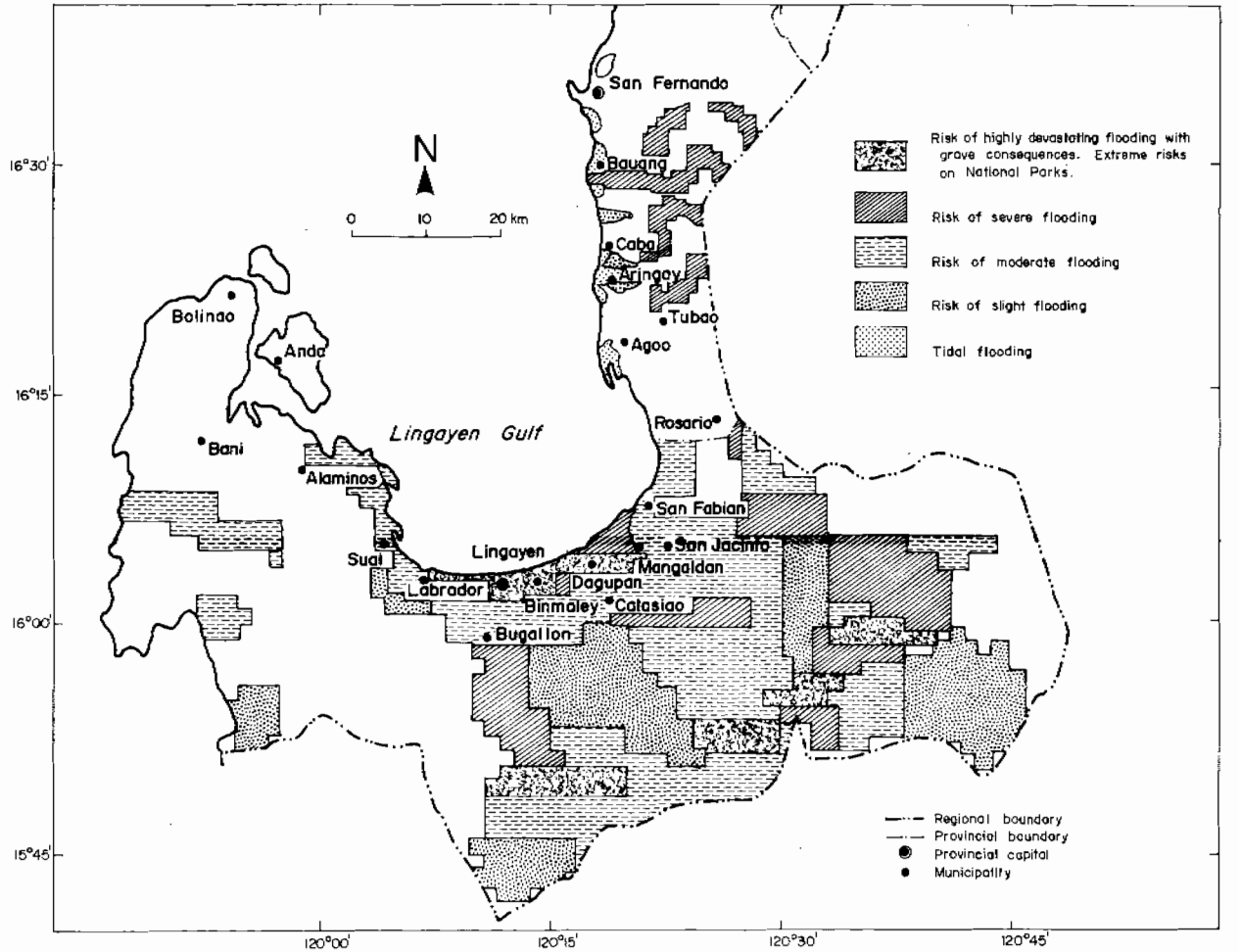

Fig. 2. Flooding map for Pangasinan and La Union.

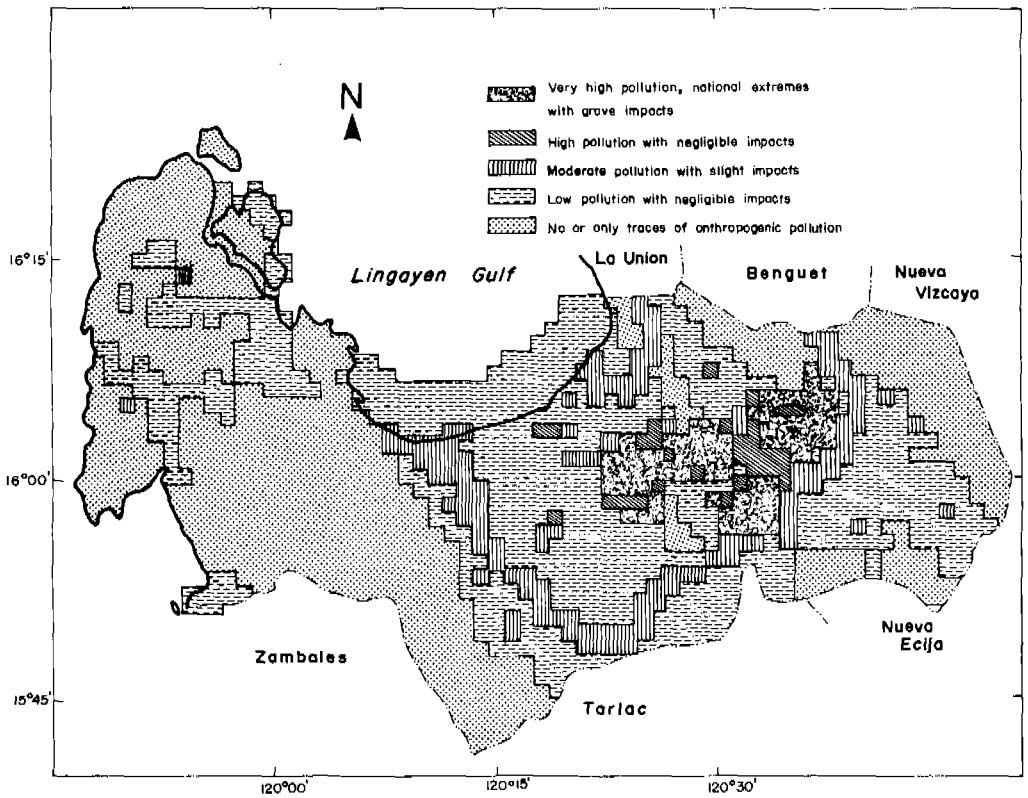

Fig. 3. Surface quality map for Pangasinan.

The Coastal Municipalities Adjoining Lingayen Gulf

Within Pangasinan and La Union, 17 municipalities and one city are located along the coastal area bordering Lingayen Gulf (Fig. 5).

In Pangasinan, the ten municipalities are Bolinao, Anda, Bani, Alaminos, Sual, Labrador, Lingayen, Binmaley, Mangaldan and San Fabian; and the only city bordering the gulf is Dagupan. These units cover a total land area of 1,252 km^2 which is 23% of the total land area of Pangasinan.

The seven municipalities in La Union are Rosario, Sto. Tomas, Agoo, Aringay, Caba, Bauang and San Fernando. These cover a total land area of 503 km^2 or 34% of the total land area of the province.

Land Classification and Use

As of June 1987, the certified alienable and disposable lands (A and D) made up most of the land in the coastal municipalities of Pangasinan and La Union. Tables 2 and 3 show the status of land classification in the coastal municipalities of both provinces.

Based on the existing general land use criteria of the Bureau of Forest Development (now the Forest Management Sector), the coastal municipalities have six different land uses, namely:

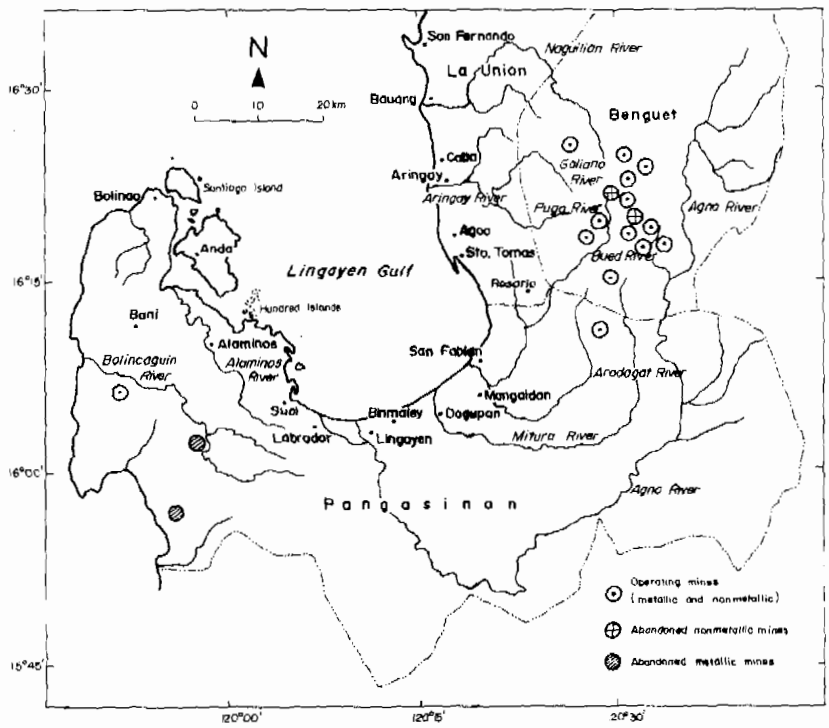

Fig. 4. Location of operating and abandoned mines vis-à-vis river systems.

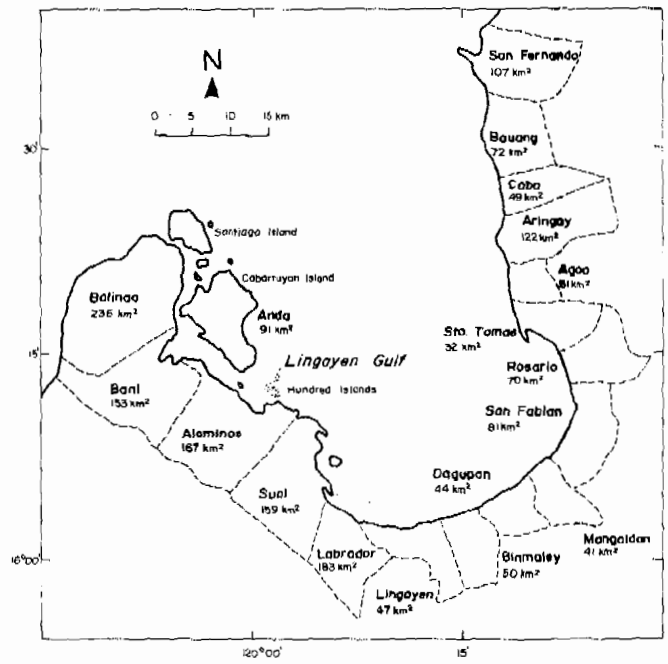

Fig. 5. Land area of the coastal municipalities adjoining Lingayen Gulf.

Table 2. Status of land classification in the coastal municipalities of Pangasinan bordering Lingayen Gulf as of 30 June 1987.

Coastal municipality	Land area (km^2) (A and D)	Certified alienable and disposable land (km^2) (A and D)	Total	Classified lands (km^2) Timberland	Fishpond development
Bolinao	235.8	184.3	51.5	48.0	3.5
Anda	90.8	83.8	7.0	7.0	-
Bani	152.7	114.8	37.8	37.8	-
Alaminos	166.8	164.8	1.9	0.6	1.4
Sual	159.0	96.8	62.2	62.2	-
Labrador	183.0	34.8	148.2	148.2	-
Lingayen	47.3	47.3	-	-	-
Binmaley	50.3	50.3	-	-	-
Dagupan City	43.6	43.6	-	-	-
Mangaldan	41.0	41.0	-	-	-
San Fabian	81.3	81.3	-	-	-
Total	1,251.6	942.8	308.6	303.8	4.9
% to total	100.0	75.3	24.7	24.3	0.4

Sources: Region I Offices of the National Census and Statistics Office and the Bureau of Forest Development.

Table 3. Status of land classification in the coastal municipalities of La Union bordering Lingayen Gulf as of March 1988.

Coastal municipality	Land area (km^2) (A and D)	Certified alienable and disposable land (km^2) (A and D)	Total	Classified lands (km^2) Timberland	National park
Rosario	70.0	66.0	4.0	4.0	-
Sto. Tomas	32.4	29.5	2.9	2.9	-
Agoo	51.4	37.2	14.2	12.0	2.1
Aringay	122.1	39.2	82.9	82.9	-
Caba	48.6	43.9	4.7	4.7	-
Bauang	71.6	65.6	6.0	6.0	-
San Fernando	106.9	97.9	9.0	9.0	-
Total	503.0	379.3	123.7	121.5	2.1
% to total	100.0	75.4	24.6	24.2	0.4

Source: Bureau of Forest Development (Region I).

1. Built-up area - residential, commercial, institutional, industrial and utility areas;
2. Cropland - land planted to seasonal and annual/perennial crops;
3. Grassland - pasturelands;
4. Shrubland - lands planted to bamboos and shrubs;
5. Woodland - shrublands and forest lands; and
6. Wetland - swampy areas, saltbeds, fishponds, mangroves and rivers/ riverbeds.

Tables 4 and 5 show the existing land uses in the coastal municipalities of Pangasinan and La Union. Cropland accounts for the largest areas in both provinces.

Table 4. Existing land use (km^2) in the coastal municipalities of Pangasinan bordering Lingayen Gulf.

Coastal municipality	Land area	Built-up area	Cropland	Grassland	Shrubland	Wetland
San Fabian	81.3	3.2	37.9	31.0	-	9.2
Mangaldan	41.0	9.6	28.9	-	-	2.5
Dagupan City	43.6	6.5	11.8	-	-	25.3
Binmaley	50.3	1.5	21.8	-	-	27.0
Lingayen	47.3	4.3	28.2	-	-	14.8
Labrador	183.0	0.8	14.7	133.9	29.2	4.4
Sual	159.0	0.5	49.8	100.8	6.4	1.5
Alaminos	166.8	4.8	110.0	43.3	2.0	6.7
Bani	152.7	2.5	56.9	52.1	22.4	18.8
Anda	90.8	0.7	49.3	15.5	21.0	4.3
Bolinao	235.8	1.0	59.8	34.9	139.6	0.5
Total	1,251.6	35.4	469.1	411.6	220.6	115.0
% of total	100.0	2.8	37.5	32.9	17.6	9.2

Source: Bureau of Soils.

Table 5. Existing land use (km^2) in the coastal municipalities of La Union bordering Lingayen Gulf.

Coastal municipality	Land area	Built-up area	Cropland	Grassland	Shrubland	Woodland	Wetland
Rosario	70.0	1.2	33.4	32.9	2.5	-	-
Sto. Tomas	32.4	1.0	17.7	4.3	2.6	-	6.8
Agoo	51.4	4.9	30.0	7.6	7.4	-	1.5
Aringay	122.1	3.8	29.3	31.3	28.2	16.2	13.2
Caba	48.6	1.6	15.6	18.7	12.7	-	-
Bauang	71.6	4.4	10.5	9.9	40.2	-	6.6
San Fernando	106.9	14.3	25.4	36.8	28.6	-	1.8
Total	503.0	31.2	161.9	141.5	122.2	16.2	29.9
% of total	100.0	6.2	32.2	28.1	24.3	3.2	5.9

Source: Bureau of Soils.

Development Issues and Recommendations

The issues relevant to the sustainable development of the coastal zone resources of the Lingayen Gulf area have been broadly categorized into: (1) water quality, (2) conflicting uses of marine and coastal resources, (3) socioeconomics and culture and (4) institutions/laws. Tables 6 to 9 elaborate on these issues as well as on the short- and long-term recommendations to their resolution.

Table 6. Management issues and recommendations relevant to water quality in the Lingayen Gulf area.

Specific issues	Strategies, programs and projects: Short-term	Strategies, programs and projects: Long-term
1. Siltation from the mining operations within the Baguio mining district--due to the tailings ponds which are usually washed-out during heavy rains, having the silt carried downstream and settled at ricefields and irrigation canals and/or discharged in Lingayen Gulf.	Periodic monitoring of the maintenance of tailings ponds to ensure their continued usefulness; treatment of mine tailings prior to disposal.	Accelerating the construction of San Roque multi-purpose dam to decrease mine pollution within the Agno River.
2. Accelerated erosion due to forest denudation, vegetable "truck" gardening and urban expansion in the gulf's upland watershed.	Rationalizing urban development, especially within the Baguio area, through effective land use controls and shifting cultivation in forest zones within the watersheds of rivers linked to Lingayen Gulf.	Rehabilitating disturbed area within the watershed as a result of road building. Intensifying reforestation of denuded areas within the watershed.
3. Increased urbanization within the coastal zone, especially within the Agno-Bued delta, has caused pollution to major river systems due to inadequate areawide drainage and sewerage systems.	Providing buffer zones along riverbanks where waste should not be dumped.	Assisting concerned local government units in increasing their administrative and fiscal capability to plan and implement an effective urban development program, with cost-effective waste disposal recycling as a major system component.
4. Intensified farming within the Pangasinan basin and the use of technology packages involving the use of chemicals will adversely affect water quality and salinity levels in the coastal zone. The expansion of irrigation facilities may lead to a significant diversion of freshwater from the coastal zone, resulting in the decline of fisheries production and increased salinization of lowlands.	Expanding the use of organic fertilizers for crop production; identifying environmentally sound ways of silt disposal or recycling from irrigation canals and ditches.	Preparing an environmental impact assessment for major dam and irrigation projects within the watershed of rivers linked to Lingayen Gulf.
5. Uncontrolled human activities have resulted in the deterioration of water quality in the gulf.	Promoting proper use of environmentally acceptable pesticides/chemicals; more farm testing on the use of organic and inorganic fertilizers; proper sewerage treatment and disposal; continuous water quality studies; identifying sources of pollutants.	

Table 7. Management issues and recommendations relevant to conflicting resource uses in the Lingayen Gulf coastal zone.

Specific issues	Strategies, programs and projects	
	Short-term	Long-term
1. Increased tourist arrivals in places of interest (see Fig. 6) in the gulf area may generate more wastes and cause destruction of marine resources, especially coral reefs.	Tapping local government units, hotel and tourist associations and other NGOs to help in proper waste disposal and control; regulating or banning the harvest of corals, shells and other marine products for commercial purposes.	
2. Port development may increase traffic of interisland and ocean-going vessels in the gulf and may affect water quality due to increased incidence of oil waste discharge and other ship-related wastes.	Enforcing appropriate regulations regarding dumping of ship wastes in nearshore areas; preparing contingency measures for possible oil spills from oil tankers.	
3. Conversion of swamplands and fishponds into urban uses (Agno-Bued delta), impairing their ecological value as breeding and feeding grounds for fish and other aquatic organisms.	Enforcing environmental impact assessment to future conversion of wetlands especially within the Agno-Bued delta; expanding revegetation of mangrove forests within the gulf area.	Preparing comprehensive area-wide land use considering the ecological values of natural resources within the Agno-Bued delta.
4. Overexploitation of the fisheries resources in Lingayen Gulf has resulted into low biomass/stock densities, low catch rates/income levels and increased competition/conflict between and among municipal and commercial fishermen.	Regulating fishing effort by establishing "open and closed" seasons for fishing operations and regulating the number of commercial fishing boats; providing alternative livelihood to fishermen; educating fishing communities on the effects of blast and cyanide fishing through massive multimedia approach; improving logistics for law enforcement to patrol coastal areas; building/supporting fishermen's organizations to actively participate in coastal management. Establishing a CRM council for Lingayen Gulf.	Increasing opportunity cost in other sectors of the economy.
5. Coral reef degradation has resulted in the breakdown in the reef structure, causing the decline in productivity.	Rehabilitating seagrass beds; educating fishing communities on the effects of blast and cyanide fishing through massive multimedia approach; setting up artificial habitats to remove pressure from natural reefs; replanting mangroves in affected areas to check erosion.	Initiating coral transplantation experiments.

Table 8. Socioeconomic and cultural issues relevant to sustainable development of the coastal resources of Lingayen Gulf.

	Specific issues	Strategies, programs and projects
1.	Many fishermen and other occupational groups along Lingayen Gulf overexploit the coastal resources.	Information campaign on family planning methods with feedback mechanisms to assess their effectivity; setting up employment activities other than fishing such as cottage industries, backyard agriculture, livestock raising, tourism and aquaculture.
2.	Sustenance fishermen of Lingayen Gulf generally suffer from underemployment and low income.	Setting up area-specific alternative livelihood programs as showcase/pilot projects; intensifying nonformal education programs; developing practical occupational skills; expanding credit and marketing cooperatives and associations.
3.	Cultural degradation is gradually being manifested in coastal communities.	Providing alternative livelihoods to fishermen; intensifying nonformal education programs; counteracting negative effects of media by promoting and properly developing and enriching indigenous culture; enforcing laws against illegal practices; passing *barangay* and municipal ordinances on the conduct of persons (e.g., tourists) and activities.
4.	There is low environmental awareness among the coastal populace regarding proper utilization of coastal resources.	Including environmental subjects in school curricula; multimedia campaign such as on radio, tv, posters and billboards; setting up habitat restoration projects such as artificial reefs, sanctuaries, mangrove reforestation and coral and seagrass transplantation to increase environmental awareness.

Table 9. Legal and institutional issues relevant to sustainable development of the coastal resources of Lingayen Gulf.

	Specific issues	Strategies, programs and projects
1.	Limited awareness and knowledge of CRM by the local government units concerned.	Promoting awareness and education on proper CRM at all levels of the government through trainings, community organizations, etc.
2.	Limited support from the local government units on activities related to the preservation of coastal resources.	Providing alternative livelihood assistance to fishermen, which includes an inventory of available resources in the area; support services like market and credit; and encouragement to local entrepreneurs to support fishermen.
3.	Poor implementation of existing laws and policies regarding fishing activities, particularly illegal fishing, due to lack of equal application of laws; lack of clear definition of the responsibilities of agencies (law enforcers) involved in the protection of coastal resources; and absence of facilities to protect coastal resources and to apprehend blasters.	Strictly enforcing laws and policies against illegal fishing practices; providing facilities to law enforcers to protect coastal resources.
4.	Lack of integration among agencies, resulting in overlapping of functions and programs.	Clearly defining the agencies' role, functions, jurisdiction and resources to eliminate duplication and confusion among fishermen.
5.	Absence of guidelines, laws or policies on seafarming at the national and local levels.	Piloting policies made by the local government units at the *barangay* level.

Session 2

Habitat Restoration/Enhancement and Alternative Livelihood

Artificial Reefs: A Fisheries Management Tool for Lingayen Gulf

RAMON MICLAT[a] and EVANGELINE MICLAT[b]

Miclat, R. and E. Miclat. 1989. Artificial reefs: a fisheries management tool for Lingayen Gulf, p. 109-117. *In* G. Silvestre, E. Miclat and T.-E. Chua (eds.) Towards sustainable development of the coastal resources of Lingayen Gulf, Philippines. ICLARM Conference Proceedings 17, 200 p. Philippine Council for Aquatic and Marine Research and Development, Los Baños, Laguna, and International Center for Living Aquatic Resources Management, Makati, Metro Manila, Philippines.

Abstract

One of the ways by which man responds to the various factors that impair the productivity of the coastal ecosystems is the establishment of artificial reefs. These man-made structures, regardless of the material used and when submerged in the marine environment, provide shelter, food and breeding ground to marine life. This paper gives an overview of the concept of artificial reefs, their use and potential benefits, and issues arising from their wide acceptance (in the Philippines, in general, and in Lingayen Gulf, in particular). The popularization of artificial reefs in the gulf, coupled with the absence of a government policy on these projects, raises several issues on the: (1) siting, proper use, ownership and management of artificial reefs; (2) adoption of appropriate technology in constructing, monitoring and planning; and (3) development of intersectoral coordination and linkages to avoid conflicts of interests. Major recommendations to resolve these issues are also outlined.

Introduction

Artificial reefs are man-made structures set up in the marine environment to serve as shelter, source of food and breeding ground for different fish and other organisms in the absence of a natural habitat. Though some would limit the use of the term "artificial reef" to man-made fish habitats in the marine environment, others use the same term to refer to artificial structures set up in the freshwater environment for the same purpose, but which are more commonly known as "fish attractors" or "fish hides" (locally called *rama* or *buya*).

Artificial reefs may be constructed from various materials--scrap automobile tires, old car bodies, rubble, cement or concrete blocks, PVC pipes, sunken ships and barges, and bamboos. Practically anything submerged in the aquatic environment which provides shelter and food can concentrate fish. Several factors have been documented to effect fish concentration in artificial reefs. Thigmotropism, or the desire of the fish to be close to solid objects upon first contact, may

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account for the first appearance of fish shortly after artificial reef construction (Stone 1974). The structure also serves as landmark or visual point of reference for fish when set up in a barren area (Ogden and Ebersole 1981) and as temporary shelter where fish could take cover to conserve their energy in the presence of water current. But more importantly, depending on the life span of the material used, artificial reefs provide shelter, food and breeding ground to fish.

The fish feed on the algae that have accumulated on the reef surface within the first month of installation. Newly recruited juveniles also serve as food for bigger fish which eventually settle in the reefs. Within only two months, more and larger fish rapidly colonize the artificial reefs (Miclat 1983; Barreto 1986). While some recruits establish themselves permanently and breed in the reefs, others depend on them only during certain life stages. An eight-month old artificial reef was reported to harbor a number of fish individuals and species equivalent to that of a natural reef of the same size (Stone et al. 1979). Artificial reefs were also shown to contain 10-14 times more concentration of fish than that of a natural reef with the same area (Randall 1983).

Artificial Reefs in the Philippines

In the Philippines, artificial reefs are made either of tires or bamboos (Figs. 1 and 2). The first tire artificial reef was constructed by Silliman University Marine Laboratory in Dumaguete City in 1977 to monitor fish productivity (Alcala 1979). The next year, the UP-Marine Science Center (now UP-MSI) constructed another one in Bolinao, Pangasinan, to study the succession of fish and benthic organisms (Murdy 1979). This was followed with studies conducted by BFAR-Coral Reef Research Project (CRRP) on artificial reefs as supplemental fishing ground with the establishment in 1979 of its first tire artificial reef in Caubian Island, Cebu, and in Tagbilaran City, Bohol. In 1981, the first bamboo artificial reef in the country was made by BFAR-CRRP in San Juan, Batangas. Experiments were carried out to improve the methods of construction; identify types of bottom preference; and test fishing gears to be used. These were done with visual census of fish recruitment and measurement of fish production as gauges of the efforts' success.

Due to the interest generated by artificial reefs among researchers, fishermen, sports divers and other academic and social groups, BFAR developed background materials, defining the types and uses of artificial reefs and the criteria for artificial reef establishment (see Table 1). Then, in 1986, through the joint project with the Home Improvement Tulungan Program of the Ministry of Human Settlements (MHS) Development Corporation, BFAR came up with a mimeographed manual in the Pilipino vernacular which detailed the procedures of tire and bamboo artificial reef construction, installation and costing.

To date, more than 70 small-scale artificial reefs have been established in the 12 regions of the country (Fig. 3) with the launching of a nationwide Artificial Reef Development Project (ARDP) in 1985 by BFAR-Department of Agriculture (DA) in a cooperative effort with government agencies (MHS, Na-

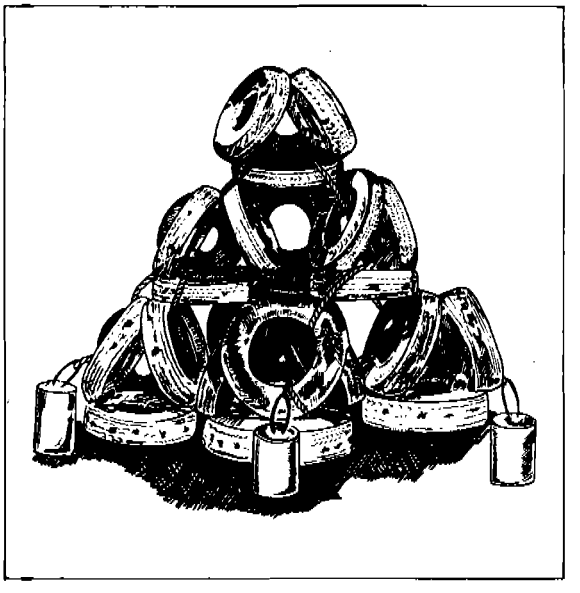

Fig. 1. A typical artificial reef tire module.

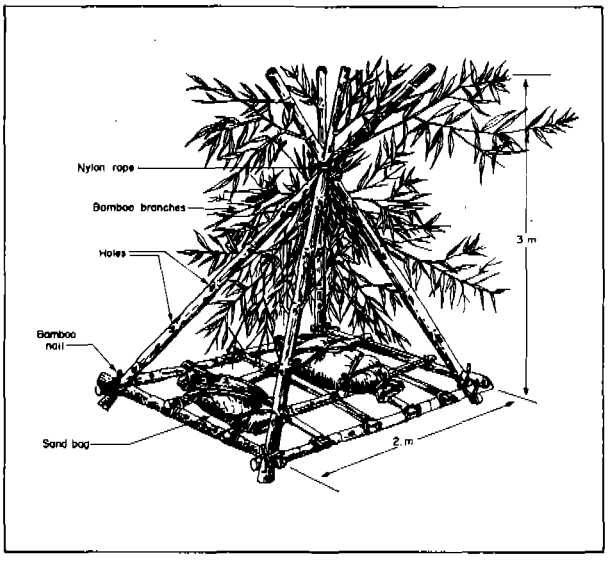

Fig. 2. Typical model of a pyramidal artificial reef bamboo module.

Table 1. Some criteria and considerations in establishing artificial reefs.

Site selection

1. Should be over 1 km away from natural reefs;
2. Should be near an alternative food source (i.e., seagrass beds);
3. Should be constructed on a barren area of flat or gently sloping bottom of relatively good visibility; and
4. Should be at depths (15-25 m) protected from wave action but still accessible to local fishermen.

Considerations

1. Community involvement is a must to ensure success; e.g., the cooperation and understanding of the local fishermen.
2. Preconstruction dialogues, lectures, orientations through slide-seminar presentations among the local fishermen should be conducted.
3. A dive team with experience in artificial reef construction can help in on-site-selection, construction of modules, monitoring and research.
4. Establishment of artificial reefs should have specific scientific standards and should not be misused just to serve as promotional gimmicks for a special interest group.
5. Artificial reef projects must be based on the right perspective and understanding of their concepts. They should be considered as habitats where fish and other valuable marine organisms may seek shelter and food. Artificial reefs are certainly not meant to replace natural reefs.

Source: BFAR-CRRP 1987.

tional Environmental Protection Council), provincial and municipal governments, civic organizations, village councils, fishermen's associations, tire companies and NGOs. Many tire or bamboo artificial reefs are planned for construction and establishment in the different regions under the revitalized artificial reef building efforts of DA. The program has a long-range objective of providing supplementary or alternative fishing grounds for sustenance fishermen in areas where natural reefs have been extensively destroyed. This concept shall also serve as an entry point for disseminating information on coastal resources conservation. It is imperative to note that these artificial reef projects are community-based, therefore, endorsed to the people. By doing so, the fishermen (as target

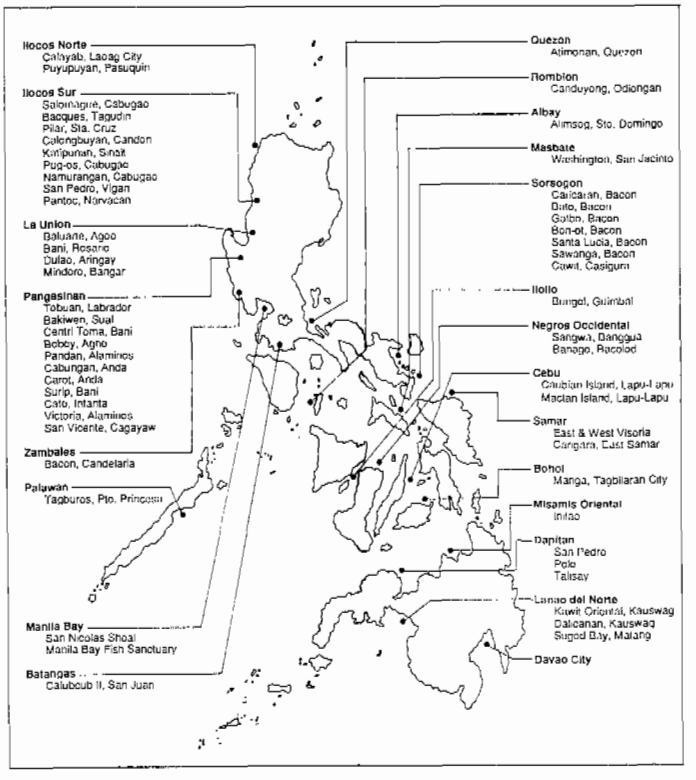

Fig. 3. Sites of the BFAR artificial reef development project.

beneficiaries) are made to realize that their direct involvement is essential in improving a dwindling fisheries resource. They are encouraged to participate in the construction, installation and repair, monitoring of progress and protection of the artificial reefs. This system also develops in them a sense of responsibility for their limited resources.

The national artificial reef program also aims to consolidate and monitor all other artificial reef building efforts [such as those of the Central Visayas Regional Project (CVRP), Silliman University, and other groups] to achieve coordinated artificial reef activities and management.

Case Studies on Benefits

Fish recruitment monitored through underwater observations and fish yields based on catch statistics measures the success of the artificial reef development. Some studies show that a bamboo reef of eight modules combined with a floating FAD or *payao* (Fig. 4) with a bottom area of 254 m^2 at 12 m depth, could yield 900 kg of fish. This catch is from a four-month fishing operation commencing one year after artificial reef establishment. The catch amounted to more than ₱11,000[c] with the cost of reef construction and maintenance placed only at ₱1,260 (Barreto 1986). Of the 88 species of fish recorded in the artificial reef, 46 were of commercial importance.

Similarly, a large-scale artificial reef of 36 tire modules (Fig. 5) with an area of about 1,500 m^2 at 20 m depth and five *payao* structures, recruited 41 commercially impor-

[c]₱21.00 = US$1.00

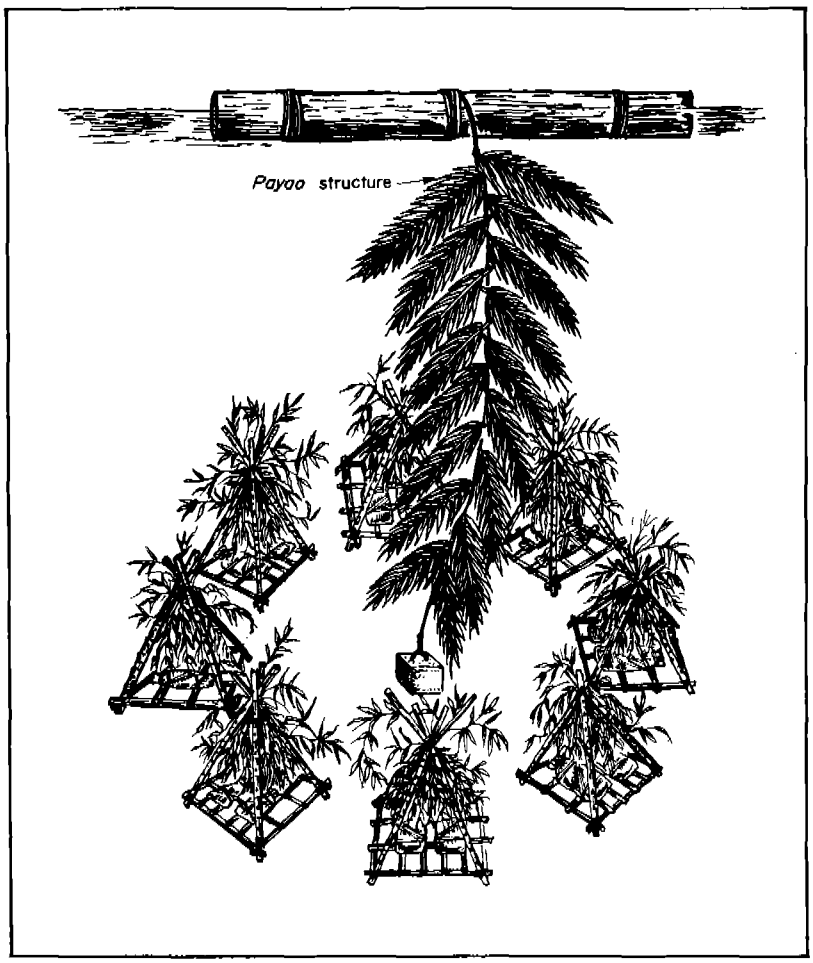

Fig. 4. Diagram of the artificial reef in Calubcub II, San Juan, Batangas.

tant species (representing 50% of the total species recorded). Catch record for one year from this artificial reef amounted to more than 800 kg with a value of approximately ₱24,000 (Miclat 1987). This did not include fish caught by sustenance fishermen from the adjacent village which were not recorded and were estimated to represent about 30% of the recorded catch. Costs of reef construction and maintenance amounted to ₱18,000.

Artificial Reefs in Lingayen Gulf

Of the more than 26 different artificial reefs constructed in Region I, 15 are located in the Lingayen Gulf area. These are in the towns of Agoo, Rosario and Aringay in La Union, and Labrador, Sual, Bani, Agno, Alaminos and Anda in Pangasinan (Table 2). The popularity of artificial reefs in the gulf was a result of the two pilot projects in Barangay Tobuan, Labrador/Sual boundary and Agoo in 1981 of the Japan Overseas Cooperation Volunteers (JOCV), BFAR Region I Office and BFAR Central Office. Kitamado (1984) reported that the area around Sual-Labrador is the most feasible site for artificial reef construction because of its gently sloping topography, sandy-muddy substrate composition and the vastness of barren bottom. The

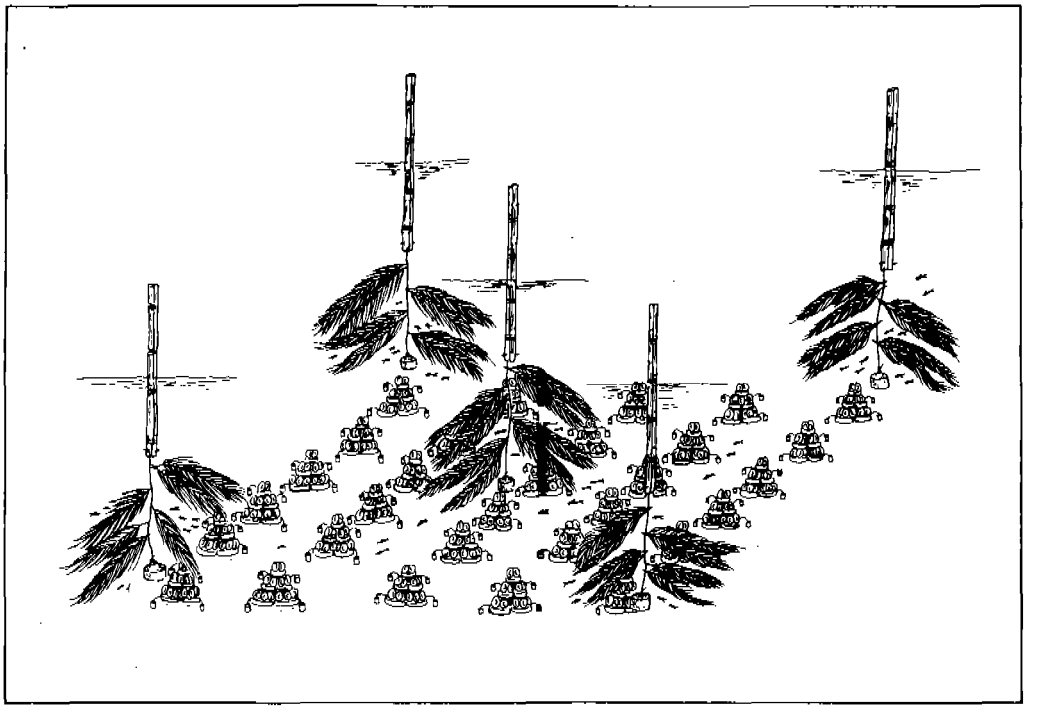

Fig. 5. Diagram of the 30-module tire artificial reef in combination with five *payao* as the site's buoy marker.

Agoo site is also recommended. Most of Region I's artificial reefs are constructed under the BFAR-MHS cooperative effort. At present, artificial reef projects in the gulf are being continued under the DA-BFAR program with complementary activities by some fishermen's associations organized by NGOs.

Issues

In view of the absence of a government policy or guideline on artificial reef projects in Lingayen Gulf (and in the country as a whole), here are the issues that have evolved which warrant immediate attention before a massive artificial reef program is implemented:

1. People are inclined to think that all artificial reefs are constructed for fishing purposes. Hence, these are at present fished uncontrollably. No distinction has been made between artificial reefs for fish catch improvement and those for habitat rehabilitation. There is a need for such distinction.
2. Some Lingayen Gulf fishermen have misused artificial reefs as they did natural reefs, by using dynamite and sodium cyanide, among other destructive fishing practices rampant in the gulf.
3. Some private sectors clamor for ownership of artificial reefs or tenureship of portions of the sea where *baklad* or fish corrals can be established. Such a misconception arises from the notion that the artificial reef is a type of fishing gear that may be owned rather than an extension of the natural resources (particularly of coral reefs) which are communal property.

Table 2. Sites of BFAR Artificial Reef Development Project (ARDP).

Site	Date of installation	Materials used	Cooperating agencies
Ilocos Norte			
1. Calayab, Laoag City	March 1986	10 tire modules (TM)	MHS, BFAR (Region I), fishermen
2. Puyupuyan, Pasuquin	February 1986	10 TM	Fishermen
Ilocos Sur			
3. Salomaque, Cabugao	December 1982	15 bamboo modules (BM)	BFAR (Region I), Japan Overseas Cooperation Volunteers (JOCV), municipal council, fishermen's association (FA)
4. Salomaque, Cabugao	December 1983	2 units midwater bamboo and tire artificial reefs	BFAR (Region I), JOCV, municipal council, FA
5. Becques, Tagudin	January 1986	7 TM	MHS, BFAR (Region I), Samahang Kabuhayan (SK/8 FAs in Ilocos Sur)
6. Pilar, Sta. Cruz	February 1986	8 TM	MHS, BFAR (Region I), SK
7. Calongbuyan, Candon	February 1986	8 TM	MHS, BFAR (Region I), SK
8. Katipunan, Sinait	June 1986	10 TM	MHS, BFAR (Region I), SK
9. Pug-os, Cabugao	June 1986	10 TM	MHS, BFAR (Region I), SK
10. Namruangan, Cabugao	June 1986	10 TM	MHS, BFAR (Region I), SK
11. San Pedro, Vigan	June 1986	9 TM	MHS, BFAR (Region I), SK
12. Pantoc, Narvacan	July 1986	8 TM	MHS, BFAR (Region I), SK
La Union			
13. Baluarte, Agoo	January 1982	800 tires	BFAR (Region I), JOCV, municipal council, FA
14. Bani, Rosario	October 1985	6 TM	MHS, *barangay* members
15. Dulao, Aringay	June 1986	10 TM	BFAR (Region I), municipal government, MHS, FA, Philippine Long Distance Telephone Co. (PLDT), Philippine Navy (PN)
16. Mindoro, Bangar	June 1986	10 TM	BFAR (Region I), municipal government, MHS, FA, PLDT, PN
Pangasinan			
17. Tobuan, Labrador	November 1981	800 tires	BFAR (Region I), JOCV, FA
18. Baquioen, Sual	November 1985	10 TM	BFAR (Region I), MHS, Young Men's Christian Action (YMCA), FA
19. Centro Toma, Bani	August 1985	6 TM	BFAR (Region I), MHS, SK
20. Boboy, Agno	October 1985	13 TM	BFAR (Region I), MHS, SK
21. Pandan, Alaminos		13 TM	BFAR (Region I), MHS, SK
22. Cabungan, Anda	January 1986	10 TM	BFAR (Region I), MHS, SK
23. Carot, Anda	January 1986	10 TM	BFAR (Region I), MHS, SK
24. Sunip, Bani	October 1985	14 TM and 1 BM	BFAR (Region I), MHS, SK
25. Cato, Infanta	June 1985	14 TM	BFAR (Region I), MHS, SK
26. Victoria, Alaminos	February 1985	300 tires	BFAR (Region I), FA, *Tambuyog* Development Center

Source: Miclat 1987.

4. The mechanics of management of the artificial reef and where that responsibility resides within a certain municipality are still unclear.
5. Siting or location of the artificial reef sometimes intervenes with other fisheries activities (e.g., milkfish fry concessions, fish corrals, baby trawl operations), thus resulting in social conflicts.
6. Lack of wide-scale information drives on concepts of the artificial reef among the coastal fishermen, municipal government officials, and planners around the gulf contributes to differences in understanding the

objectives of artificial reef projects and brings about conflicts of interest among different sectors.

7. Lack of technical know-how on artificial reef construction, site selection, monitoring and planning has resulted in the loss of artificial reef structures.
8. Linkages have yet to be developed among the different groups involved in artificial reef projects in the Lingayen Gulf area. Disparities among these groups on project implementation sometimes occur and become detrimental to the success of a coordinated reef-building effort in the gulf.

Recommendations

The above issues can be addressed by the following:

1. Two types of artificial reefs should be constructed in Lingayen Gulf - those mainly for fishing and those constructed in protected areas to induce recruitment of fish and other organisms and to contribute to habitat improvement.
2. Fisheries laws on the use of coastal resources should also apply to artificial reefs. Any form of destructive fishing method should be banned.
3. The artificial reefs should remain a communal property, just like any natural resource, for the main reason that these are established to alleviate fishing pressure on natural reefs and to augment the dwindling fish yield of the degraded coral reefs.
4. Artificial reef projects should be community-based and managed by the municipal government through a legitimate fishermen's organization, in coordination with the concerned government agency on fisheries. Every fisherman should be encouraged to join this organization.
5. The artificial reef sites within the gulf should be established outside the influence of other fisheries activities (e.g., milkfish fry concessions, baby trawl operations and fish corrals) so as to avoid social conflicts.
6. Massive information drives on CRM (including the artificial reef concept) should be conducted for the coastal folks, municipal government officials and planners concerned with the gulf.
7. Technology on the establishment of artificial reefs should follow specific scientific standards that will ensure the long life span of the structures.
8. Linkages among the concerned government agencies, NGOs and fishermen's associations must be made to have a well-coordinated and successful artificial reef development program.

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The Marine Conservation and Development Program of Silliman University as an Example for Lingayen Gulf

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White, A. 1989. The marine conservation and development program of Silliman University as an example for Lingayen Gulf, p. 119-123. *In* G. Silvestre, E. Miclat and T.-E. Chua (eds.) Towards sustainable development of the coastal resources of Lingayen Gulf, Philippines. ICLARM Conference Proceedings 17, 200 p. Philippine Council for Aquatic and Marine Research and Development, Los Baños, Laguna, and International Center for Living Aquatic Resources Management, Makati, Metro Manila, Philippines.

Abstract

The Marine Conservation and Development Program (MCDP) of Silliman University was initiated in 1984 with the primary goal of organizing community-based marine management programs for three island villages in the Visayan region. This paper provides an overview of the program, the implementation strategies utilized and the results obtained. The positive results attained, which have persisted after the two-year project life span, emphasize the significance of education and community organization/involvement in the development of successful marine resources management programs in the Philippine context. Lessons and/or generalizations from the MCDP experience are drawn, and the potential utility/applicability of such approaches in the Lingayen Gulf area are explored. The need for relatively immediate and tangible benefits for communities/participants involved in the management effort has been identified as an essential element for success.

Introduction

This paper is derived from previous publications on MCDP of Silliman University by White (1988) and by White and Savina (1987a). The background and implementation strategies are a précis of the article on the same topic that appeared in White et al. (1986). These are collated and presented herein to provide plausible approaches towards improved management of the Lingayen Gulf coastal zone.

The MCDP of Silliman University was intended to enable three island communities to protect and improve their marine resources. The sites were Apo Island, Negros, and Pamilacan and Balicasag Islands, Bohol, in the Visayas (Fig. 1).

Similar to the resource-use problems in Lingayen Gulf, destruction of coral reef habitats, overfishing and a consequent decline in fish catches are serious problems affecting small-scale fishermen throughout the Visayas. The households on Apo (88), Pamilacan (168) and Balicasag (62) were no exception in experiencing these problems. The approach taken by MCDP was that resources

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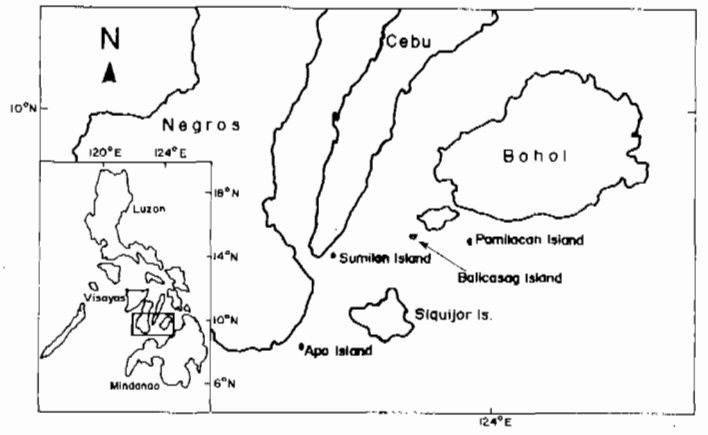

Fig. 1. Projected island sites in the Visayas, Philippines.

management must be based in local communities and that these needed to address their problems directly. It was thought that resources cannot be protected or managed on a sustainable basis unless those who exploit them are committed to this goal and involved in the management process. Thus, MCDP focused on education, and community organization and involvement as a means to marine resources management.

The general objectives of MCDP included (1) institutional development at Silliman University; (2) implementation of marine resources management programs at the three sites; (3) community development programs to establish working groups of local people for accomplishing marine resources management; (4) a small agroforestry and water development project; and (5) an outreach and replication project to extend programs to neighboring fishing communities.

The MCDP was implemented by a project team based in the Biology Department of Silliman University. This team consisted of co-directors from the Departments of Social Work and Biology, a general coordinator from the University Research Center, and technical inputs from Silliman University Marine Laboratory. There were two full-time consultants, a resources manager and an anthropologist, while the core of the project was composed of five full-time community development workers stationed three weeks a month on the islands.

Implementation Strategies

There were five general steps in the implementation process which were not necessarily chronological, but rather overlapping and ongoing, during the process.

Integration into the Community

During the first three months, the field workers moved into the community, introduced the project, met with community leaders, attended meetings and generally became accustomed to the island situation. Baseline data collection during this period included socioeconomic and demographic surveys; a pretest of environmental and resource knowledge and perceived problems of local people; and an environmental survey to document the status of coral reefs and the diversity and abundances of reef fish. This was accomplished so that changes in the reef quality as a result of management efforts could be noted.

Education

The focus of education was on marine ecology and resources management. It was mostly nonformal, done in small groups with an occasional formal presentation using slides, posters or other visuals in a semi-lecture format. Local people were involved in the education process by drawing on their

special knowledge. As some people learned, their assistance was solicited in making presentations to less informed groups.

Core Group Building

The crux of MCDP was the formation of marine management committees at each of the island sites. It was assumed that the only effective resources management would originate from the communities themselves.

The core groups grew out of many activities supported by the project. For example, special work groups emerged for the construction of community education centers at each site which turned out to be supportive of the larger program. The *barangay* structure provided initial organization for the core groups, but with time, individuals emerged who were more interested and motivated to achieve marine resources management. As the residents identified their main management problems, the concept of a marine reserve began to emerge as one possibility. As this concept became a reality, a group emerged which was willing to take on the responsibility of implementation with the support of the community. This group, i.e., the marine management committee, then became involved in the drafting of a municipal ordinance which would set up the marine reserves (with a sanctuary) on one part of the island.

An important lesson in the process was that the act of doing physical activities (such as building the community center) was critical in solidifying the working groups which later managed the marine reserves.

Formalizing Organizations

Formal recognition of the newly formed marine management committees was necessary to permanently establish their existence. The accomplishment of various tasks gave positive feedback to the community and helped in the recognition of the core groups. When marine reserves began to function and some benefits were noted by the community (like repelling illegal fishers), the communities were supportive. Inauguration ceremonies for completed projects were also important to give status to physical achievements.

New opportunities for projects provided added incentives for the continuation of working groups. Examples were: (1) placing giant clams in the fish sanctuary areas of all three islands; (2) refining the marine reserve guidelines into legal documents; (3) training marine management committee members in the guiding of scuba and snorkeling tourists to the sites, and in collecting fees for the use of facilities; and (4) initiating alternative income schemes such as mat weaving and sea cucumber mariculture and marketing.

Strengthening Organizations

This step came after the original two-year implementation period for the project. This involved more subtle forms of recognition by the visitors to the project sites who were genuinely enthusiastic about the marine reserves and the condition of the coral reefs. One form of this recognition came from other similar projects. For instance, the Central Visayas Rural Project (CVRP) used several MCDP sites to train their field workers and drew on the knowledge and experience of marine management committees. A marketing cooperative also grew out of the marine management committees on Apo Island, which has been reinforced by visitors who buy locally woven mats.

The ingredients of the five steps are quite particular to the local situation. They can nevertheless be generalized as above to point out the main considerations in designing a community development program with goals similar to MCDP.

Field Results

At the end of the two-year program, the original goals of MCDP were met. There were functioning marine reserves on each of the three islands which were being managed entirely by the community. The question remained, however, whether this could last,

given the outside pressures on these communities and the vagaries of politics in the Philippines.

The author was able to visit the sites again in May 1988. At that time, it was observed that the marine reserves were still demarcated by buoys and signs. The marine management committees were intact, although with different officers at two sites. Municipal ordinances, as written and approved in 1985, were being enforced. The community education centers were being used for meetings of marine management committees and in the case of Apo Island, the center was being rented to tourists for overnight stays on the island. On Apo and Balicasag Islands, diving tourism increased because the sanctuaries were luring divers looking for healthy reefs with dense fish populations.

Baseline data on the diversity and abundance of fish in the sanctuaries were compared with new data collected in late 1986. The changes reported by White (1988) show that the abundance of fish censused over the study period increased 173% for Apo, 89% for Pamilacan and 45% for Balicasag. There was also an absolute increase in the mean number of species at each site. The quality of benthic habitats at the islands was either maintained or slightly improved. Residents on each island reported that their fish yields had improved or at least maintained at the high levels documented during the project. Apo Island, for example, was shown to have a reef yield of 31.8 t/km^2/year (White and Savina 1987b).

Lessons for Lingayen Gulf

The islands in western Lingayen Gulf are fringed with coral reefs which provide livelihood for many of the local residents. The problems of overfishing, coral habitat destruction and the general decline of coralline resources are all present and getting worse. The lack of resource maintenance and the overuse of the fisheries are problems of the "commons" where too many people depend on a dwindling resource. The people's natural reaction to this situation is to get whatever resources they can while these last. Thus, there is increasing blast fishing and use of small-meshed nets. What is the solution? The MCDP may offer some insights.

The MCDP has shown that it is possible to organize local communities to manage their own coral reef resources, and that they will continue to do so if they derive benefits from this activity. The people on the islands saw some immediate results from their efforts in the form of structures, increasing fish abundance and outside recognition among others, and have continued to perceive benefits. Thus, only observable results can sustain such a program. In Lingayen Gulf, people have the same needs but they would have to be organized to begin similar management efforts.

Small islands provide some advantages to marine resources management efforts because resources are more accessible to the residents and less so to outsiders. This provides an incentive for the residents to manage their own area for their own use and advantage. This is a form of ownership which was legalized by the municipal ordinances designed by MCDP. In Lingayen Gulf, the situation is more complicated because the islands are not isolated; and each has many barrios which overlap in their use of the coral reef areas. This could be dealt with by studying which areas are exploited by the different barrios so that agreements could be made on jurisdiction of particular areas and resources.

Baseline data in the case of MCDP were used as an educational tool to illustrate to residents the condition of their environment and to reinforce their marine management committees. The extensive data collection by the ASEAN-US CRMP in Lingayen can also be used to advantage by sharing this with the local people, and showing them changes as a result of their actions. The collection can also be used to show how bad the situation is in their areas as compared to other parts of the Philippines. MCDP did this for fish yields among the islands.

The formation of respected community groups was essential for MCDP. The marine management committees were critical in the process of generating support from the wider

community. This lesson should be closely considered in Lingayen Gulf since it is certain that "notoriously-respected" groups are drawing the communities in the area away from marine conservation. A management strategy will need to consider how conservation-oriented groups can begin to gain respect. This will happen if they have good arguments and can show immediate and substantial results as in MCDP.

A last lesson of importance is the need for linkages among all participants--community leaders, mayors and their councils, local law enforcement officers, private business and national government organizations. The MCDP was able to facilitate these linkages from Silliman University which has a permanent status in the local community. The Marine Laboratory of Silliman University has continued to play a role in this process by periodically visiting the islands and encouraging the management efforts. Lingayen needs a similar model whereby some local institutions can serve as a catalyst in the implementation process and longer-term maintenance of local resources management.

Conclusion

There are no simple answers on how to organize local fishermen and residents to manage their own resources. Nevertheless, it has been shown that it is possible on small islands where the coral reef resources are still relatively intact. The solution entails much more than law enforcement since wide community support is necessary for success. This support will only be generated if some immediate benefits accrue to the community. Education may help people understand why management is necessary and may help initiate their participation. But only results will sustain a program. Rural people, who live close to their environment and source of livelihood, will sense and respect those results when they are attained. These people will also strive to maintain and manage their resources if given a chance to do so.

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Mariculture as an Alternative Source of Livelihood for Sustenance Fishermen in Lingayen Gulf

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Palma, A., R. Legasto and J. Paw. 1989. Mariculture as an alternative source of livelihood for sustenance fishermen in Lingayen Gulf, p. 125-132. *In* G. Silvestre, E. Miclat and T.-E. Chua (eds.) Towards sustainable development of coastal resources of Lingayen Gulf, Philippines. ICLARM Conference Proceedings 17, 200 p. Philippine Council for Aquatic and Marine Research and Development, Los Baños, Laguna, and International Center for Living Aquatic Resources Management, Makati, Metro Manila, Philippines.

Abstract

In general, mariculture is a relatively new activity in the Philippines, especially in Lingayen Gulf. Although mollusk culture has been practised for many years in several areas of the country, other mariculture practices such as finfish cage and seaweeds culture are relatively recent developments. This paper gives an overview of existing mariculture practices in the Philippines and presents an exploratory discussion on the potential of mariculture in Lingayen Gulf as an alternative source of livelihood for the sustenance fishermen. Potential mariculture activities include cage culture of finfish and mollusk and seaweeds farming. Constraints and management issues affecting mariculture development such as site selection, pollution, capital investment and technology transfer are briefly discussed.

Introduction

Fishing has always been a major economic activity in the Philippines (Samson 1985). Production from marine capture fisheries was 1.3 million t in 1985 with municipal fisheries contributing about 60% of the total catch (BFAR 1986). In Lingayen Gulf, municipal landings was 8,900 t in 1985 constituting 26% of the total marine catch in the area. As an economic sector, municipal or small-scale fisheries is a large employer compared to the commercial sector. However, most of those in the municipal sector are sustenance fishermen.

In the Philippines, coastal aquaculture (which comprises brackishwater pond culture and mariculture) has been rapidly developing, especially in the last decade (Rabanal 1986). Brackishwater pond culture of milkfish and shrimp is the predominant culture practice in many parts of the country (Camacho and Bagarinao 1986). Mariculture of mollusks, on the other hand, ranked second to pond culture as the most widely adopted culture practice. However, in terms of production, seaweeds

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ranked second to pond culture. Total aquaculture production in the country in 1985 was 494,700 t. Approximately 95% of this comes from coastal aquaculture. In the Lingayen Gulf area, brackishwater pond culture production was 19,500 t in 1985. Majority of the fishfarms practice milkfish monoculture (see Palma, this vol.).

Lingayen Gulf is a rich fishing ground. However, there has been a slight decline in production from municipal fisheries in recent years. This is possibly due to depletion of fish stocks caused by intensive exploitation (McManus and Chua, in press). Apart from this, there has been increasing conflict with trawlers which frequently encroach on the traditional fishing grounds of artisanal fishermen. There have been previous attempts to improve the plight of sustenance fishermen such as modernization of fishing gears and motorization of fishing boats through credit schemes, but these have aggravated the resource situation and competition among fishermen. Clearly, there is a need to alleviate the conditions of the artisanal fishermen by reducing fishing pressure through alternative livelihood such as mariculture. This paper explores this possibility in the Lingayen Gulf area.

Mariculture

Mariculture is defined as the managed cultivation of aquatic species in coastal waters (Hansen et al. 1981). It takes advantage of the natural features in the coastal zone such as protected coves, bays, inlets, estuaries, reef flats and lagoons. Farming areas may extend horizontally from the shore to the sublittoral zone, and vertically from the water surface down to the seabed. Site selection depends on the degree of environmental control desired, the type of culture system and the species to be cultivated. Species cultivated in the Philippines include groupers, sea bass, snappers, siganids, oysters, mussels and seaweeds like *Eucheuma*, *Gracilaria* and *Caulerpa* (Trono and Ganzon-Fortes 1983; Cordero 1984; Rabanal 1986; Beveridge 1987; Fortes 1987; and Juntarashote et al. 1987). Except for *Eucheuma*, most of these are cultured in protected or semiprotected environments.

The most common finfish cultured are groupers and sea bass for the export market and prime local outlets (e.g., restaurants). These are reared in wooden net cages moored close to the shore in coves and bays in several areas of the country. Hatchery of sea bass and grouper is relatively new such that most of the seed stocks are caught from the wild. In Lingayen Gulf, there are small-scale net cage operations that raise groupers and snappers in Sual, Pangasinan. Snappers are cultured as a side species and marketed locally. Elsewhere, such as in Iloilo, Cavite, Bulacan and Davao, groupers and sea bass are reared as broodstock for hatchery operations and to some extent as food fish. Fry caught from the wild are also stocked but reared only to juvenile stage for subsequent export to Hong Kong and Taiwan. Other species of fish like siganids and milkfish are also being reared in net cages but these operations are generally experimental or pilot in nature. The bulk of milkfish production still comes from pond culture. In Lingayen Gulf, siganids are cultured in net cages as well as in ponds. However, production is low and marketed locally. Commercial ventures in cage culture of groupers and sea bass are as yet limited although the market potential is vast considering the demand for juveniles and table fish from Hong Kong, Taiwan and Japan.

Although production of cultured fish in cages (especially groupers and sea bass) is increasing, no production statistics are presently available. This is largely due to the recent development of marine cage culture as compared to its freshwater counterpart. Mariculture of crustaceans (e.g., penaeids) is still experimental and takes the form of nursery and broodstock rearing in net cages. However, nursery rearing has been practised in commercial scale in some areas in Central Philippines (Beveridge 1987). Lobsters, on the other hand, are presently being stocked in net cages for fattening purposes prior to marketing.

The culture of oysters and mussels has been practised for many years in several areas in the Philippines notably northern Panay Is-

land, Negros Occidental, Cavite and Pangasinan (Young and Serna 1982). Production of oysters in 1986 was 16,500 t while that of mussels was 12,100 t (Juntarashote et al. 1987). Production is largely for domestic consumption as attempts to export these products are plagued by problems of microbial contamination (Palpal-latoc et al. 1986). Major constraints in the expansion of mollusk culture, especially for the export market are poor coastal water quality (including the occurrence of red tides) and improper culture and postharvest techniques (Juntarashote et al. 1987). The culture of mollusks relies solely on natural spat fall and using bamboo stakes or rafts for growout. The raft method gives higher productivity per unit area and lessens silt contamination. It is, however, more capital-intensive than the stake method. Culture period is from six to eight months. Culture of bivalves is established in about 17 provinces in the country (Young and Serna 1982). Recent reviews on the status of mollusk culture in the Philippines include those by Young (1987) and Juntarashote et al. (1987).

Seaweed culture is rather restricted to certain areas in the country. There are about six provinces with substantial mariculture production of seaweeds. Bohol in Central Philippines is the major producer (Trono and Ganzon-Fortes 1983 and Cordero 1984). This is partly due to the establishment in the province of Marine Colloids, Inc. which is the leading producer and exporter of *Eucheuma* in the country. The company also exports processed seaweeds in powder form. While most species of seaweeds cultured in the country are for human consumption (such as *Gracilaria* and *Caulerpa*), *Eucheuma* spp. are generally cultured for the production of carrageenan for use in the food and pharmaceutical industries (Hansen et al. 1981). Mariculture production of seaweeds in 1986 was 15,600 t largely consisting of *Eucheuma* (BFAR 1986).

Caulerpa spp. are being cultured mainly in Mactan Island, Cebu. The seaweeds are cultured in impounded natural hollows situated along the rocky coastlines of the island (Cordero 1984). Although a large portion of the production is marketed locally, there have been occasional exports to Japan. The product is frequently dehydrated with salt and then rehydrated in seawater upon reaching the market in Japan. So far, attempts at commercial culture of *Caulerpa* in other areas of the country have not been successful.

Gracilaria culture is generally a side activity and production is seasonal. No commercial venture has been attempted as of the present time.

A summary of some mariculture practices in the Philippines is shown in Table 1. Recent reviews of the status of coastal aquaculture in the Philippines are given by MacIntosh (1982), Rabanal (1986) and RAPA (1986).

Mariculture Potential of Lingayen Gulf

Lingayen Gulf has an area of 2,100 km^2 (Mines 1986). On the Pangasinan side of the gulf, there are several estuaries and many sheltered coastal water bodies due to the presence of rivers like Patalan (Bued), Dagupan and Agno, and islands like Santiago, Cabarruyan and Hundred Islands. Coral reefs are also extensive, especially towards the western part off Bolinao. Such coastal features, particularly along Pangasinan, are very suitable for mariculture activities. In addition, the gulf has relatively abundant fry of many commercially important species like groupers, siganids and milkfish (Mines 1986; McManus and Chua, in press). The area is also a good source of marine aquarium fish which, unfortunately, are generally caught using cyanide. Among the possible mariculture activities in Lingayen Gulf are mollusk farming, net cage culture of finfish and seaweed culture.

Mollusk Culture

The estuaries of Agno River, specifically the areas along Manal in Binmaley district, Dawel in Dagupan City, Tambac Bay, Lucap Bay and Caquiputan Channel have been identified as natural grounds for oyster (Glude et al. 1982). Other species of mollusks like abalone and giant clam (*Tridacna*) are

Table 1. Mariculture methods practised in the Philippines.

Type of mariculture	Advantages	Disadvantages	Method	Description
Mollusk				
On-bottom	Low capital input; easy to prepare and construct.	Susceptible to crawling predators, siltation and poor water circulation. These problems are especially acute for the stake method.	Stake	Use of bamboo or trunks of trees as stakes in the intertidal and sublittoral zones. Spat settle on the surface and are allowed to grow to marketable sizes before being harvested.
			Wigwam	Variation of the stake method where 7-10 poles of bamboo are staked in a 2-m radius from a central pole and arranged like a wigwam.
			Broadcast	Uses boulders or logs placed on firm bottom where spat are allowed to settle and grow. Harvesting is done by divers.
Off-bottom	Hanging method results in higher productivity per unit area as compared to on-bottom culture practices; minimal problems with respect to crawling predators and siltation.	High capital input	Hanging	Horizontal bamboo poles are supported with posts where wires or or strings with oyster or mussel shells are suspended. The empty shells serve as spat collectors. Spat are allowed to settle and grow until marketable size is attained. For mussel, thinning can be done or even transplanting to other areas where primary productivity is higher.
			Tray	Usually made of bamboo trays (1.5 m x 1 m) with 15 cm diameter supports to hold the collectors. Oysters are reared with this type of method. Oyster seeds are left in tray and allowed to grow to marketable size.
			Long line	Clutch consists of a long line of threaded empty shells held apart by tubes 12-15 cm long. The lines are strung parallel to each other and spaced about 20 cm apart.
			Raft	Strings of threaded oyster shells or coconut shells are suspended in a 4 m x 4 m floating bamboo raft. The strings are parallel to each other and spaced 0.5 m apart.

Finfish	Species cultured are generally with high market value like groupers and snappers. Easily relocated to better site when inclemental weather or poor water quality (e.g., pollution) becomes a problem. Minimal problems with undesirable species unlike in ponds.	Periodic cleaning of nets is necessary to ensure proper water exchange and remove biofoulers. Trash feeds are expensive. Nets, frames and floats need replacement or repair after a few years (commonly two years) of operation.	Floating cages	These are nylon net cages with sizes ranging from 1-4 m^2 by 1-3 m deep. Several net cages are set in a wooden frame and provided with floats (styrofoam or empty fuel drums). Total farm size is generally less than 1,000 m^2.
Seaweeds			Bottom culture	Cuttings of seaweeds (*Eucheuma*) are attached to the corals and arranged on the bottom into plots of uniform sizes.
			Raft	2.5 m x 5 m monofilament netting materials (30 cm mesh size) are used and set on 6 m x 6 m bamboo rafts where cuttings (50-100 g) are tied at the mesh intersections. The raft is anchored to the bottom.
			Fixed off-bottom	A monofilament net is horizontally attached and tied to bamboo or wooden poles (with 2 or 3 poles as support). One module usually consists of 200 nets.
			Monoline	A nylon string (about 10 m) is secured across 3 wooden or bamboo poles. Cuttings are tied to the string. About 35 cuttings per string are set at about 20-25 cm above sea bottom. Each monoline is set parallel to the others spaced 1 m apart. This method is the most widely practised at present due to lower capital cost and easy maintenance compared to other methods for the culture of *Eucheuma*. Predator problem is minimal.
			Coastal enclosures	This is practised mainly in Mactan Island for the culture of *Caulerpa*. Natural hollows of limestone along the coast are converted into ponds by embankment. Sluice gates and canals are constructed to provide water exchange. These enclosures are seldom completely drainable.

not cultured presently although the potential exists in the hard bottom areas of Pangasinan. Giant clam is under experimental culture by UP-MSI in Bolinao. Mussel culture is presently non-existent in the gulf area.

In Pangasinan, oyster farms cover an aggregate area of 38 ha consisting of an estimated 600 operators (BFAR 1987). These are concentrated along the Dagupan-Binmaley area where several river channels provide favorable salinity, nutrient supply and natural food suitable for oyster growth. The farms are generally small, with an average area of slightly over 100 m^2. The main species cultured is *Crassostrea iredalei*. Hanging or *bitin* method using bamboo poles and polyethylene ropes is the most common culture method. Five to twelve oyster hanging lines produce one kerosene can (equivalent to 1 l) of marketable oysters sold at ₱22-25[c] per can. Culture period lasts from three to four months.

Oyster farmers are either full-time operators or part-time fishermen. In the latter case, oyster farming provides supplementary income to fishing which is the main source of livelihood.

Potential areas for expansion of oyster culture are some 4,000 ha in Tambac Bay, Lucap Bay and Caquiputan Channel (Glude et al. 1982). Pilot oyster farms have been established by BFAR in these localities. Sual Bay can also be tapped for oyster farming but would require spat transplantation since the area has no natural spat fall. The potential areas identified are located near or within the economically depressed fishing communities. Thus, the development of oyster farming in these areas can contribute to the upliftment of the economic conditions in these fishing communities.

Cage Culture

The cage culture of fish in Lingayen Gulf is a recent development, mostly undertaken by the private sector. There are three medium-scale operations located in Buenlag in Binmaley district, Mangas Cove in Sual and Salapingao near Dagupan City. Cages are both of the floating and fixed types consisting of nursery cages measuring 1 x 1 x 1-1.5 m and grow-out cages with double nettings measuring 2 x 2 x 1-2.5 m. The cages are set in wooden frames which serve as catwalk and working area. Species cultured are siganids, groupers and snappers. There is no venture of rearing aquarium fish in cages in the gulf area. Siganid fry or *padas* are abundant in the gulf and are generally caught using fine-meshed nets. The *padas* are used for the manufacture of fish paste and dried fish (Calvelo and Giñon 1974).

Municipal fishermen are the suppliers of fry for ongoing cage culture activities in the gulf. The price of a grouper fingerling (about 5 cm in length) is about ₱1.20/pc., while snappers and siganids fetch ₱0.25/pc. and ₱0.15/pc., respectively. Fry abundance is seasonal and supply at present does not meet the demand as some of the fry are imported by operators from other provinces. As mentioned earlier, siganids are largely cultured in ponds. Cage culture of siganids is presently very marginal in terms of production.

Management of the cages is of the modular type. Stocks are kept in one cage for a period of up to one month depending on the size at stocking. Size grading is done at least once every two weeks to minimize cannibalism. Growout period is six months for siganids and snappers, and up to eight months for groupers. Some of the groupers are harvested after one or two months stocking for export to Taiwan. However, most of the stocks are reared to marketable size ranging from 500 g to 1 kg.

In the Salapingao area, there are a number of small-scale net cage operations aside from the existing medium-scale venture. Two fishermen-families have set up two units of net cages. Others have established nursery cages to rear groupers and snappers from fry to juvenile stage for sale at higher prices.

Farming of Seaweeds and Other Species

Although seaweeds (especially *Eucheuma*) are found in Lingayen Gulf, stocks are not

[c]1988: ₱21.00 = US$1.00

sufficient to allow commercially viable ventures. Most of the stocks had been overexploited in the past and have not recovered until now. Transplantation is a key towards seaweed farming in order to augment current stocks. However, these are still under experimental studies by various government institutions such as UP-MSI and BFAR (McManus and Chua, in press). Cultivation of invertebrates like abalone and sea cucumber has not been attempted, although the market exists especially for export. At present, these are harvested from the wild.

Constraints and Management Issues

The development of mariculture in the Lingayen Gulf area is potentially viable and would greatly benefit subsistence fishermen. However, several constraints hamper accelerated mariculture development in the potential sites.

1. Pollution. The Pangasinan portion of the gulf is densely populated. Most of the untreated domestic wastes especially from Dagupan City are being discharged directly into the gulf. Moreover, agricultural runoffs and mine tailings from the mining district of Benguet may be contaminating the gulf with pesticides, nutrients, heavy metals and silt. High bacterial coliform counts had been detected in oysters harvested near the Dagupan-Binmaley areas. Continued discharge of pollutants into the gulf will greatly affect the development of mariculture in the area Such situation will render oysters and finfish unfit for human consumption in the future. There is thus a need to control the discharge of waste into the gulf without prior treatment.

2. High capital investment. Mariculture activities such as cage culture is relatively capital intensive. In order to stimulate mariculture development among subsistence fishermen, some form of financing scheme must be provided either on concessional credit terms or through cooperative ventures involving material input instead of cash.

3. Transfer of technology. At present, various mariculture technologies have not been packaged properly for dissemination to end users. Lack of trained manpower to serve as extension personnel as well as availability of sufficient funds for extension work hampers dissemination of mariculture technology. There is also a need to establish pilot mariculture projects to showcase appropriate technology and provide skills training to fishermen.

4. Site selection. There is a need to properly evaluate potential sites for mariculture activities. At present, most of the potential sites remain unsurveyed. There is also a need to assess potential mariculture sites in terms of legal and institutional aspects. Possible schemes whereby subsistence fishermen can be provided with practical tenurial systems to be able to establish mariculture farms need consideration.

5. Availability of fry and feeds. Abundance of finfish fry for cage culture fluctuates seasonally. Moreover, wild fry production is not sufficient to meet the demand for cage culture both locally and abroad. There is a need for research on hatchery production of finfish fry like groupers, snappers and siganids. So far, these are still experimental. Similarly, low-cost formulated feeds need to be studied. Relatively low-valued fish (trash fish) are presently used to feed groupers and snappers. These, however, are becoming expensive and their supply may not keep up with demand since they are also consumed by the coastal population.

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Mariculture Potential of Giant Clams and Sea Urchins in the Lingayen Gulf Area

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Trinidad-Roa, M.J. 1989. Mariculture potential of giant clams and sea urchins in the Lingayen Gulf area, p. 133-137. *In* G. Silvestre, E. Miclat, and T.-E. Chua (eds.) Towards sustainable development of the coastal resources of Lingayen Gulf, Philippines. ICLARM Conference Proceedings 17, 200 p. Philippine Council for Aquatic and Marine Research and Development, Los Baños, Laguna, and International Center for Living Aquatic Resources Management, Makati, Metro Manila, Philippines.

Abstract

Sea urchins and giant clams are among the most intensively exploited invertebrates in the Lingayen Gulf area. Sea urchins are collected for their gonads, and giant clams, for their meat and shell. The threat of local extinction of commercially important species and the urgent need for alternative sources of food and income in the gulf area provide impetus for the enhancement of mariculture activities of these species/groups. This paper presents an overview of current giant clam and sea urchin mariculture technologies, their availability, potential applicability in the Lingayen Gulf area, and recommendations towards accelerated realization of this potential. Recommendations center around the need to (1) address the issue of territorial use rights; (2) enhance extension/education effort to increase awareness and strengthen local sociopolitical structures; and (3) refine available technology (using local species/strains) under local conditions toward improved production levels.

Introduction

Sea urchins and giant clams are among the most extensively exploited invertebrates in the Lingayen Gulf area. Sea urchins (locally known as *kuden-kuden, santol-santolan* or *tuyon*) are collected for their gonads. Occasionally consumed locally, most of the sea urchin catch is exported to Japan where it is an expensive delicacy called *uni*. In the Philippines, the chinoid species preferred is *Tripneustes gratilla (shirahige uni)*, although *Diadema setosum* and *Echinothrix diadema* are also used if *T. gratilla* is not available. On the other hand, all seven species of giant clams (locally called *taklobo, kima,* or *saliot*), viz. *Tridacna gigas, T. derasa, T. squamosa, T. maxima, T. crocea, Hippopus porcellanus* and *H. hippopus,* are harvested for both meat and shells. The larger species *(T. gigas, T. derasa, T. squamosa, H. porcellanus* and *H. hippopus)* are more highly prized. Clam meat is largely for local consumption. The shells are used in the shellcraft industry and in the collectors' trade.

Management of sea urchin and giant clam resources, particularly in Lingayen Gulf, is virtually non-existent. Although a ban exists

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on the exportation of giant clam products, gathering for local consumption continues at a high rate. Clam meat cannot be legally shipped out of the country, although giant clam shells are exported as finished shellcraft products and collectors' items. In the case of sea urchin collection, no regulation appears to govern it. Hence, the only factors that control their harvest are the demands of buyers, availability of preservatives for the gonads and vagaries of the weather. If the current exploitation trend of these resources continues, it is conceivable that widespread local extinction will take place, as has already occurred for the larger species of giant clams (Alcala 1986; Juinio et al. 1986). In order to restock depleted reefs and provide the required levels of production, as well as alternative sources of food and livelihood for coastal inhabitants, mariculture of these species has become essential in conjunction with proper management.

Sea Urchin and Giant Clam Mariculture

Sea Urchins

Sea urchins have been among the most extensively used animals for embryological studies (Tyler and Tyler 1966). Since the early 1800s, sea urchin eggs and sperms have been used to elucidate the processes of fertilization and early development (Hinegardner 1969). Thus, a number of species have been examined and reared under laboratory conditions (see Aiyar 1934; Caces-Borja 1956; and Sato, in press). Matsui (1968) was among the first to suggest the use of raft-type methods for mariculture of sea urchin. Culture and propagation, however, have not yet been done on a large scale.

Supplementary food in the form of unicellular algae is essential for rearing the larvae. Larval food requirements are said to vary with sea urchin species (Hinegardner 1969). Sato (in press) reported *Chaetoceros gracilis* to be the most suitable for five species cultured in Japan. Regulation of temperature and salinity, as well as maintenance of a certain amount of stirring or agitation (to keep larvae suspended in the water column) is required for successful rearing to juvenile stages (Hinegardner 1969; Rupp 1973; Sato 1987).

In the Philippines, sea urchin (*Tripneustes gratilla*) culture is currently being attempted at the UP-MSI laboratory in Bolinao, Pangasinan. Successful trial spawnings have already been undertaken using simple methods of spawning induction (such as exposure to air, increased water and air temperatures and agitation of the urchins). Based on culture studies conducted in Japan, there are no insurmountable technological problems involved in sea urchin culture. The broodstock is easy to acquire and handle; spawning induction involves simple methods; and mature eggs and sperms are easily obtained without problems of self-fertilization because the sexes are separate. Ongoing population studies indicate that *T. gratilla* are fast-growing and attain sexual maturity at about 6 cm diameter (i.e., 15 months). What is needed, though, is to modify these techniques to suit local conditions (e.g., sea urchin species, materials and culture facilities available) especially in terms of scaling up operations to suit mass culture requirements.

Giant Clams

La Barbera (1975) and Jameson (1976) were the first to rear giant clams to the juvenile stage. Since that breakthrough, all the tridacnid species have been successfully cultured (Beckvar 1981; Fitt et al. 1984; Crawford et al. 1986; Murakoshi 1986; Alcazar et al. 1987). However, the only large-scale commercial production of giant clams at present is at the Micronesian Mariculture Demonstration Center in Palau, Caroline Islands (Heslinga and Perron 1982; Heslinga and Watson 1985). The methods of Heslinga et al. (1984) rely on (1) large numbers of broodstock for natural spawning; (2) low larval stocking densities; (3) feeding with natural phytoplankton from unfiltered seawater; (4) postlarval culture in shallow, outdoor raceways; and (5) growout in ocean

nurseries. The use of serotonin and/or macerated gonads or gonad extracts to induce spawning in all species, as well as determination of gonad maturity by biopsy, has removed the complete dependence on natural spawnings (Braley 1986; Alcazar and Solis 1986; Crawford et al. 1986; Alcazar et al. 1987; and Trinidad-Roa, in press).

The most desirable species for culture are *T. gigas* and *T. derasa*, which not only have very high growth rates but achieve bigger sizes as well. To a certain extent, *H. porcellanus* and *H. hippopus* are also favored for culture because of their reasonably fast growth rates and their popularity in the shellcraft trade.

The most attractive aspect of giant clam culture is that once the symbiotic algae, called zooxanthellae, become established within the clams' mantles (within a two-week postfertilization), they do not require supplementary feeding as long as they are exposed to sufficient sunlight and clean, flowing seawater. Juveniles can be harvested within three to four months and outplanted for growout in the ocean nurseries. Depending on the desired clam product and the species of clams (which determines the growth rate), harvest of outplanted clams can take place as early as one-and-a-half years from fertilization. However, to obtain the greatest biomass production (as calculated for *T. derasa*), the ideal ages at harvest are six years for adductor muscle and other soft tissues, and more than seven years for the shell (Watson and Heslinga, in press). Recent studies indicate that even faster growth rates can be achieved with giant clams if they are provided with additional sources of nitrates or ammonia (Heslinga 1988 and Onate and Naguit, in press).

At the moment, the greatest limitation to mass production of giant clams in the Philippines is the dearth of broodstock, especially of the larger, faster-growing species.

Applicability in Lingayen Gulf

Mariculture of both species involves a hatchery or land-based phase and a growout or ocean nursery phase. The hatchery phase includes the period from spawning to the early juvenile stage when the animals have to be provided with specific diets; clean, flowing, filtered seawater; and a predator-free environment in which to grow before they are transferred to the field. Growout (to commercial sizes) is usually accomplished in ocean nursery areas. In this author's experience, putting the giant clams in protected cages out in the ocean as soon as they are of appropriate sizes (10-15 mm) not only results in better growth and survival rates, but also: (1) allows more tank space in the hatchery for succeeding batches of larvae; (2) obviates the need to pump and filter seawater for the juveniles; and (3) lessens labor input in terms of cleaning raceways periodically to prevent predator and algal buildup.

Sea urchins during the larval and early juvenile phases require feeding with cultured diatoms. However, as they grow bigger, their diets shift primarily to seagrasses and seaweeds which can be provided by naturally occurring species in the ocean nursery.

Suitable areas for (marine) hatcheries require access to unpolluted seawater and freshwater, reliable electricity and reasonably good transport facilities.

For the ocean nurseries, giant clams require protected areas that are not subject to destructive waves during the typhoon season but still have good flowing seawater. Lagoons, sandy areas of the reef, as well as seagrass beds have been proven to be suitable. Coral reef communities are not as favorable because they can harbor giant clam predators such as octopi, mulluscivorous fish and hermit crabs. Sea urchins will obviously thrive in seagrass areas, especially where they have been known to occur. Under certain habitat conditions, both giant clams and sea urchins can conceivably be cultured in the same area. For both groups, it is essential that the area is within monitoring distance so that the growers can periodically check on the animals, as poaching can become a big problem. In Lingayen Gulf, there is an abundance of suitable areas for the mariculture of both clams and sea urchins.

The technology for rearing clams and sea urchins from egg to juveniles is not particularly complex. However, the infrastructure and operating expenses required are substantial and may not be within reach of the sustenance fishermen. As such, it is important that government or private institutions (with the capability to build and staff such hatcheries) provide the seeds for growout in the ocean nurseries of individual fishermen or fishing cooperatives. The mechanism by which this technology can be transferred is most feasible through the *barangay* level or fishermen's cooperatives, with the guidance of experienced social and biological science workers, especially during the early stages.

Recommendations

In coming up with a coastal area management plan integrated with mariculture efforts, specifically for giant clams and sea urchins, it is essential that the establishment of ownership of portions of reef areas (e.g., concession areas) for farming or growout of these species, even if only for limited periods of time, should be considered. Thus, a fisherman who decides to venture into ocean farming has a legitimate basis for putting his "plot" off-limits. This concept can be extended as well to communal ownership of an area by a *barangay*, a fishermen's cooperative or the like.

Juinio et al. (1986) recommended a reseeding program as well as the setting up of giant clam breeding units in protected areas (in conjunction with existing marine parks) to encourage propagation of new recruits. Experimental reseeding of reefs has been reported in Central Visayas, Philippines, as well as in Palau (Heslinga and Perron 1982).

For sea urchins, a management scheme that has been proposed for trial implementation in Bolinao, Pangasinan has already been presented by UP-MSI to the municipal council. The plan (which was also formulated in order to help the commercial sea urchin resources of Bolinao to recover) involves selective harvest at (initially) a minimum size of 6 cm, the imposition of a closed season from December to January (to coincide with the peak spawning season) and the setting up of "mini-sanctuaries" to serve as sea urchin breeding grounds. Implementation of these proposals is intended to be at the village level involving the local inhabitants themselves.

For the long-term success of mariculture efforts toward providing alternative sources of food and livelihood to coastal inhabitants (as well as helping depleted reefs recover), a great deal relies on the establishment of rapport with the coastal communities so they will eventually have the initiative to properly manage the marine resources. Thus, community development workers have their work cut out for them in terms of bridging the gap among the planners, researchers and the people in the fishing villages. It is initially important that the concepts of management and conservation of resources be reintroduced hand in hand with feasible choices to existing (presumably destructive) practices. Current community structures (political, economic, social) that enhance the achievement of management goals will have to be strengthened. Local inhabitants can also be assisted in terms of using proper growout, harvesting and processing techniques. Marketing and pricing of products should also be addressed so that the endeavor would be economically feasible.

However, there is still a lot of ground to cover in order to improve mariculture efforts, especially in terms of increased production. For instance, broodstock enhancement is needed to provide a constant supply of fertilizable eggs. Hardier and faster-growing "strains" are also needed to improve the seeds produced. Ways by which larval and juvenile survival and growth rates can be increased by the use of improved larval feeds, nutrient supplements, better tank designs, and more appropriate techniques of handling larvae and juveniles need additional research. To maximize utilization of tank space and reef areas, the polyculture of sea urchins and giant clams with other vertebrates (e.g., siganids), invertebrates (e.g., lobster, *Trochus* sp., abalone) and seaweeds could be an interesting area of research. Improved product handling, processing, packing, marketing and promotion

have been barely explored. As alternative sources of income for instance, giant clams can be sold in the aquarium trade (Heslinga et al. 1988 and Trinidad-Roa and Gomez, in press), while sea urchins can be bred for use in laboratory experiments. Less commercially important species of sea urchins could also be tried as food for other cultured species.

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Session 3

Socioeconomic, Cultural and Legal/Institutional Framework

The Economics of Municipal Fisheries: the Case of Lingayen Gulf

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Abstract

This paper presents the results of a study on the economics of municipal fisheries in Lingayen Gulf based on data collected during the period January 1987 to January 1988. Information on capital assets, costs and returns, and household expenditures obtained indicate, among others, the following: (1) relatively heavy capitalization in municipal fishing activity in the area; (2) considerable underemployment among participants in municipal capture fisheries; (3) quite low net returns from fishing relative to family expenditures; and (4) the abject poverty of municipal fishermen and their families. Suggested measures center around the need for alternative livelihood and better management (such as correcting the open access situation and better law enforcement). It is emphasized, however, that such microlevel programs must be part of holistic macrolevel approaches that address socioeconomic inequity and foster genuine industrialization (to draw manpower away from the natural resources and agriculture sector).

Introduction

An ironic situation in Philippine society often cited in development literature is the case of municipal or subsistence fishermen. It has been said that they and their families, whose livelihood rests on catching one of the cheapest sources of protein, suffer from severe protein malnutrition.

The desperate existence of the fisherfolks, the general situation throughout the Philippines, is so vividly illustrated in the case of Lingayen Gulf. This is borne out by the data gathered by the socioeconomic research team of the ASEAN-US CRMP (Philippines) from January 1987 to January 1988. Four data gathering instruments were used, namely, (1) the demographic profile; (2) the capital assets profile; (3) the daily cost and returns schedule; and (4) the weekly household consumption expenditure schedule. Of the four instruments, the first and second are "one-time", while the last two are year-long instruments. Approaching the participatory

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research method, the "respondent-cooperator" fishermen were the ones who filled up the year-long instruments with the assistance of research staff. This paper briefly presents results using the last three instruments and leaves out the discussion of the demographic characteristics of cooperators. It should be emphasized that the results presented are preliminary in nature, and are intended to help draw general inferences pertaining to the economics of Lingayen Gulf municipal fisheries. More detailed treatments (e.g., incorporating fishing gear variability and seasonality, etc. in the analyses) will be incorporated in the final project report when the analysis phase is completed.

The Area and Selection of Respondent-Cooperators

On 15 January 1987, the record-keeping of individual costs and income, as well as household income and expenditures of 60 cooperators, was started in six selected research sites. These sites were: Alaska, Aringay and Balawarte, Agoo, in Sector III; Nibaliw West, San Fabian, Capandanan, Lingayen and Uyong, Labrador in Sector II and; Mangas, Sual and Telbang, Alaminos, in Sector I (see Calud et al., this vol., for delineation and description of sectors used herein). For the selection of sample sites, the following criteria were used:

Type of Fishing Gear

There is a large variety of fishing gears used by the municipal fishermen in Lingayen Gulf. Mines (1986) stated that "due to differences in bottom topography, nature of substrate and the kind of fish species commonly found in the area, some types of fishing gears are indigenous in a particular sector but not used at all in other areas; while some are commonly used in one sector, but rarely used in other sectors of the gulf." The western coast (Sector I), for instance, is described as rocky and coralline. Hence, the fishing gears commonly used are surface/drift gill nets, fish traps and other types of fishing equipment which normally do not touch or scrape the sea bottom. Sector II is generally shallow with a muddy substrate; thus the gears commonly used are baby trawls and beach seines. The eastern coast (Sector III) is characterized by a hard, sandy bottom with scattered rocky substrate. In this sector, the most common gears are round haul seine and baby purse seine. These major gear types were considered in the selection of the sample sites.

Fishing as a Major Source of Income

In all the sites selected, fishing is considered a major economic activity. The number of municipal fishermen in relation to the total population was also considered.

The Community's Response to the Research Program

The daily recording of catch and expenses by individual fishermen is a tedious task, and may be considered an unfamiliar activity given their orientation. Thus, the community's response to the research program is important. During the initial months, community meetings were conducted (in coordination with some local organizations/institutions) to explain the program objectives and method of data collection. The fishermen's willingness to be involved in the program was a major factor in the sample site selection.

Accessibility of the Area

One of the main tasks of the socioeconomic research team was the bimonthly monitoring of the record-keeping activity. Ten individual cooperators in each site were chosen. The criteria were that the cooperator must: (1) be a full-time fisherman; (2) be willing to participate in the research program; and (3) be able to read and write. The staff decided to have ten cooperators in each site

instead of the eight originally projected to give allowance for one or two cooperators who would later lose interest in the activity.

Capital Assets

Distribution

Of the 60 cooperators involved in the research, 45% (27) owned a motorized *banca*; 13% owned a nonmotorized *banca*; and 42% are non-*banca* owners or simply renters or *tripulante* (see Table 1). Sector II accounted for the biggest share of motorized *banca*, followed closely by Sector III. Based on the research staff's findings, this uneven share of the distribution could be explained by the: (1) concentration of fisheries credit programs of the government and NGOs in Sectors II and III, and (2) relative urbanization of Sectors II and III as compared to Sector I.

Table 1 also shows the engine type owned by those who used motorized vessels as a general confirmation of the previous statement, except for the case of Sector II where those who owned a lower horsepower engine would have a slight edge over those that have a higher horsepower engine.

The types of gear used in the area essentially confirm the findings of Mines (1986) which led to the sectoral classification adapted in the different studies under the program. In Sector I, one could see the preponderance of gears suited for its coralline shores, and the same applies for Sectors II and III. But one common factor in all sectors was the multigear nature of the fisheries to suit the seasonality of exploited species and area of operations.

In terms of other equipment used (e.g., ice box and other containers, lighting paraphernalia), the data gathered essentially confirm the previous statement on the relative edge of Sectors III and II over Sector I. The number of units owned by the cooperators in Sector III was higher than those in Sector I.

Sources

Although there were a number of "credit for capital asset" programs that were initiated in the area in the early 1980s, personal savings and borrowings (see Table 2) were still the major source of financing of capital assets in the gulf and each sector.

For vessel, only 27% availed of the credit program of the government such as *Biyayang*

Table 1. Percentage distribution of respondent-cooperators' ownership of:

Fishing craft by type and sector

Type of vessel owned	Sector I	Sector II	Sector III	Total
Motorized	25.0	75.0	35.0	45.0
Nonmotorized	45.0	0.0	10.0	18.3
Renter/non-owner of a vessel/*tripulante*	45.0	25.0	55.0	41.7
Total	115.0[a]	100.0	100.0	105.0[a]

[a]Values exceeding 100.0% are due to ownership of more than one type of vessel.

Motorized vessels by engine horsepower and sector

Engine type	Sector I	Sector II	Sector III	Total
1 - 15 hp	33.3	53.3	0.0	37.0
16 - 22 hp	66.7	40.0	100.0	59.3
No hp given	0.0	6.7	0.0	3.7
Total	100.0	100.0	100.0	100.0

Table 2. Percentage distribution of respondent-cooperators by source of capital asset and sector.

Vessel owners

Source	Sector I	Sector II	Sector III	Total
Biyayang Dagat	0.0	40.0	11.1	21.2
Kilusang Kabuhayan at Kaunlaran[a]	0.0	13.3	0.0	6.0
Personal money	66.7	33.3	77.8	54.6
Others	33.3	13.3	11.1	18.2
Total	100.0	100.0	100.0	100.0

Engine owners

Source	Sector I	Sector II	Sector III	Total
Biyayang Dagat	100.0	9.1	42.9	33.3
Personal money	0.0	27.3	14.2	19.1
Others	0.0	63.6	42.9	47.6
Total	100.0	100.0	100.0	100.0

Fishing gear owners

Source	Sector I	Sector II	Sector III	Total
Personal money	100.0	81.2	84.6	86.5
Loan	0.0	18.8	15.4	13.5
Total	100.0	100.0	100.0	100.0

[a]National Livelihood Program.

Dagat (Marine Livelihood Assistance Program). As mentioned, all of these were accounted for by Sectors II and III. Moreover, 56% of the cooperators were able to acquire their assets on cash terms; 10% through resourcefulness and friendliness; and 34% on installment basis. As a whole, 40% of the total assets could be accounted for by Sector II.

Value

The total value of all the capital assets owned by the cooperators amounted to about ₱463,000[b] (Table 3a). Roughly, the average cooperator owned ₱7,700 worth of capital assets (Table 3b). This average could be misleading in the sense that the range of values varied from a low of less than ₱100 to a high of ₱53,000. Almost half of the total value was accounted for by Sector II, followed by Sector III. Again, this confirmed the impact of the credit for capital asset programs implemented in the area. More than 50% of the total value was accounted for by the vessel and engine, the two primary assets financed by such credit programs. Thus, relatively, there was heavy capitalization in fishing in the area, and this was further confirmed by the heavy depreciation expense in the total cost structure.

Daily Cost and Return

Fishing Days and Hours

For the period covered, the average number of days per month spent in fishing by the cooperators was only 10.7 days (see Table 4). Those in Sector III spent more days fishing

[b]1987: ₱20.50 = US$1.00

Table 3a. Total cost or value (₱) of capital assets owned by respondent-cooperators by asset type and sector.

Type of asset	Sector I	Sector II	Sector III	Total
Banca	28,450	160,000	50,150	238,600
Engine	10,100	38,400	22,800	71,300
Fishing gears	28,040	40,930	33,490	102,460
Other fishing equipment	41,940	4,680	4,160	50,780
Total	108,530	244,010	110,600	463,140

Table 3b. Average value (₱) of capital assets owned by respondent-cooperators by asset type and sector.

Type of asset	Sector I	Sector II	Sector III	Total
Banca	1,420	8,000	2,510	3,980
Engine	500	1,920	1,140	1,190
Fishing gears	1,400	2,050	1,670	1,710
Other fishing equipment	2,100	230	210	850
Total	5,420	12,200	5,530	7,720

Table 4. Monthly and sectoral variation in mean number of days spent fishing by respondent-cooperators.

Month	Sector I	Sector II	Sector III	Total
January	3.2	6.0	8.5	5.9
February	10.5	10.3	15.0	11.9
March	15.5	11.0	15.2	13.9
April	10.6	8.5	13.4	10.8
May	10.9	8.7	15.8	11.8
June	7.5	7.1	12.4	9.0
July	8.6	9.7	14.9	11.1
August	10.7	8.1	11.1	10.0
September	9.3	9.8	13.2	10.8
October	9.6	11.9	13.5	11.7
November	10.1	8.1	18.3	12.2
December	7.0	10.2	11.4	9.5
Year-round	9.5	9.1	13.6	10.7

than those in Sectors I and II. Monthwise, January exhibited the lowest number of fishing days while March and October exhibited the highest. The data on the average fishing days indicated that, generally, the subsistence fishermen of the gulf were severely underemployed. This pointed to the possible kind of programs concerning resources management and upliftment of the plight of the people.

Of the reasons given for not fishing, the perception that the fishermen would not catch anything tops the list. This perception was based on observations that others came back with minimal catch that could not even cover the explicit costs of fishing. Not far behind in the list was the reason of natural causes (e.g., rough sea condition).

Table 5 shows the number of hours spent at sea per fishing day. For the whole of the

Table 5. Monthly and sectoral variation in the mean number of hours spent at sea per fishing day by respondent-cooperators.

Month	Sector I	II	III	Total
January	5.5	11.1	7.4	8.0
February	6.5	7.7	8.3	7.5
March	5.2	6.3	8.6	6.7
April	5.6	4.8	8.9	6.4
May	5.6	4.2	8.6	6.1
June	6.1	4.9	9.2	6.7
July	7.8	7.6	9.3	8.2
August	7 9	6.8	7.1	7.2
September	8.9	7.9	8.2	8.3
October	9.6	6.8	9.4	8.6
November	7.8	5.8	8.3	7.3
December	4.8	7.1	8.1	6.7
Year-round	6.8	6.7	8.4	7.3

gulf, each cooperator spent about seven hours in fishing. The fishermen of Sector III spent the longest hours perhaps because they were better skilled and more adventurous among the cooperators. Those who used immobile lift nets (i.e., respondents from Sual and Alaminos) fished longest, for about eleven hours.

• Volume and Value

On each fishing trip, the cooperator would likely catch an average of 9 kg of fish (Table 6). Sector I accounted for the highest volume caught (13 kg) per fishing day while Sector II exhibited the lowest (5 kg). For all sectors, December to March seemed to be the peak months and May to June, the lean months.

On the average, a fishing team grossed ₱150 (Table 7). The average value was highest for Sector III (₱199). Although this sector was only second in terms of volume, it accounted for the highest value of catch because the fisherfolk caught higher-priced species/varieties(Table 8). Sector II exhibited the lowest value, consistent with its relatively lower average catch compared to that of the other two sectors.

Table 6. Monthly and sectoral variation in mean catch (kg) per fishing day of respondent-cooperators.

Month	Sector I	II	III	Total
January	7.9	13.8	15.0	12.2
February	13.5	9.1	8.9	10.5
March	18.3	3.9	11.6	11.3
April	16.2	2.4	10.5	9.7
May	11.8	1.9	9.2	7.6
June	14.5	2.0	7.9	8.1
July	7.8	3.3	8.0	6.4
August	20.7	5.2	6.6	10.8
September	9.9	4.8	6.1	7.0
October	11.7	4.8	6.8	7.7
November	12.4	5.0	8.0	8.4
December	9.8	6.0	15.9	10.5
Year-round	12.9	5.2	9.5	9.2

Table 7. Monthly and sectoral variation in mean value (₱) of catch per fishing day of respondent-cooperators.

Month	Sector I	II	III	Total
January	115.6	143.0	332.1	196.9
February	201.2	163.1	151.5	172.0
March	246.2	85.5	178.5	170.1
April	182.1	43.5	182.4	136.0
May	159.3	29.6	205.7	131.5
June	188.6	31.1	186.0	135.2
July	115.4	72.6	199.4	129.1
August	223.3	92.2	152.9	156.2
September	138.2	93.6	172.8	134.9
October	132.7	71.7	188.5	131.0
November	171.5	77.3	215.6	154.8
December	131.1	95.9	221.1	149.3
Year-round	167.1	83.3	198.9	149.7

Table 8. Monthly and sectoral variation in mean price of fish (₱/kg) caught per fishing day by respondent-cooperators.

Month	Sector I	II	III	Total
January	12.5	21.2	19.8	17.8
February	14.5	16.2	22.9	17.8
March	15.2	13.4	18.5	15.7
April	12.8	9.5	19.3	13.9
May	12.0	7.6	26.4	15.3
June	11.6	9.1	21.6	14.1
July	9.2	14.5	24.4	16.0
August	9.3	13.7	19.0	14.0
September	8.8	15.5	23.3	15.9
October	6.7	12.8	23.7	14.4
November	10.4	11.2	26.0	15.9
December	8.2	12.3	20.8	13.8
Year-round	10.9	13.1	22.1	15.4

Disposition of the Catch

On the average, not all of the catch was marketed. Of the catch 2.5% was given away either to authorities or to relatives; 2% was eaten out at sea while fishing; and 4% was brought home for family consumption.

Of the marketed fish, the average share of the cooperators per fishing trip was ₱49 (Table 9). Sectorwise, the average share in Sector I was the highest (₱51) since most of the cooperators here were lift net owners; followed by Sector III (₱50) and Sector II (₱47).

Average Cost and Cost Structure

On the average, the cooperators spent ₱73 per day to cover fishing costs. Of this amount, 45% (₱33) was used for gasoline; 29% for repairs and maintenance; and 7% for petrol for lighting purposes. Those in Sectors III, II and I spent ₱78, ₱65 and ₱68, respectively. The highest cost for Sector III was reflective of the venturing out of municipal waters by fishermen from the area. In fact, about 70% of their average total cost comprised gasoline expense (see Table 10).

Table 9. Average monthly share (₱) per fishing day of respondent-cooperators.

Month	Sector I	II	III	Total
January	38.0	87.4	58.1	61.2
February	57.2	80.8	53.6	63.9
March	59.5	40.3	47.7	49.2
April	52.0	28.3	47.6	42.6
May	45.6	30.4	56.2	44.1
June	59.8	22.0	50.6	44.1
July	36.2	47.8	48.7	44.2
August	42.3	46.4	41.8	43.5
September	47.2	55.6	40.3	47.7
October	54.6	39.9	45.4	46.7
November	57.1	28.0	54.7	46.6
December	61.2	56.2	56.5	58.0
Year-round	50.9	46.9	50.1	49.3

Table 10. Percentage distribution of respondent-cooperators by cost item.

Gasoline cost (₱) per fishing day and sector

Cost	Sector I	II	III	All
10 and below	50.0	40.0	30.0	40.0
11 - 20	25.0	15.0	5.0	15.0
21 - 30	15.0	10.0	5.0	10.0
31 - 40	10.0	20.0	0.0	10.0
41 - 50	0.0	5.0	0.0	1.7
51 - 60	0.0	5.0	10.0	5.0
61 - 70	0.0	0.0	5.0	1.7
71 - 80	0.0	0.0	0.0	0.0
81 - 90	0.0	0.0	25.0	8.3
91 and above	0.0	5.0	20.0	8.3
Total	100.0	100.0	100.0	100.0

Repair cost (₱) per fishing day and sector

Cost	Sector I	II	III	All
10 and below	84.2	80.0	85.0	83.1
11 - 20	10.5	5.0	10.0	8.5
21 - 30	5.3	0.0	0.0	1.7
31 - 40	0.0	5.0	0.0	1.7
41 and above	0.0	10.0	5.0	5.0
Total	100.0	100.0	100.0	100.0

Petroleum cost (₱) per fishing day and sector

Cost	Sector I	II	III	All
5 and below	35.0	95.0	65.0	65.0
6 - 10	20.0	5.0	25.0	16.7
11 - 15	15.0	0.0	10.0	8.3
15 and above	30.0	0.0	0.0	10.0
Total	100.0	100.0	100.0	100.0

Continued

Table 10 (continued)

Cigarette cost (₱) per fishing day and sector

Cost	Sector I	II	III	All
2 and below	35.0	50.0	40.0	41.7
3 - 4	25.0	35.0	10.0	23.3
5 - 6	30.0	15.0	35.0	26.7
7 - 8	10.0	0.0	10.0	6.7
9 and above	0.0	0.0	5.0	1.7
Total	100.0	100.0	100.0	100.0

Ice cost (₱) per fishing day and sector

Cost	Sector I	II	III	All
2 and below	100.0	80.0	30.0	70.0
3 - 4	0.0	15.0	25.0	13.3
5 - 6	0.0	5.0	40.0	15.0
7 and above	0.0	0.0	5.0	1.7
Total	100.0	100.0	100.0	100.0

Food cost (₱) per fishing day and sector

Cost	Sector I	II	III	All
5 and below	70.0	95.0	75.0	80.0
6 - 10	15.0	5.0	20.0	13.3
11 - 15	15.0	0.0	0.0	5.0
16 and above	0.0	0.0	5.0	1.7
Total	100.0	100.0	100.0	100.0

Marketing cost (₱) per fishing day and sector

Cost	Sector I	II	III	All
2 and below	75.0	60.0	45.0	60.0
3 - 4	5.0	15.0	10.0	10.0
5 - 6	0.0	10.0	15.0	8.3
7 - 8	15.0	15.0	10.0	13.3
9 and above	5.0	0.0	20.0	8.3
Total	100.0	100.0	100.0	99.9

Other costs (₱) per fishing day and sector

Cost	Sector I	II	III	All
5 and below	80.0	90.0	80.0	83.3
6 - 10	0.0	10.0	20.0	10.0
11 - 15	10.0	0.0	0.0	3.3
16 and above	10.0	0.0	0.0	3.3
Total	100.0	100.0	100.0	99.9

To include the implicit costs in fishing, some assumptions were made in calculating the opportunity costs for capital and labor. For capital, the prevailing savings interest rate served as the measure (5%). For labor, a daily (eight-hour work) wage of ₱35 was assumed. This figure is way below the legal minimum wage rate. But due to widespread unemployment and underemployment and based on job opportunities and earnings in the area, this figure is deemed reasonable. Table 11 shows the total cost per sector per month.

Net Returns

On the average, the net returns or the resource rent that "accrued" to each of the cooperators per fishing day was only ₱17.20. Sector III fishermen got a ₱30.00 resource rent each while those from Sectors I and II got ₱26.10 and ₱-4.40, respectively. Figs. 1 to 3 illustrate the low net returns and/or incomes from municipal fishing operations in the Lingayen Gulf area, and provide some evidence that the common access equilibrium may have already been reached in the case of the gulf.

Efficiency of Gears

Table 12 essentially reveals the reason for the preponderance of dynamite users in the gulf (without taking into account other implicit costs, whether social or personal). The long line and dynamite group was the most efficient, followed by baby trawl. Bottom set gill net operations were the most inefficient.

Household Expenditures

On the average, a cooperator family spent ₱1,290 per month (Table 13). Those from Sector I spent the highest (₱1,340), followed by those from Sectors II and I (₱1,265) and III (₱1,170). Their spending pattern generally exhibited the same structure except for a relatively higher share of food and a relatively lower share of recreational expenditures in Sector III.

One need not compare the spending pattern with the poverty thresholds to recognize the dire poverty stalking the families of the cooperators. The average monthly share a fisherman obtained from fishing amounted to ₱470 in Sector I, ₱425 in Sector II and ₱690 in Sector III or ₱530 in all three sectors combined. By simply comparing such average monthly share with the actual household expenditures, one could conclude that a fisherman cannot solely provide the financial necessities of a family. Even if it would be assumed that there are two fishermen per family, each family would still need to look for other sources of income (except in the case of Sector III).

Table 11. Monthly and sectoral variation in average total costs (₱) (both implicit and explicit) per fishing day of respondent-cooperators.

Month	Sector I	II	III	All
January	77.7	116.7	126.8	107.1
February	104.4	83.7	140.7	109.6
March	103.6	69.2	122.4	98.4
April	96.3	180.2	141.6	139.4
May	80.8	46.4	126.8	84.7
June	87.2	64.4	133.9	95.2
July	62.2	77.3	128.9	89.5
August	55.3	90.8	99.2	81.8
September	59.1	159.0	117.5	111.9
October	380.5	274.3	125.8	260.2
November	69.0	65.9	131.1	88.7
December	60.0	78.4	115.4	84.6
Year-round	103.0	108.9	125.9	112.6

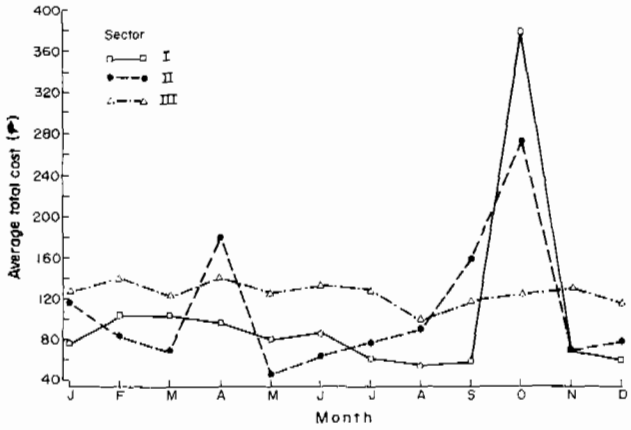


Fig. 1. Average total cost (₱) (including both explicit and implicit costs) per day of respondent-cooperators by month and sector.

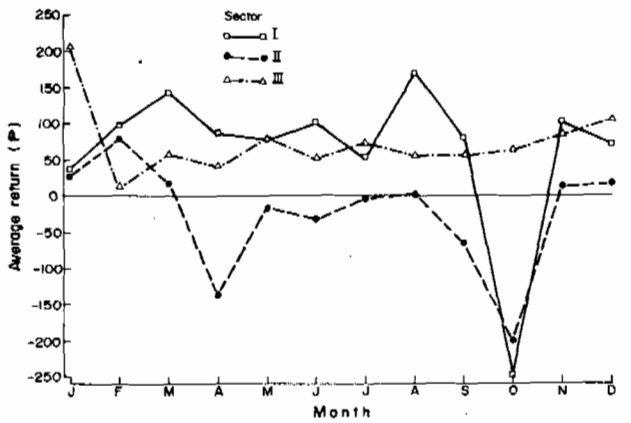


Fig. 2. Average returns (₱) per day of respondent-cooperators by month and sector.

Preliminary Analysis of Variability in Fishing Effort and Catch

Variability of Effort per Fishing Day

The following is an attempt to explain variation in time spent in fishing or whatever factors motivate a fisherman to stay longer at sea and exert more effort.

The specifications include the following:

$E = f(C, P, H, A, I, S, F, D_1, D_2)$

or in log-log form are

$$\log E = \log a + B_1 \log C + B_2 \log P + B_3 \log H + B_3 \log A + B_4 \log I + B_5 \log S + B_5 \log F + B_6 \log D_1 + B_7 \log D2 + e$$

where E = number of hours in fishing

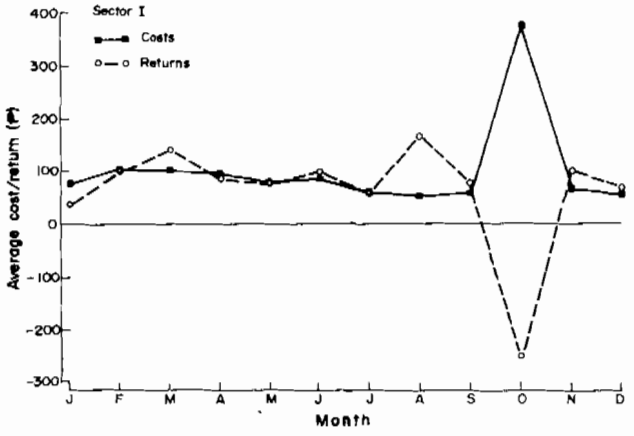
C = cost of fishing

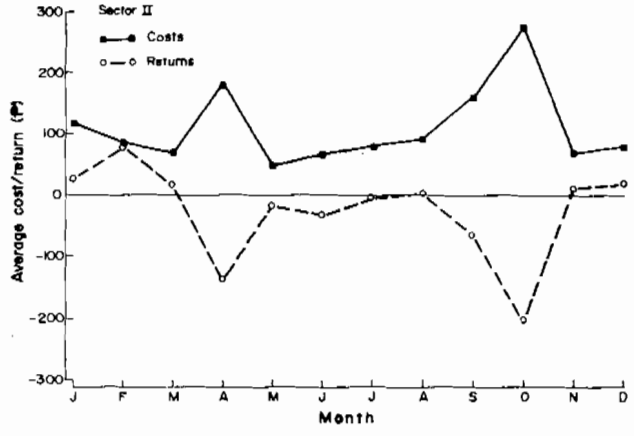
P = weighted price of fish in the area

H = household expenditure

A = age

I = educational attainment





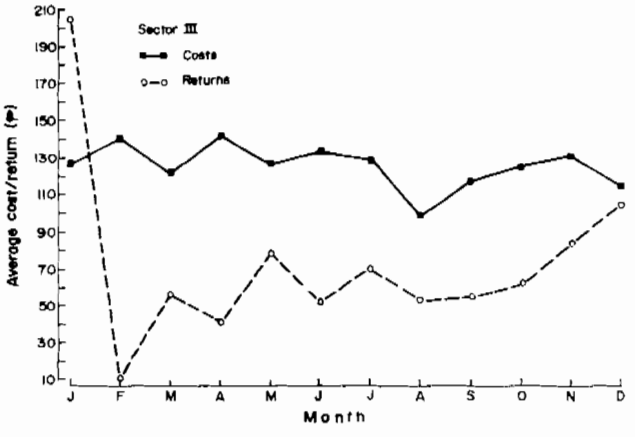


Fig. 3 (continued)

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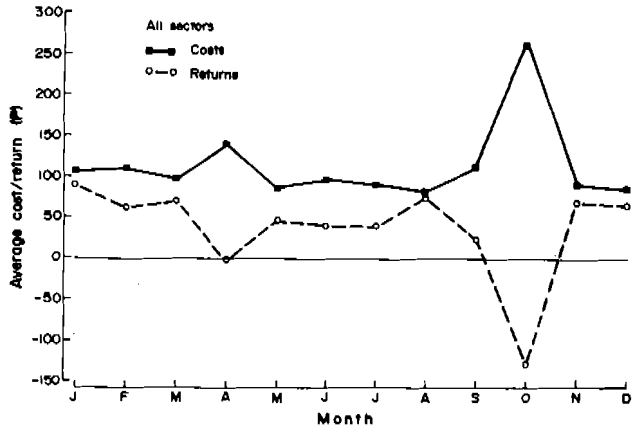

Fig. 3. Monthly variation in average costs and returns (₱) per day of respondent-cooperators.

Table 12. Total cost (₱), catch volume (kg) and net returns (₱) per fishing day for selected municipal fishing gears in Lingayen Gulf.

Gear type	Average total cost	Average total volume	Average net return
Bottom set gill net	88.2	5.6	-4.4
Baby trawl	148.4	9.0	30.4
Parigdig/lift net	140.1	15.5	17.9
Long line and dynamite	110.7	10.4	62.6

Table 13. Average monthly household expenditures (₱) of respondent-cooperators by month and sector.

Expense type	Sector I	II	III	All
Food	658.3	636.2	820.2	662.9
Medicine	97.4	121.7	75.2	107.8
Education	102.1	85.1	61.2	89.4
Clothing	237.9	130.6	138.6	173.3
Recreation	87.0	98.4	24.2	86.7
Utility	43.4	103.5	37.5	73.4
Others	118.2	89.5	10.9	93.3
Total	1,344.3	1,265.0	1,166.8	1,286.8

S = household size
F = number of years in fishing
D_1, D_2 = dummy for sector: if
$D_1 = 0$, $D_2 = 0$: Sector I
$D_1 = 1$, $D_2 = 0$: Sector II
$D_1 = 0$, $D_2 = 1$: Sector III
a = constant

The results are as follows:

logE = log 0.788 + 0.269 logC + 0.357 logP
s.e 0.093 0.140
t 2.90 2.55
-0.011 logH - 0.420 logA + 0.216 logI
0.105 0.202 0.108
-0.11 -2.07 2.00
+0.092 logS + 0.065 logF + 0.90 logD1
0.090 0.074 0.154
1.02 0.58 0.58
-0.081 logD2
0.146
-0.56 $R^2 = 0.6382$
Adjusted $R^2 = 0.5502$
F = 7.251

From the above equation the following can be drawn:

1. Of the variations, 64% can be explained by the variables chosen.
2. Of the five explanatory variables, two are highly significant at P>0.01 (i.e.,cost and weighted price) and two others are significant at P>0.05 (i.e., age and education). All have the expected signs.

Variability of Catch

The following is an attempt to explain variability in catch, V, across the gulf.

V = f(E, C, P, H, A, I, S, F, D_1, D_2)

or in log-log form

logV = loga + B_1logE + B_2logC + B_3logP + B_4logH + B_5logA + B_6logI + B_7logS + B_8logF + B_9logD1 + B_{10}logD2

The results are as follows:

logV = log 0.931 + 0.624 logE +
0.986 logC - 1.32 logP
s.e 0.298 0.186 0.274
t 2.10 5.29 -4.82
- 0.168 logH - 0.242 logA + 0.038 logI
0.191 0.387 0.205
-0.88 -0.62 0.19
- 0.187 logS + 0.168 logF + 0.077 $\log D_1$
0.166 0.136 0.280
-1.124 1.241 0.274
- 0.1001 logD2
0.265
-2.64 $R^2 = 0.6814$
Adjusted $R^2 = 0.5929$
F = 7.68

The following could be drawn from the above:

1. The specification could account for 68% of the variation in catch, and the overall fit is quite good.
2. For most of the variables, the expected signs were obtained, except for household size. Of the explanatory variables, cost, price and being in Sector III are highly significant at 0.01 level, while effort and dummies for the sectors are significant at 0.05 level.

Conclusion and Recommendations

The results above indicated the abject poverty that stalks the coastal communities surrounding Lingayen Gulf. The immediate reason appears to be the condition in the area--the dissipation of resource rent due to the near attainment of common access equilibrium. Data sets on capitalization, costs and returns and household expenditures support this conclusion. Solely addressing the common access issue, however, would not solve the problem of poverty. The present situation did not evolve in a socioeconomic vacuum. Factors that may be macro in character must be considered in the planning process to remedy the existing situation. It must be realized that although programs that deal with the micro situation might ease poverty (e.g., alternative source of income such as backyard poultry and piggery), the benefits would not be long-lasting unless laid down under a holistic macro plan. Some environmentalists have opined that the solution to environmental degradation and natural resources depletion could not be found in the sectoral areas themselves. This is because the real causative

factors stem from the social and economic structures of the country. The problems of inequity on the macro level need to be addressed, and real industrialization should be pursued to increase opportunities and draw manpower from the natural resources and agriculture sectors.

Given these considerations, the following proposals specific to the Lingayen Gulf area need attention:

1. With the relatively high capitalization in the area, a stop to credit schemes for fishing capital/equipment should be effected and the available funds rechanneled for socioeconomic projects that would be community-based and that rest on the principle of cooperation and self-reliance. This proposal is not only to ease some pressure away from the resources, but also to promote better institutional structures that could be the basis of a community-based resources management program.
2. Alternative sources of income must be promoted and should consider the nature of fishing and the number of days spent for fishing. One should also consider the possible role of other family members, especially those of the women and children.
3. Some pricing mechanisms that would show and internalize the real costs of illegal fishing (such as dynamite fishing) are needed. As may be gleaned from the data, the "efficiency" of the gear is the best explanation for the persistence of illegal fishing methods. No amount of half-hearted implementation could solve this problem.
4. Studies that would link the micro with the macro situation would be desirable. Studies of market interlinkages could be revealing in the sense that market structures could be analyzed and imbalances identified.

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Prospects for Territorial Use Rights in Fisheries in the Lingayen Gulf Area

ELMER FERRER[a]

Ferrer, E. 1989. Prospects for territorial use rights in fisheries in the Lingayen Gulf area, p. 157-162. *In* G. Silvestre, E. Miclat and T.-E. Chua (eds.) Towards sustainable development of the coastal resources of Lingayen Gulf, Philippines. ICLARM Conference Proceedings 17, 200 p. Philippine Council for Aquatic and Marine Research and Development, Los Baños, Laguna, and International Center for Living Aquatic Resources Management, Makati, Metro Manila, Philippines.

Abstract

In many countries, fisheries resources are legally defined as common property and open-access. However, experiences over the decades have shown that open-access exploitation of fisheries resources leads to excess fishing capacity and dissipation of resource rents. To overcome the problem of failing fisheries, resources allocation through territorial use rights in fisheries (TURFs) have been advocated.

In Lingayen Gulf, TURFs have been known to exist in the form of exclusive use rights in the construction of fish corrals, oyster culture beds, catching of fish fry and, more recently, in the laying down of artificial reefs. The natural acquisition of TURFs by fishermen's organizations in connection with their artificial reef projects opens the feasibility of a community-managed TURF. The existence of traditional use rights in the use of *payao* and artificial reefs enhances the feasibility of using or adopting localized/traditional TURFs to meet both economic and social objectives.

Introduction

In many countries, fisheries resources are legally defined as common property and open-access. However, experiences with many fish stocks over the decades have shown that open-access exploitation of fisheries resources leads to excess fishing capacity and dissipation of resources rents. Failing open-access fisheries throughout the world have been characterized by declining total yields, sharp decreases in the yield per unit of fishing effort, disappearance of the more highly valued species, cutthroat competition among fishermen and, in some cases, the economic collapse of the fishing industry (Berkes 1986). Lingayen Gulf is not exempted from this trend.

Management Alternatives

To overcome the problem of failing fisheries, several management alternatives have been put forward. These include, among others, the following (Panayotou 1982):

1. Selectivity of gear - such as restriction on the size of meshes, spacing

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of hooks or the opening of pots, aim to achieve and maintain the most productive age structure of the stock by allowing immature fish to grow larger and more valuable, and possibly to reproduce before they are caught.

2. Gear restrictions - such as bans on the use of poisons and explosives, aim at the protection of the resource and its productivity.
3. Seasonal and area closures - aiming to improve the productivity of the resources by ensuring uninterrupted spawning and protection of juvenile fish; the closure of a fishery during certain seasons or in certain areas may also control total effort and catch.
4. Catch quotas - aim to improve the productivity of the stocks through direct control of fishing mortality; theoretically, any catch quota can be set and enforced, thereby, maintaining the stock at the desired level of production.
5. Fishing effort controls - such as limits on the number of fishing units, quantity of gear, or capacity of vessels, aim to improve the yield and economic performance of the fishery through the elimination of excessive fishing effort.
6. Economic controls - such as taxes on effort or catch, royalties and license fees, aim to indirectly control fishing effort by directly removing the economic surplus (or resource rent) which encourages overexpansion of effort; taxes and fees drive a wedge between social and private costs of fishing which dissuade fishermen from expanding effort beyond the socially optimum level.
7. Resources allocation through territorial rights - such as leasehold arrangements, franchises, or allocations of ownership over an area or a stock, aims to create the appropriate environment for self-management through the establishment of private or community ownership of common property resources; the "owners" of the resource, having an interest in its current and future productivity, would be inclined to control fishing effort to maximize the net benefits from the resources, in much the same way as farmers regulate their activities to maximize the returns from their land.

The Concept and Practice of Common Property

The condition of common property has characterized the use of most marine fisheries throughout the world for several centuries. Briefly, common property resources are those to which access is both free and open to a set of users or potential users. The consequences from the condition of common property include the following:

1. Tendency to waste the resource physically. No individual fisherman has an incentive to restrain his catch in the interest of future returns, for anything he leaves in the sea for tomorrow will be taken by others today. Thus, fish stocks tend to be used at, and frequently beyond the point of maximum sustainable yield.
2. Economic waste. In the absence of controls on capital and labor, there will tend to be too much effort spent on too few fish. In overutilized fisheries, the same or even larger amounts of fish can be taken with fewer fishermen and vessels than are actually employed. This means that the same or greater total revenues could be produced with lower total costs.

   The difference between total revenues and total costs that would occur if access to the fisheries were controlled, or the condition of common property were removed, is an "economic rent." In common property fisheries, this rent is dissipated

because whenever it occurs, it produces a surplus profit to the fishermen. Since access is free and open, the surplus profit will attract more fishermen. New fishermen and capital will come into the fisheries until rent is totally dissipated.

3. Low income. A related consequence is that average incomes of small-scale fishermen tend to be at, or close to, the bottom of the scale.
4. Conflict. This occurs in the form of congestion among fishermen using the same resource with the same gear; among large- and small-scale fishermen using different gears for the same resources or among fishermen using different kinds of gears for different stocks but on the same space, as between mobile trawlers and fixed nets or pots.

In essence, the consequences of free and open-access fisheries are generally quite damaging. The only possible rationale for this is that it offers employment opportunities in situations where alternative opportunities are scarce or nonexistent. But this is a benefit which, in the long run, may be outweighed by the other damage.

The Concept and Practice of Territorial Use Rights in Fisheries

TURFs have been known to exist for centuries. In fact, community fishing rights and other forms of proprietary rights have been the rule rather than the exception in many traditional coastal fisheries. They have emerged (and some are still maintained) where conditions permit relatively easy acquisition and defense of exclusive rights. Sedentary resources such as oysters, mussels, and seaweeds have long been subject to use rights. Enclosed bodies of freshwater (ponds, lakes and flood plains) have also been subject to exclusive use rights for centuries (Christy 1982). TURFs have also emerged in areas or situations where ease of acquisition and defense of exclusive rights are not readily apparent. They have developed in marine areas such as lagoons, along beaches, and with regard to coral reefs. More recently, TURFs are being established, legally or illegally, with FADs and other new or recently expanded technologies.

Range and Variety

TURFs are more pervasive than previously thought to be the case, in both modern and traditional marine fisheries. A partial list of fisheries and techniques using or permitting exclusive TURFs would indicate this. These include the following (Christy 1982):

1. Oyster and clam bottom
2. Seaweed beds
3. Raft culture
4. FADs: floating (e.g., *payao*) and fixed on the bottom (e.g., artificial reefs)
5. Beach seine rights
6. Fishpens and cages
7. Set net rights
8. Bottom fish traps (e.g., lobster pots and octopus shelters)
9. Coral reefs
10. Lagoon fisheries
11. Fish traps/corrals

To the author's knowledge, all of these varieties of TURFs except probably beach seine rights and set net rights, exist in Lingayen Gulf.

Significance

Christy (1982) pointed out several consequences of TURFs, which include the following:

1. Prevention of the damaging consequences of common property. A TURF can remove, to a greater or lesser extent, the conditions of common property, thus reducing their negative consequences (e.g., the tendency to waste the resource physically). TURF owners can limit the inputs of capital and labor at the point where the greatest net benefits are produced. This could be the point where net economic revenues or social objectives are maximized

(such as maximum employment at satisfactory levels of income).

2. Improvement of the welfare of small-scale fishing communities and enhancement of equity. Community-managed TURFs provide both opportunity and incentive to manage the resources within the territory. Since the owners (group of individuals or community) of TURFs have an exclusive right to future products, it will be in their interest to ensure the flow of future products. This would facilitate the imposition of management measures as well as enforcement. The most effective form of enforcement occurs where it is in the self-interest of the user to comply with the rules.
3. Enhancement of self-regulation and help in minimizing conflicts. TURFs are viable especially for small-scale fisheries wherein the community of users is relatively homogenous, and the group size is relatively small. Reciprocal and mutually reinforcing relationships are feasible, thus, facilitating self-regulation and minimizing conflicts.
4. Possible creation of a class of "sealords" or monopoly of the resources. While community-managed TURFs provide control over the resources and the benefits derived from them, the opposite can be damaging to the plight of small-scale fishermen. If localized TURFs develop on their own, without effective community control, these may create a class of "sealords" and result in a monopoly of resources. The case of the fishpens in Laguna Lake illustrates this.

The Philippine Experience: A Historical Perspective

Prior to Spanish colonization, the Philippines was inhabited by various ethnic groups organized into independent villages known as *barangay*. No comprehensive account exists of the manner in which these communities relate to their environment, particularly the coastal resources. But early Spanish documents (in Blair and Robertson 1903-1909) as cited by Lopez (1983) mentioned that:

> *Barangay* in the vicinity of Manila claimed as much of the sea and nearby rivers as they could defend against neighboring *barangay* (Francisco Colin 1663); and
>
> Tagalogs established fishery limits and set aside sections of river for use as trading centers. Use of these areas by nonmembers of a settlement was contingent on the payment of fees (Juan de Plasencia 1589).

As the Spanish rule prospered, the *barangay* were incorporated into the dominant sociopolitical system, and with it TURFs claimed by each village broke down. Coastal and offshore waters became open to exploitation by all parties who had the means to do so.

During the American occupation of the Philippines, exclusive use of coastal waters, this time by individuals, was again established by the Fisheries Act of 1932 for fish corrals, fishponds, oyster culture beds and for fry gathering. However, municipal fishing licenses issued under the act still allowed subsistence fishermen to exploit all waters within the jurisdiction of a municipality.

The Lingayen Gulf Area

In at least one locality (Bolinao, Pangasinan), the Fisheries Act was used to concentrate control of municipal waters within a small circle of the affluent. Waters to a depth of 10 fathoms (18 m) were divided into five or six lots and leased by auction. Concessionaires exacted fees from net fishermen and corral-builders who wished to operate within their lots, based on estimates of potential catch. Hook-and-line fishermen were exempt from this levy because their catches were considered negligible. The concessionaire could then control the number of fishermen utilizing his lot and, at least in theory, make sure his stock would remain productive (Lopez 1983).

The exclusive use of coastal waters by individuals or corporations continues up to the present, and remains the dominant arrangement for TURFs in Lingayen Gulf. For instance, Ordinance No. 8 from the Office of the Municipal Secretary (series of 1976) of Bolinao and known as the "Basic Fishery Ordinance" declares:

> "Operating fish corrals, oyster culture beds or catching of '*bangus* fry' or fry of other species for propagation shall be considered as exclusive fishery privileges which shall be granted always to the highest bidder in public bidding held according to the provisions of this Ordinance."

In the municipality of Sual, TURFs for fish cages and stationary lift nets have been awarded to individuals or corporations. Similar arrangements exist for the oyster rafts and mussel stakes off Binmaley and San Fabian. Fish corrals all over the gulf are administered under individual or corporate franchises.

In the municipality of Agoo, La Union, a similar provision for exclusive use of coastal waters in the operation of fish corrals, oyster culture beds and fry gathering exists in the ordinance pertaining to fisheries. However, there are no clear provisions with regard to the operation of *payao* or FADs prevalent in the La Union area of Lingayen Gulf. Nevertheless, an observation has been made regarding its use and another FAD, the artificial reef. Galvez (1988) noted the existence of an important cultural and institutional practice in Balawarte - a form of sea tenure system. As he observed, "anyone who has laid down an artificial reef in an area earns the sole right to fish around the reef."

This form of sea tenure may have developed over the long years that the people have been practising the laying down of *payao*. In the process, it has institutionalized a traditional use right in the operation of *payao* and its variant, the artificial reef.

A recent development in the gulf area is the natural acquisition of TURFs by fishermen's organizations in Alaminos, Sual and Labrador in connection with their laying down of artificial reefs in the coastal waters adjoining their communities.

In the statement of management rules for the artificial reef project, the fishermen's organizations stated categorically that their members should be given priority to the benefits accruing from the project. Furthermore, their rules provide that anyone fishing within 50 m of the artificial reefs should share 5% of his catch either in cash or in kind. They also provide that only gill net and multiple hook and line may be used in catching fish from the artificial reefs. Blast fishing and cyanide poisoning are strictly prohibited. Working committees have also been formed to monitor and maintain the operations of the artificial reefs.

This new development in the acquisition and maintenance of TURFs provides an alternative arrangement in CRM. It poses the feasibility of community-based management of TURFs over the dominant practice of individual and corporate management.

Lessons and Recommendations

Successful experiences in coastal fisheries management indicate the importance of tradition and local organizations. Fishermen who have inherited detailed knowledge of the natural environment and time-tested systems for fishing, and who have organized themselves have a better chance of managing their fisheries successfully. Thus, in the formulation of a community-based CRM plan for Lingayen Gulf, there is a need to examine the ways by which localized/traditional TURFs can be used or adopted to meet both economic and social objectives. Additionally, there is a need to:

1. Explore the possibility of organizing the small fishermen of Santiago Island and have them bid for the exclusive use right of setting up fish corrals;
2. Harness the traditional use rights prevailing in the coastal communities in the setting up of artificial reefs; and
3. Incorporate organizing as an essential element of community-based CRM.

Another critical factor in the success of coastal fisheries management is the use of extra-local authority or "enabling legislation" such as provincial or municipal ordinance. Such facilitates the protection of community-managed TURFs and gives legitimacy to local rules for the use of the coastal resources. While BFAR is looking into the possibility of formulating a fishery administrative order for the setting up of artificial reefs, the provincial boards and municipal councils in the provinces of Pangasinan and La Union can initiate the promulgation of ordinances to protect community-managed TURFs.

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Overview of the Development Targets and Concerns for the Province of Pangasinan (1987-1992)

ILOCOS REGIONAL DEVELOPMENT COUNCIL-
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Ilocos Regional Development Council-National Economic Development Authority (IRDC-NEDA). 1989. Overview of development targets and concerns for the province of Pangasinan (1987-1992), p. 163-166. *In* G. Silvestre, E. Miclat and T.-E. Chua (eds.) Towards sustainable development of the coastal resources of Lingayen Gulf, Philippines. ICLARM Conference Proceedings 17, 200 p. Philippine Council for Aquatic and Marine Research and Development, Los Baños, Laguna, and International Center for Living Aquatic Resources Management, Makati, Metro Manila, Philippines.

Abstract

This paper gives an overview of development concerns and targets for the province of Pangasinan based on the medium-term development plan covering the period 1987-1992. It presents a brief profile of the province, its pressing development problems and objectives/requirements during the plan period.

Provincial Profile

Pangasinan's land area of 5,368 km^2 covers one-fourth of the Ilocos Region's land area. Pangasinan is composed of 46 municipalities and 1,348 *barangay* including the cities of Dagupan and San Carlos. The provincial capital is Lingayen.

Population, Labor and Employment

Pangasinan has the highest population among the four provinces in Region I. In 1987, its total population (including its cities) reached 1,847,300 or 46% of the total regional population. As of April 1988, 714,000 composed the labor force, 633,000 of which were employed; thus a provincial employment rate of 89%. Of those employed, 52% were in agriculture. The unemployment rate of 11% was higher than the regional unemployment rate (6%).

Family Income and Expenditure

The average monthly family income for Pangasinan and its cities was ₱2,440 in 1985[b]. However, the average monthly family expenditure was ₱1,950. Both parameters were below the region's average monthly family income of ₱2,620 and expenditure of ₱2,190. The proportion of families earning less than ₱10,000 annually was 6%.

[a]Don Pedro Bldg., Pagdaraoan, San Fernando, La Union.
[b]1985: ₱19.00 = US$1.00

Natural and Financial Resources

Pangasinan has the largest arable land area in Region I. Of the province's total area (536,818 ha), about 70% are classified as alienable and disposable lands best suited for intensive crop production. Its forest lands make up about 30% of the combined forest area in the Ilocos Region.

About 48% of Pangasinan's land area is used for agricultural production. Pangasinan is a leading producer of rice, corn, lowland vegetables and livestock. It also has the largest fishpond area in Region I. Three-fourths of the region's freshwater area is in Pangasinan. The province borders Lingayen Gulf, the most productive fishing ground in Region I. Communal waters occupy nearly 5,000 ha, the biggest in the region.

The Hundred Islands in Alaminos, Sual Beach and other beaches around Lingayen Gulf make Pangasinan a favorite summer spot, especially for water-oriented recreation.

In terms of local government revenues, Pangasinan generated ₱102 million in 1987[c] representing a per capita revenue of ₱55 versus the region's ₱89. Pangasinan's average per capita government expenditure was ₱60 compared to the region's ₱77.

Agriculture and Industry

During the first half of 1987, Pangasinan accounted for more than 60% of the rice production in the Ilocos provinces. Nearly half of the region's inland fisheries production came from the province. In 1986, fish production totalled 32,000 t, accounting for about 80% of the fish production in the Ilocos provinces.

For the third quarter of 1987, Pangasinan was the primary source of limestone, shale clay, white clay and guano silica.

In 1987, there were 454 newly registered business establishments in the province, of which 280 were engaged in trading. Total investments were ₱45 million.

[c]1987: ₱20.50 = US$1.00

Infrastructure and Utilities

In 1983, the total road length in Pangasinan represented 26% of the regional total. More than one-half of the roads are asphalted while the rest are of earth and gravel. In terms of communication facilities, all of the municipalities of Pangasinan are serviced by telegraph facilities. As of June 1987, there was one postal station for every 36,200 persons. About 87% of the municipalities have been provided with electricity. Less than one-fifth of its total population still has to be supplied with potable water. One-third of the potentially irrigable land still needs to be irrigated.

Development Concerns

The natural endowments of Pangasinan have been projected to offer growth and development. Certain problems, however, impede the maximum utilization of these resources. Farm siltation and river pollution are two major concerns. Two of the region's major river basins, Agno and Bued, have served as dumping sites of mine silt and wastes generated by mining companies in Benguet. This river system traverses and pollutes wide tracts of agricultural lands in Pangasinan.

Decreases in crop production (particularly rice) in Pangasinan are attributed to the high cost of farmlands and mining activities in the uplands.

Pond management and fingerling dispersal, technological assistance and coordinated systems of fish production are still inadequate.

Small-scale, backyard livestock production is common. Its expansion is limited by the lack of breeder stocks and efficient dispersal programs, as well as inadequate capital to support increased production. Backward linkages of the industrial sector with the agricultural sector need to be strengthened to complement the planned increases in crop and livestock production.

Marketing and credit facilities and training programs appropriate for craftsmen, production workers and managers are inadequate and constrain the development of small and light industries. Raw materials like rattan, bamboo and narra are dwindling to the detriment of cottage industries.

The lack of standard hotels and other necessary tourist facilities hampers the tourist-drawing potentials of Pangasinan. Its water-oriented recreation resources have yet to be fully developed.

The rural areas, particularly in the eastern and western portions, need to be beneficiaries of an expanded program in health, nutrition, family planning, education/training and other social services. These areas lack water, electricity and sanitary disposal systems.

Communicable diseases are the main causes of morbidity and mortality. These have yet to be controlled more effectively. In 1987, one-fourth of the children in the 0-6 age group were found to be malnourished. The services of more physicians, nurses and dentists are required by the increasing population.

As of June 1987, more than one-fifth of the total number of *barangay* in Pangasinan needed electrical facilities. Existing school buildings and health facilities need substantial repair and improvement. While the road density of the province is slightly higher than that of the region, many road sections (*barangay* or farm to market roads) need repair and improvement. Port facilities are inadequate to meet the development in agriculture and industry. Large areas, especially in the eastern and central parts, require flood control systems to protect farms and property.

Development Targets and Requirements

Agriculture and Natural Resources

Pangasinan's population is projected to have an annual growth rate of 1.6% during the 1987-1992 period. Its population shall have reached 2,003,000 by 1992. During this period, the percentage of the total population belonging to the active labor force would be 55%. Continuing to absorb majority of the labor force shall be the agriculture sector, followed by services and trade. The agriculture, fisheries and forestry sectors shall likewise experience the highest average annual growth rate in labor absorption during the period.

Pangasinan is and will continue to be a major producer and supplier of rice in Region I. For the 1987-1992 period, the area planted with rice shall increase by 5% from 196,000 ha in 1987 to 206,000 ha by 1992.

Fish production shall grow to be a major livelihood activity for coastal municipalities. Activities, however, should shift from capture fisheries to aquaculture given the resource situation.

Livestock and poultry production shall be encouraged. Meat production is projected to grow by 1.6%. Vegetable, cotton and native burley tobacco production and tree farming shall also be expanded.

Industry, Trade and Tourism

The development of cottage, small- and medium-scale industries depends on the extension of liberal financial assistance, technical and consultancy services and manpower and entrepreneurship training needed by the industry. Handicraft, furniture, food processing, machine shop, leather production, leathercraft and cotton spinning are the industries to be developed in Pangasinan.

Agricultural and resources-oriented industries need to be established. A comprehensive survey of the province's mineral resources and other indigenous materials shall be undertaken. The further development of the mineral industry is a high priority.

Trade strategies must be focused on the creation of centers and subcenters to serve as trading posts for agricultural and industrial products. Additional efforts in product development and standards, and campaigns on responsible consumerism are essential for trade activities.

The next five years will call for the improvement of hotels, inns and other tourist facilities especially in designated tourist zones.

In all of these activities, adequate infrastructure support is necessary.

Social Services/Facilities and Infrastructure

For the planning period, the increasing number of students at all levels will need a general education that is relevant and supportive of regional and national development. This will require the provision of adequate and well-maintained facilities and the training and retraining of teachers and school administrators. Moreover, the financial and social well-being of school personnel will demand proper attention.

The provision of quality health care shall seek the service of some 400 midwives by 1992. Existing health facilities will need to be dispersed strategically in rural areas. Based on planning standards, additional 100 units and 400 units of *barangay* health stations will be needed to serve the population by 1992.

Social welfare projects for the coming years must fill the need of highlighting the welfare of the family and the child. Opportunities for work, increased income and productivity must be geared toward the disadvantaged groups and individuals.

Throughout the whole development period, there is compelling need to provide integrated services in transportation, communication, power, water resources and other social facilities.

Induced investment supportive of balanced agroforestry development will require the construction, repair and maintenance of vital support facilities. This requirement, when provided, shall strengthen the link between these complementary sectors.

The backlog in rural roads will need to be minimized within the period. Urban roads are already deemed sufficient. Rural road development needs greater attention even on the assumption that no change occurs on the existing area of agricultural lands.

By 1992, 300 postal stations will be needed by the growing population.

Reference

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Overview of the Development Plan for the Province of La Union (1987-1992)

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Abstract

This paper gives an overview of development programs and objectives for the province of La Union based on the medium-term development plan for the period 1987-1992. It gives a profile of the province, previous development efforts and programs for implementation during the five-year period.

Planning Framework

Provincial Profile

General profile

La Union is located in the southwestern part of the Ilocos Region[b]. It stretches over a length of 102 km from north to south lying between 120° 15' and 120° 36' E longitude and 16° 13' and 16° 57' N latitude. It is bounded in the north by Ilocos Sur, in the south by Pangasinan, in the east by Benguet and in the west by South China Sea.

La Union, with a total land area of 149,300 ha, is considered the smallest province in the region. Its area is 7% and 0.5% of the total land area of the region and country, respectively. It is composed of 20 municipalities and 575 *barangay*. Of the former, San Gabriel has the biggest land area, 17,810 ha (12%) while Agoo has the smallest, 3,910 ha (3%) of the total provincial land areas. In terms of the number of *barangay*, San Fernando has the most (59) while Bagulin has the least (10).

Population and family income

In 1980, La Union had a population of 452,600, which was considered the second highest among the region's seven provinces. It was estimated to have grown at an annual average rate of 2.3% to a level of 508,300 in

[a]Don Pedro Bldg., Pagdaraoan, San Fernando, La Union, Philippines.

[b]The Ilocos Region referred to in this paper is the old regional delineation with seven provinces and four cities.

1985. The growth rate was slightly higher than the average growth of 1.9% during the 1970-1980 period because of the combined effects of better health and the increase in the immigration stream resulting from, among others, the designation of San Fernando as the regional capital, the establishment in 1983 of a State University and the implementation of major projects providing the pull factors to population migration.

The province's population is concentrated in the coastal municipalities. Almost one-third is in the three most populated towns of San Fernando, Bauang and Agoo. The capital town of San Fernando has remained the most populated town with its population in 1980 of 68,400 accounting for 15% of the provincial population. The least populated towns in 1980 were the upland towns of Bagulin, Burgos, Pugo and Santol, with a combined population of 26,800 constituting only 6% of the total provincial population.

The population density of the province in 1980 was 303 persons/km^2. The municipality of Agoo had the highest density with 891 persons/km^2 while San Gabriel, the largest municipality in terms of land area, had the lowest with 58 persons/km^2. The lowland/coastal municipalities, on the average, were more densely populated than the upland municipalities.

On the average, there are slightly more women than men in the province, with a ratio of 98 men for every 100 women. In 1980, in the young segment of the population, i.e., in the 0-19 age group, the ratio was 106 men to 100 women. In the older age groups, the opposite was true, 100 women to 90 men.

La Union's population is growing older as shown by the decreasing proportion (to total population) of the 0-14 age group. Since 1970, when this group accounted for 44%, the proportion has gone down to 40% in 1980 and to 39% in 1985. The 15-64 age group, on the other hand, has increased in proportion from 53% in 1975 to almost 56% in 1985. The implications of this to the province's employment generating capacity are of prime consideration in planning.

In terms of age dependency ratios, La Union in 1980 had 85 dependents for every 100 potential earners. The number has declined to 79 in 1985. Of the total number of dependents in 1980, 75 belonged to the 0-14 age group while 10 were aged dependents.

In 1980 the province had a predominantly rural population with 84%. Except for San Fernando, all the municipalities had more than four-fifths of their population in the rural areas. The municipalities of Bagulin, Burgos and Santol, all upland municipalities, have remained totally rural even as of 1985.

The urban-rural population ratio in 1980 was 19 to 100, and in 1985, 22 to 100. The tempo of urbanization during this period was 3%.

Although both urban and rural areas exhibit similar trends of decreasing proportions in the youth group (0-14) and increasing in the potential economically active group (15-64), the levels vary. In 1980, the proportion of the youth group to the 15-64 age group in the urban and rural areas was 37% to 41% and 53% to 57%, respectively.

Also in 1980, the number of dependents in the rural areas was higher than that in the urban ones. Every 100 persons in the productive age group of the urban population had 75 dependents while every 100 in the rural population had 87 persons. These figures imply the necessity of providing more income-generating opportunities in the rural areas.

Part of La Union's population growth comes from a net immigration flow. For the period 1975-1980, the net immigration rate was 3.2/1,000 persons, or a gain of 1,470 persons. Of the total gain, 23% were intra-regional migrants while the rest were inter-regional migrants.

In 1985, there were about 90,000 families in La Union with an annual average family income of ₱36,600[c]. The urban family's average annual income of ₱48,000 was almost 40% more than the rural family's ₱34,500.

In terms of distribution by income class, around 80% of the families (72,800) have incomes equal to or less than the annual average. There was a higher proportion of rural

[c]1985: ₱19.00 = US$1.00

families (72%) receiving less than the rural average income as compared to the urban families (69%).

Financial resources

In 1983, La Union had a total revenue of ₱18.3 million[d], 51% of which came from internal revenue and specific tax allotments. One-fourth of the total revenues were in the form of national aid. Only 21.4% of these revenues came from the exercise of the province's taxing power and its proprietary or business activities.

In 1983, too, the province incurred expenditures amounting to ₱17.1 million for economic development (30%), capital outlays (23%), public welfare (15%) and general administration (15%).

San Fernando, a first-class municipality, had a total revenue of ₱7.7 million, the highest of the 20 municipalities. Bagulin, a fifth-class municipality had the lowest revenue, ₱224,000.

Past Development Trends

Production

As of 1985, the total area for crop production was 51,540 ha, 96% of which were for temporary crops and 4%, for permanent crops. Since 1980, the area cultivated to crops increased by 10.5% or an annual increase of 2%.

Rice is the most widely grown crop in the province, with 64% of the total agricultural area in 1985 devoted to its cultivation. Rice crop yield in 1985 was 128,200 t (2.56 million *cavan* at 50 kg/*cavan*), or an average yield per ha of 3.9 t (77 *cavan*/ha). This level of yield was 22% below the *Masagana* 99 (a government national rice production program) target of 99 *cavan*/ha. Irrigated areas gave a greater yield of 4.3 t/ha, 14% higher than that of rainfed areas' 3.8 t. Tobacco remains to be the main commercial crop of the province. In 1985, tobacco production reached 5,900 t, harvested from 5,980 ha. This yield was roughly equal to the national average of 1.0 t/ha. Vegetable areas covered 8,580 ha or 14% of the total crop area for 1985. Vegetable production of 48,300 t from 8,580 ha placed vegetable productivity at 5.6 t/ha.

During the 1978-1982 period, poultry production declined by an annual rate of 5.6%. Livestock production generally increased at an annual rate of 0.9%, with carabao and goat production registering positive growth rates of 0.2% and 5.4%, respectively, and cattle and hog production registering negative growth rates of 3.1% and 1.1%, respectively.

Fisheries production remained practically stagnant during the 1983-1984 period, with production increasing only by 0.4%. Commercial and inland fisheries production registered positive growths but municipal fishing, which accounts for more than half of the total fisheries production, registered a negative 32% growth.

Cement production in the province, both in terms of output and value, declined from 6.54 million bags in 1983 to 4.75 million bags in 1984. Likewise, output of sand and gravel and pebbles declined. But, limestone production increased from 338,000 t in 1983 to 477,000 t in 1984. The declining trend in production may be attributed to the general economic slowdown experienced nationwide.

Labor force and employment

The population of 15 years old and over reached 293,700 in 1983 from a level of 260,000 in 1977, or an annual growth rate of 2%. The labor force participation rate fluctuated during the six-year period (1977-1983), with an average level at 63%. The highest rate was noted in 1982 at 72% while the lowest was in 1977 at 57%. In 1985, the rate even went down to 55%. Employment rates also fluctuated and averaged 95%. A downward trend was noted in 1977-1982 period, from 95% in 1977 to 92% in 1982.

In the 1975-1984 period, the agriculture, fisheries and forestry groups registered a generally declining trend, with an average annual rate of decline of 3%.

[d]1983: ₱14.00 = US$1.00

Two major industry groups registered negative growths (in terms of employment) during the 1975-1980 period: manufacturing with an annual rate of 2% and wholesale and retail group, with 5%. The 1980-1984 period saw tremendous declines in the electricity, gas and water groups with annual decline of 12%, and in the agriculture, fisheries and forestry groups with 9%. The financing, insurance and real estate, and the transport, storage and communication groups registered moderate rates of decline at 5% and 4% annually, respectively.

Development Challenges

Low incomes

The average income per family in 1985 was ₱36,600. Although this level was 19% more than the regional average, it was still considered relatively low. Estimates made by NEDA placed the poverty line at ₱31,300/year. With average income at only 17% more than the poverty line, it is estimated that 65% of the families in La Union have incomes lower than the threshold level.

Uneven growth and development

Despite generally having a relatively higher level of development compared with the other provinces in the region, many rural households in La Union barely benefit from the effects of such growth. Many municipalities, particularly those at the foot of the Cordillera Mountain, remain isolated from the mainstream of the development process due to lack of access, both in physical and economic terms, to productive activities, services and facilities. Such disparities in growth are evidenced by the following :

1. In 1984, San Fernando had revenues four times more than the second highest earning municipality, Agoo.
2. Also in 1984, the ₱389,400[e] average revenue of the four most depressed municipalities (all upland) was only 12% of the average revenue of the three municipalities (all coastal) with the highest revenue next to San Fernando.
3. In 1985, the average annual family income of an urban family, ₱48,000 was 40% more than that of its rural counterpart.

Geographically, growth has not been widespread but has largely been focused on the coastal and developed areas. This may be attributed to the growth center approach which caused the funnelling of investments in a few municipalities.

Environmental degradation

The destructive effects of indiscriminate disposal of industrial wastes, especially mine tailings, from the upland provinces; increasing forest denudation for agricultural purposes (e.g., shifting cultivation or felling of trees for fuel in the tobacco industry); and the proliferation of illegal means of fishing have been manifested by the frequency of destructive flash floods, inefficiency of river and irrigation systems and the disappearance of certain species of aquatic animals.

Aggravating this increasing environmental stress is the presence of such pollutive entities as cement plant, tobacco redrying plants and large-scale swine breeding which emits an obnoxious odor.

Rising social problems resulting from the qualitative inadequacy of social services

In terms of social facilities like schools and hospitals, the province is generally sufficiently provided for. In terms of the service component, however, the province is found wanting. For instance, while the classroom-pupil ratio is 1:22, the teacher-student ratio is 1:31 at the secondary level. Although adequate in number, many of the facilities are in a dismal state of disrepair, thus contributing to the low level of social services offered.

Some services particularly needed in urban areas (e.g. sewerage, solid waste disposal) are not adequately provided, if at all. The incidence of drug dependency, juvenile delin-

[e] ₱19.75 = US$1.00

quency and prostitution remains unabated because of the inadequacy, if not complete absence, of services and facilities to counteract them.

People's participation and program orientation

Project/program identification has largely been motivated politically and by the national government and has focused considerably on the showcase type of project. This is not to say, however, that these projects have not succeeded in providing some of the basic socioeconomic development prerequisites, like income and employment. To a limited extent, they have.

The point is that external assistance could be of limited efficacy and could be misdirected without local participation. Externally generated programs become of limited efficacy when these require local participation only at the implementation phase. They also become misdirected when geared solely to serve the national interests or, much worse, the interests of those initiating and implementing them, totally neglecting local inputs.

The challenge, therefore, consists of redesigning nationally formulated programs/projects so that these will be relevant not only to the national interests but also to the local communities.

Strategic location and function of the province

La Union has been dubbed as the "gateway to the North" because its main roads lead to the northern coastal provinces like Ilocos Sur, Ilocos Norte and Cagayan and to inland ones like Benguet and Abra. Moreover, the province's capital, San Fernando, is the center of the Ilocos Region. These, obviously, bind La Union to the rest of the region.

As such, the province cannot plan for its development in total isolation from the rest of the provinces in the region. Inevitably, its planning horizon, at least in particular aspects, needs to transcend its political boundaries.

Development Framework

Objectives

The basic objectives of the La Union Five-Year Plan are to:

1. Increase income and productivity levels to attain a "better quality of life." This requires the expansion of employment opportunities for the unemployed and the underemployed, and the intensification of projects to expand the output of essential items like food to provide not only for the minimum consumption of the province's population but also to generate surplus for export.
2. Ensure a more equitable distribution of economic opportunities. The distribution policy will seek to ensure that the more depressed segments of the population would enjoy higher levels of economic and social services in order to lessen the geographic development disparities and income differentiation.
3. Attain a higher level of social development. The delivery of social services will be improved, expanded and made more responsive in the depressed and underserved areas to attain a higher level of well-being among the people of La Union. These services include those on health, education and social justice.
4. Improve environmental quality. While intensified economic growth is an overriding objective, it should not be pursued at the expense of the environment. Effective measures to control the ill effects of pollutive industries should be devised.
5. Increase local participation in the development process. Existing local institutions shall be activated and strengthened to ensure their effective delivery of development services.
6. Devise a settlement pattern conducive to the development of the

province as an administrative center. The fulfillment of this objective requires the consideration not only of the existing relationship between production areas and market centers and urban-rural areas within Integrated Area Development (IAD) boundaries, but also of the implications of the multifunctional roles of certain municipalities of the province, particularly San Fernando. One of this municipality's roles, that as an administrative center, connotes its being a service area which transcends provincial boundaries. The plan also intends to set boundaries to create key and support programs as shown in Table 1.

Overall Strategy

The IAD strategy was adopted not only to set a new pace and direction in the overall development of La Union, but also to achieve complementarity of combined intervention efforts or inputs of both private and government entities, whether in the form of policies, institutions, programs and projects on the one hand; and popular participation in the planning and implementation process, on the other.

The IAD concept is deemed appropriate in La Union as a response to the need for balanced development between the predominantly rural agrarian and fast-growing urban sectors. Through IAD, the rural areas, especially the upland towns where agriculture remains the key economic activity, shall be linked to the urban centers in the coastal areas where the finance, technology and organizational expertise needed to stimulate development are located. The application of IAD to La Union is seen to be a step towards meeting the present government's commitment to develop the countryside and the depressed urban areas/groups.

For planning purposes, and considering such factors as geographic unity and cohesion, the province has been divided into three sub-IADs as follows:

Area I (northern area) - Luna, Balaoan, Santol, Bangar, and Sudipon.
Area II (central area) - San Fernando, San Juan, Bacnotan, Naguilian, San Gabriel, Bauang, Bagulin and Burgos.
Area III (southern area) - Caba, Aringay, Agoo, Rosario, Tubao, Pugo and Sto. Tomas.

Spatial Development Framework

Existing Land Capability and Use

A large portion of the province's land area, with varying range of slopes from 0-3% and 30% and above, is class R which is suitable for forest production and limited grazing. This class occupies an area of 100,410 ha or 67% of the province's total land area. Belonging to classes A, B_S and B_W are 39,570 ha (27%) of the total land area which are suitable for crop production with varying requirements for soil conservation. Class X which is found along the province's coastal areas facing South China Sea occupies an area of 1,570 ha (1%).

Of the total land area of La Union, 108,290 ha (73%) are classified as alienable or disposable, 8,410 ha (7.7%) of which are under urban and industrial uses; 52,210 ha (42%), under cultivation; 1,480 ha (13%) for inland fisheries; 44,810 ha (41%) of grasslands and 350 ha reserved for a national park.

Based on these figures, it can be noted that there is an indiscriminate land use mix and a lack of spatial interrelationship. This can be attributed to urbanization and the lack of proper zoning ordinances. In terms of development, coastal municipalities are being favored at the expense of inland municipalities which are lagging behind. Among the areas that are highly urbanized are San Fernando, Bauang, Agoo and Rosario. Built-up areas account for 8,407 ha of occupied lands which are mainly concentrated along major transport routes.

Land capability assessment shows that 39,570 ha are classified as prime agricultural land capable of sustaining the economic productivity levels of crops/land use over time

Table 1. Key and support programs to be created by the La Union development plan, with their respective objectives and strategies.

Program	Objectives	Strategies
Key		
Agricultural development	Maximize rice production and achieve self-sufficiency in other food like vegetables, corn, fish, livestock and poultry.	Expansion of agriculture and fisheries areas.
	Increase production of commercial and other agricultural crops serving as raw material inputs for manufacturing and processing industries.	Intensification of production through the use of improved varieties and the provision of other inputs and support activities.
	Provide, improve and expand marketing and other postharvest facilities and services.	
	Reorient agriculture research to the demands of an intensified and diversified agricultural strategy.	Diversification of production by employing multiple and intercropping methods.
	Intensify extension services and credit support especially in the production of long-gestation/perennial crops.	Specialization in crops where the province has a comparative advantage (e.g., tobacco and grapes).
Natural resources conservation and environmental protection	Conserve and protect forest areas, natural reserves, marine resources and other environmentally critical areas.	Reforestation/agroforestation of identified denuded forests or forest lands encroached upon for agricultural use.
	Minimize, if not completely stop, the use of environmentally destructive methods of resources exploitation, e.g., blast fishing, *kaingin*, etc.	Promotion of community/cooperative effort in both resources exploitation and conservation and management.
	Introduce measures to rehabilitate areas put to inappropriate use, e.g., *kaingin* areas.	Hastening of subclassification of public forests.
Rural industrialization	Promote/develop cottage and small-scale industries using agricultural crops indigenous to the province as inputs.	Encouraging the development of labor-intensive industries for the manufacture and processing of agricultural inputs and tools and machineries.
	Provide the necessary impetus and intensified support to reinforced agriculture development by utilizing surplus.	
	Promote employment-generating activities to enhance rural incomes.	

Continued

Table 1. (continued)

Program	Objectives	Strategies
Support		
Support services and facilities	Provide the needed social support services and infrastructure facilities.	More qualitative improvement of existing facilities and services and addition of these to focus on underserved and unserved areas.
Institutional development	Improve the province's capability to plan for and manage its development. Enhance beneficiary participation in program/project planning and implementation. Promote efficient institutional linkages and coordination for development planning.	Activation of existing entities and linkages for development planning. Involvement of intended beneficiaries as early as in the project planning stage. Integration of activities across the spatial and functional areas.
Domestic tourism promotion	Increase domestic tourist arrivals. Develop the tourism sector as a support market for cottage industry products.	Creation of a systematic tourism marketing program. Setting up of commercial centers within tourists' destination to market cottage industry products.
Urban infrastructure package	Upgrade infrastructure facilities to meet the growing needs of a rapidly urbanizing regional center.	

with less input to production and without any adverse effect on the immediate and adjoining environment. However, the existing land use for agricultural purposes is figured at 52,210 ha. This does not mean that there is no room for expansion since not all the agricultural areas (66,760 ha) fall within prime agricultural lands. Potential prime areas for agriculture (2,575 ha) were determined to be in the northernmost and southernmost municipalities of the province, notably Sudipen, Balaoan, Bacnotan, Bangar, Rosario, Agoo and Sto. Tomas. Area development for agricultural purposes shall be limited to 18% slope and below. There are agricultural activities in some upland areas adversely affecting environmental quality. These cultivated portions are found in the eastern part of the province, notably in the municipalities of Santol, San Gabriel, Bagulin, Burgos, Tubao and Pugo. Of the province's 19,389 ha of potential irrigable areas, 93% or 18,064 ha are already irrigated. The existing irrigation systems, mostly under the supervision of the National Irrigation Administration, are the Amburayan Irrigation System servicing Sudipen, Bangar, Balaoan and Luna; and the Masalip River Irrigation System servicing Agoo, Aringay, Sto. Tomas and Tubao.

As of 1984, La Union had 41,020 ha or 27% of its total land area classified as forest land. Out of this area, about 29,790 ha or 73.6% were classified as timberland. A watershed reserve of 90 ha is located at Naguilian for protection of the watershed area of Naguilian River. Of this forest land, a 210-ha park along the coast of Damortis and Agoo was reserved for mangrove forest. Civil and military reservations accounted for 1,085 ha. Brushlands covered 9,836 ha or 24% of the total forest area.

Encroachment of forest lands with agricultural activities is one of the pressing problems in the proper management of forest areas. Shifting cultivation which uses low-level farming system technology deprives the area not only of its forest cover but also of its habitat and sanctuaries for game and wildlife. These areas were identified to be in the municipalities of Pugo, Santol, San Gabriel, Bagulin and Aringay.

Mineral land covered 1,030 ha or 0.6% of the total land area of the province. Metallic deposits in the form of titaneferous magnetite sand which account for a volume of 23.3 million t can be found in Aringay, Caba, Agoo, Bacnotan and Sto. Tomas. As of 1985, there was no reported exploitation activity made on such mineral resource. Nonmetallic deposits in the form of limestone are abundant in the municipalities of Bacnotan, Balaoan and San Fernando with a total reserve of 69.1 million t. Considering the presence of Bacnotan Consolidated Industries (BCI) which tapped these resources for cement making, establishing another cement project is not practical. BCI is classified as a heavy pollutive industry. Its pollution effects are in 200-500 m radius in the form of dust particles and smoke emitted. Other mineral deposits are in the form of agillaceous, sticky clay and white and gritty clay. Of these deposits, sticky clay is the most promising source of income. It is used in pottery-making which augments rural income, and is abundant in almost all parts of the province.

Openland/grassland areas are the most vulnerable to intensive land use since their conversion needs less effort. Of the 62,950 ha of openland/brushland, 30,260 ha can be converted for forestry or agroforestry purposes. Openland/grassland with forest land should be subjected to intensive forestation activities. Wetlands fall under land capability class X which are most suitable for fishpond development. Of the 1,570 ha, Luna has the highest potential area of 840 ha; Bauang and San Fernando have 390 ha and 340 ha, respectively.

Proposed Land Use Plan

Being a limited resource, land should be utilized, acquired and disposed of very carefully. Hence, the allocation, intensity of land use activities and the type, design and location of structures and facilities are determined, thus:

1. Encourage the highest and best use, harmonizing private interests with social and economic policies;

2. Ensure the quality of air, water and other environmental values;
3. Optimize the benefits and minimize the cost of public utilities, services and infrastructure and other development costs;
4. Maximize the utilization of land; and
5. Reconcile conflicts, whether intertemporal or between present and future needs.

Land use planning involves deliberate and studied efforts of minimizing, if not entirely preventing, the undesirable effects of unregulated and unplanned developments such as conflicting land uses, inadequate or substandard facilities and services, congestion of people and activities and uneconomic and wasteful use of space. The most appropriate use of land is determined based on carefully undertaken studies and surveys. Thus, the land use planning study for La Union was undertaken to equate proper utilization of land resources with any development efforts in the area. The timing and phasing of the present land uses to other aspects within the framework of the overall growth and development of La Union are necessary. The restriction policies for land use planning are recommended to fully attain the maximum benefits from the land.

The existing urban land use shows that there are low-density settlements in the occupied areas in the province as of 1983. During the five-year planning period, it is assumed that expansion of areas for urban use is limited, except for the three identified growth centers which are projected to have a 2.8% annual increase in land area for urban use. It is therefore recommended that areas identified in this plan be prioritized. The expansion of urban and rural settlements has to be regulated by local land use plans and zoning ordinances. No expansion should be allowed in areas designated for cropland, pasture, inland fisheries, exploited forests and mining and quarrying.

Agricultural land expansion shall be limited to areas with 18% slope and below. This, however, does not apply to areas above 18% that are already utilized for agricultural purposes, provided that the occupancy of said area will not be expanded. However, these areas which are susceptible to degradation shall be protected to preserve environmental quality and minimize destruction.

Potential areas for agricultural expansion are identified as belonging to sub-IAD I and III where most lands are fertile and the slope is relatively plain and undulating. These are the municipalities of Sudipen, Balaoan, Bangar and Bacnotan for Area I and Agoo, Rosario, and Sto. Tomas for Area III. Upland stabilization programs shall be implemented in the municipalities of Santol, Burgos, San Gabriel, Bagulin, Tubao and Pugo where agricultural activities are being undertaken.

The ecological significance of the forest ecosystem is an important factor to consider in planning for development.

The following functions or characteristics of natural ecosystems are relevant to planning:

1. Flora and fauna genepools/reservoirs for indigenous, rare, threatened or common species;
2. Nursing and breeding areas for game and wildlife;
3. Natural barriers to protect/cleanse the areas from natural impacts;
4. Areas of high biological productivity essential to food chain/web;
5. Primary habitat for species perpetuation/protection; and
6. Areas which promote resources renewal.

These functions clearly show the necessity to protect and develop important ecosystems that are sensitive and susceptible particularly to the impact of pollution, resources extraction, infrastructure development/industrialization and incompatible land uses.

An ecologically significant area identified in the province which needs protection and rehabilitation is the National Seashore Park along Agoo-Damortis coastal area. The mangrove forest which covers the foreshore area must be developed and preserved. Other areas of major significance are the two watersheds of the three major rivers and those classified

as permanently protected forest in the municipalities of Santol, Bagulin, San Gabriel and Burgos.

Existing and Proposed Hierarchy of Settlements

As of 1980, the most populous town in La Union was San Fernando, with a population of 68,410 accounting for 15% of the total provincial population. The least populated was Burgos, an upland municipality, which population of 4,149 was less than 1% of the total provincial population.

In terms of urban-rural population ratios, San Fernando had the highest, 62 to 100, followed by Balaoan, 21 to 100; Aringay, 20 to 100; and San Gabriel, 18 to 100.

Applying the scalogram technique to determine the functional hierarchy of settlements in La Union, it was found that, based on 23 functions considered, the 20 municipalities can be ranked into nine levels which are given in Table 2.

This hierarchy underscores the existing imbalance among the municipalities in La Union, particularly between the lowland/coastal and upland municipalities.

Within the five-year period, San Fernando will remain to have multilevel functions: as regional and provincial and sub-IAD center. Beyond this period, however, San Fernando is envisioned to be transformed into a totally urban settlement, the functions of which shall be of higher level and of more specialized types.

To prepare for this, two minor centers shall be developed to take over the lower services, especially those on agricultural input and output market services. Bacnotan shall eventually serve the needs of the central municipalities of San Juan and San Gabriel including portions of Balaoan and Santol, while

San Fernando is the province's center which offers both basic and specialized services and facilities (e.g., for education, health and commerce). However, it appears that Agoo is being developed as an alternative center of the province.

To attain spatial integration in La Union (i.e., to efficiently link production areas to market towns, rural to urban areas and service centers to satellite areas), a hierarchy of settlements is proposed. This hierarchy shall provide a rational frame for the distribution and levels of services and facilities to be established in the province.

Table 2. Hierarchy of La Union municipalities based on functional analyses involving available services and facilities.

Rank/level	Municipality	Composite score
First	San Fernando	991.96
Second	Agoo	221.62
Third	Bauang	135.62
Fourth	Bacnotan	98.82
	Balaoan	96.49
	Tubao	88.81
	Naguilian	88.26
Fifth	Luna	76.72
Sixth	Sto. Tomas	66.49
	Rosario	63.77
	Bangar	62.11
	Caba	59.40
	Aringay	58.41
Seventh	San Juan	45.52
	San Gabriel	41.23
Eighth	Sudipen	30.96
Ninth	Pugo	21.13
	Burgos	18.67
	Santol	18.25
	Bagulin	15.29

Bauang shall cater to the needs of Naguilian, Bagulin and Burgos, including portions of Caba and Aringay. A third minor center, Tubao, shall also be developed to absorb certain lower functions of Agoo, a sub-IAD center which is expected to develop into a major urban center.

San Juan is expected to absorb part of the population migrating to San Fernando, and may eventually become the residential suburb to the latter.

Balaoan shall continue its historical role as center for small-scale manufacturing establishments. This sub-IAD center, however, needs to be physically linked to certain portions of its hinterlands, e.g., areas of Santol, which remain isolated. The sub-IAD centers are expected to provide the market with the outputs from the rural industries. The rest of the municipalities shall continue to supply the food and industrial needs of the higher level settlements. With this proposed settlement hierarchy, a more efficient urban-rural integration is expected to be achieved.

Plan Financing

The proposed programs and projects under the La Union Development Plan for 1987-1992 entail a total financial outlay of ₱736.4 million, or an average annual outlay of ₱147.3 million (Table 3).

Out of the total cost, ₱182.3 million (or ₱36.5 million annually) is the required net infusion from government. The amount of ₱554.1 million constitutes the private counterpart (particularly in the agricultural development and industry components) and the foreign funds committed for some infrastructure projects proposed (e.g., Overseas Economic Cooperation Fund of Japan for sports development).

At the current levels of regular budgetary appropriations to national agencies operating in the province and other fund infusions to it (e.g., infrastructure appropriations), and in anticipation of an increased revenue generation by the province and its constituent municipalities, financial capability for plan implementation is deemed adequate.

Historical figures show the following trends:

- Regular appropriations/actual allotments to national agencies in the province were estimated to average ₱86.6 million in 1985.
- Special loans availed of by the province for agricultural and industrial/trade projects in 1985 amounted to ₱15.2 million .
- Local government-generated revenues are expected to reach ₱28 million in 1987.

On the assumption that these trends shall continue, it can be gleaned that the province has the capability to finance implementation of the plan.

An important issue to consider in terms of financing, however, is the operation of the government budgeting system where budget preparation emanates from the region while decisions on the budget contents are decided upon at the central/national level. As such, there is no assurance that provincial priorities

Table 3. Financing requirements of programs and projects for implementation in the 1987-1992 development plan for the province of La Union.

Program/project	Cost (₱ x 10^6)[a]
Agricultural development	130.135
Rural industrialization	10.500
Support	
Tourism	3.857
Social services	15.160
Infrastructure	576.769
	736.421

[a]1986: ₱20.00 = US$1.00

shall be given budgetary allocations by both the national government and the implementing department.

To skirt this issue, therefore, the local government unit, in this case, the province of La Union and the municipalities therein, must strive to improve its capacity to generate on its own the needed financial resources and to manage these in the most efficient and effective manner.

Reference

IRDC-LPDS-NEDA (Ilocos Regional Development Council-La Union Provincial Development Staff-National Economic Development Authority Region I). 1986. Medium-term development plan for the province of La Union (1987-1992). NEDA Region I, San Fernando, La Union.

Working Group Reports on Issues and Recommendations

The various CRMP activities in the Lingayen Gulf area were envisioned towards eventual development of three main outputs. The first is a general CRM policy plan for Lingayen Gulf which consists primarily of zonation schemes for particular uses. It is to include marine (e.g., protected areas, tourism, commercial fishing areas) and terrestrial (e.g., urban, agricultural, watershed areas) zonation schemes, and elaborate policies, linkages/interactions among zones, and the general institutional framework for implementation. The second output includes more detailed action plans that address CRM from the perspective of the problem/resource, its prevalence and feasibility for management (e.g., fisheries management plan, alternative livelihood development plan, education action plan). The third output will be detailed action plans for selected sites requiring special attention (e.g., marine parks/reservation plan).

Since its inception in 1986, the project has generated considerable information relevant to, among others, social, legal/institutional and CRM planning issues in Lingayen Gulf. Given the preliminary inferences from these data as derived in two previous workshops (held in December 1986 and 1987) and the information presented in the three background sessions of this workshop, four working groups were formed to make issue-cause-action statements designed as initial inputs to the detailed action plans for the gulf. The four working groups and their respective issue/area of concern are as follows:

Group I: Resource management issues

Group II: Socioeconomic and cultural issues in relation to alternative management options and solutions

Group III: Legal and institutional arrangements for CRM implementation

Group IV: CRM planning

As a general case, discussions involved (whenever possible) consideration of the: (1) available data and possible data gaps; (2) preliminary actions/strategies to resolve resource-use conflicts; (3) possible implementing agencies; and (4) scale and geographical limits of various plans envisaged. Results of the deliberations of the four working groups are summarized below.

Group I: Resource Management Issues

Members: Virginia Aprieto (Chairperson)
Agnes Cargamento (Co-chairperson)
Mary Ann Leah Maaliw (Secretary)
Ernesto Baskinas
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In addressing issues on resource management, Group I focused on the following (Table 1):

- Overfishing - brought about by trawling, illegal fishing methods such as blast and cyanide fishing and others;
- Coral reef ecosystems - their overuse, destructive fishing methods prevailing in them, fishermen's lack of awareness on their value and others;
- Aquaculture - land use, methods and intensity; and
- Water quality - how this is affected by siltation, chemical pollution and mining.

Group II: Socioeconomic and Cultural Issues in Relation to Alternative Management Options and Solutions

Members: Nygiel Armada (Chairperson)
Fe Pastrana (Co-chairperson)
James Paw (Secretary)
Juliet Abunyawan
Remedios Baga
Edwin Barcia
Porfirio Basilio
Roberto Galvez
Flordeliz Guarin
Rizalina Legasto
Ramon Miclat
Leo Tepalt

The group focused on socioeconomic/ cultural issues (Table 2): overpopulation, low incomes, poor education, cultural degradation, lack of alternative income and low environmental awareness. Solutions drawn out were:

- Habitat restoration (artificial reefs, sanctuaries, transplanting corals, etc.);
- Marine reserves (national, community sites);
- Tourism (locations, national vs. community type, etc.);
- Alternative livelihoods (aqua/mariculture, tourism, handicrafts, other employment) (Table 3):
- Education (national, local, nonformal); and
- Community organization.

Group III: Legal and Institutional Arrangements for CRM Implementation

Members: Elmer Ferrer (Chairperson)
Victoria Bañez (Secretary)
Joseph Alabanza
Carlito Añonuevo
Ramon Binamira
Jorge de Vera
Rafael Guerrero
Alfredo Jacang
Florante Leal
Barbara Pernia
Josefino Tadifa
Chua Thia-Eng

Group III discussed the following issues (Table 4):

- Capability and location of institutions (government and NGOs) to implement CRM;
- Knowledge and appropriateness of existing laws affecting coastal areas;
- Institutional mandate over coastal and marine areas; and
- Low awareness among government officials about CRM at the local and national levels.

The group's recommendations on these issues were:

- Highlighting capable and motivated institutions for CRM implementation;
- Pinpointing of useful laws for enforcement;
- Recommending how to improve enforcement;
- Recommending how to increase awareness and credibility of government officials to implement CRM; and
- Suggesting new legal/institutional arrangements for field implementation.

Table 1. Summary of resources management issues, their causes and recommended actions.

Issue	Cause	Action
1. Overexploitation of fisheries resources in Lingayen Gulf has resulted into: • low biomass/stock densities; • low catch rates/income levels; and • increased competition/conflict among municipal and commercial fishermen.	1. Unregulated fishing operations.	1. Regulate fishing efforts through: establishment of "open and closed" seasons for particular fishing operations; regulation of number of commercial fishing boats; and reduction of municipal fishermen.
	2. Illegal fishing methods such as blast fishing, cyanide fishing and use of fine-meshed nets.	2. a. Provide alternative livelihood; b. Establish complementary and mutually supportive program towards: • massive multimedia approach to educate fishing communities on the effects of blast and cyanide fishing; • improvement of logistics for law enforcement to patrol coastal areas; • revision of fisheries laws; • coordination among law enforcement agencies (COSAC, INP, local government); and • creating/supporting fishermen's organizations to actively participate in CRM.
	3. Ineffective law enforcement.	3. As in no. 2.
	4. Lack of alternative livelihood.	4. As in no. 2a.
	5. Concentration of fishing in limited areas.	5. Make topographic studies and map out fishing grounds/resources.
	6. Lack of awareness on status of resources and consequences of overfishing.	6. Undertake massive multimedia approach to educate participants in capture fisheries. 7. Other actions: • establish coastal resources management council for Lingayen Gulf; • increase mesh size subject to results of study; • study seasonality and potential yield of tuna and other resources outside the gulf.
2. Coral reef degradation has resulted in the breakdown of the reef structure causing decline in productivity.	1. Poor land management (siltation).	1. a. Reforestation of mangroves in affected areas to check erosion; and b. Seagrass bed rehabilitation.
	2. Illegal fishing methods.	2. Same as action no. 2 of issue no. 1.

	3. Unregulated coral mining and fishing pressure.	3. a. Community-based management of reef resources (zoning); b. Setting up of no-access zones to serve as seed areas in which to initiate coral transplantation experiments; c. Setting up of artificial habitats (away from natural reefs) to remove pressure from natural reefs; and d. Management of coral reef areas by the coastal resources management council of Lingayen Gulf.
3. Low aquaculture production has resulted in low income of small aquafarmers.	1. Traditional management practices.	1. Demonstration of productive management practices in pilot scale.
	2. Lack of capital.	2. a. Contract farming with fish brokers; b. Organize small (1-2 ha) fishpond operators' cooperative as conduit for credit and other support programs.
	3. Lack of accessibility from source of water (inefficient water management).	3. a. As in no. 2b; and b. Government support for the construction of a common water supply canal.
4. Uncontrolled human activities have resulted in water quality deterioration in the gulf.	1. Uncontrolled use of pesticides and fertilizers even among small farmers.	1. a. Promote proper use of environmentally acceptable pesticides/chemicals (rotenone, tobacco powder). b. More farm testing on the use of organic and inorganic fertilizers (DA).
	2. Accumulation of nonbiodegradable waste in inland waters.	2. a. Proper sewage disposal (garbage bins, toilets); b. Regular garbage collection (local government); c. Proper sewage treatment; and d. Provision of buffer zones along riverbanks where wastes should not be dumped.
	3. Possible heavy metal contamination from mining operations.	3. a. Regular monitoring of mine tailing disposal system to determine concentration from the mine site to downstream of critical areas; and b. Treatment of mine tailing waste prior to disposal.
	4. Heavy deposition of silt in rivers/river mouths (silt coming from sources other than mine tailings such as logging, *kaingin*, quarrying and subsidence areas).	4. a. Reforestation (Department of Environment and Natural Resources or DENR; and b. Provision of land tenure for *kaingero* (DENR).
		5. Continuous water quality studies and identification of sources of pollutants (Philippine Human Resources Development Center, Environmental Management Bureau-DENR).

Table 2. Socioeconomic and cultural issues in relation to alternative management options and solutions.

Issue	Cause	Action	Agencies
1. The large number of fishermen and other occupational groups along Lingayen Gulf is causing overexploitation of coastal resources.	1. Cultural perception of a large family unit as beneficial in terms of security and of additional help to increasing income in fishing and other activities.	Information campaign on the disadvantages of large families and enhancement of population program.	Population Commission, National Cottage Industries Development Authority, Rural Improvement Club, Department of Education, Culture and Sports (DECS), Family Planning Organization of the Philippines.
	2. Lack of awareness of family planning methods.	Information campaign on family planning methods with feedback mechanisms to assess their effectivitiy.	Church-mandated organizations (all denominations possible), BFAR-DA.
	3. Migration into coastal areas. 4. Lack of socioeconomic activities and other forms of recreation to rechannel time and energies.	Setting up of alternative activities other than fishing, such as on recreation (sports, youth and employment clubs) cottage industries, backyard agriculture, livestock-raising, tourism, aquaculture).	
2. Sustenance fishermen of Lingayen Gulf generally suffer from underemployment and low income.	1. Stiff competition for a limited resource.		Department of Trade and Industry (DTI), provincial and municipal governments, NEDA, NGOs, BFAR-DA, UP-MSI and UP-CSWCD.
	2. Lack of alternative sources of livelihood.	Setting up of area-specific alternative livelihood programs as showcase/pilot projects (see Table 3).	
	3. Lack of functional education and practical skills.	Intensification of nonformal education programs e.g., practical mathematical calculation, value formation, environmental protection and conservation. Development of practical occupational skills.	
	4. Lack of/limited market.	Expansion of credit and marketing cooperatives and associations.	
	5. Unfair sharing practices in collective fishing activities.		
3. Cultural degradation is gradually being manifested in coastal communities.	1. Low income of fishermen.	Provision of alternative livelihoods to fishermen (see Table 3).	DECS, Department of Tourism (DOT), NGOs and provincial and municipal governments.

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	2. Lucrativeness of illegal activities, e.g., prostitution.	Enforcement of laws against illegal practices; passage of *barangay* and municipal ordinances on the conduct of persons (e.g., tourists) and activities.	
	3. Negative effects of media.	Counteraction of negative effects of media by promoting, properly developing and enriching indigenous culture.	
	4. Breakdown of community values.	Intensification of nonformal education programs.	
4. There is a low environmental awareness among the coastal populace regarding the proper utilization of resources.	1. Lack of educational campaigns on the importance of sustainable utilization of coastal resources.	Setting up of habitat restoration projects (such as artificial reefs, sanctuaries, mangrove reforestation and coral and seagrass transplantation) to increase environmental awareness of the people. Multimedia campaign (radio, TV, posters, billboards).	NGOs, DECS, DOT, media, e.g., Public Information Agency (PIA) and Kilusan ng mga Brodkaster sa Pilipinas (KBP) and BFAR-DA.
	2. Absence of subjects in resources conservation and management in educational curricula at different levels.	Inclusion of environmental subjects in school curricula.	

Table 3. Area-specific alternative livelihood programs.

Livelihood activities			Agencies
Sector I pilot area: Bolinao			
Handicraft	:	buricraft/furniture, shellcraft	DTI, Department of Science and Technology (DOST), DOT
Agriculture	:	Maguey, peanut, cassava	Fiber Industry Development Authority (FIDA), DA
Aquaculture	:	fish, seaweeds, giant clam, sea urchins	BFAR-DA
Sector II pilot areas: Sual/Labrador			
Handicraft	:	ceramics (pottery/brick), shellcraft, adobe quarrying	DTI, DOST, DOT
Agriculture	:	cashew	FIDA, DA
Livestock	:	hog and goat	FIDA, DA
Aquaculture	:	oysters, finfish, aquarium fish, seaweeds *(Eucheuma, Caulerpa)*	BFAR-DA
Sector III pilot areas: Agoo/Aringay			
Bottom set artificial reefs • for habitat restoration and fish enhancement to increase production; • to enable the communities to exercise TURFs; and • to discourage trawl intrusions in municipal waters			BFAR-DA, NGOs

Group IV: CRM Planning

Members: Liana McManus (Chairperson)
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Florence Gacad (Secretary)
Leo Dacanay
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Evangeline Miclat
Virginia Orejudos
Arcangel Vargas
Alan White

The group discussed the following goals:

- Conceptual framework for CRM planning;
- Specific mechanism for achieving planning tasks in Division 600-P as outlined; and
- Long-term planning for Lingayen CRM strategy implementation.

Review of Management Plan Formulation. In doing this, attention was brought particularly to management policies involved, the plan as a zonation scheme, issue-oriented and special-area management plans and prioritization of such plans.

Policies for management should include: (1) a definition of desired resource area per capita; (2) a redelineation of commercial and municipal fishing grounds; (3) guidelines for marine protected areas; (4) delineation of communal usage rights and municipal proprietary rights; and (5) a statement on augmenting production for domestic consumption rather than for export.

The plan is proposed to be a zonation scheme showing areas that should be designated to particular uses. It should reflect the people's will, and steps must be taken to ensure their participation in developing the plan.

Education should be a component in drawing up the various issue-oriented action plans. However, a large-scale environmental education project can also be proposed as a separate action plan.

Additional management plans should cover: (1) an aquaculture area management plan which would include an evaluation of the carrying capacity of Tambac and Dagupan areas; (2) afforestation with mangrove

Table 4. Institutional and legal issues related to CRM implementation.

	Issues	Solutions
A.	Institutional	
1.	Limited awareness and knowledge of CRM by the people and local government units (LGU) concerned.	Promote awareness and education on proper CRM at all levels of the government through trainings and community organization. These activities should be a joint effort of line agencies concerned.
2.	Limited support from LGU for activities related to the preservation of coastal resources.	
3.	Poor implementation of existing laws and policies regarding fishing activities, particularly illegal ones, due to the following: • no equal application of laws; • no clear definition of the responsibilities of agencies (law enforcers) involved in the protection of coastal resources; and • absence of facilities to protect coastal resources and to apprehend blast fishermen.	
4.	Absence of economic livelihood support to fishermen to augment their income and thus stop them from practicing blast fishing.	Provide alternative livelihood assistance to fishermen such as: • inventory of available resources in the area; • provision of support services like market and credit; • encouragement to local entrepreneurs to assist market support to fishermen; Strengthen appreciation of the people's values and traditions. Transfer appropriate technology to fishermen.
5.	Presence of bureaucracy or red tape in the processing and approval of requests of agencies concerned.	
6.	Lack of integration among agencies resulting in overlapping of functions and programs.	Clearly define agency roles, functions, jurisdictions and resources to eliminate duplication and confusion.
B.	Legal	
1.	Lack of autonomy of LGU on fishing laws and regulations.	Full support to TURF by LGU and law enforcers.
2.	Absence of guidelines, laws or policies on seafarming both at the national and local levels.	
3.	Lack of appreciation and knowledge of existing traditional local arrangement at the *barangay* level.	Policies made by LGU must be piloted at the *barangay* level.
4.	Involvement of many national agencies in the management and protection of the same coastal resources.	

Implementation of the above may be done with the following considerations:

1. CRM planning will be undertaken at the regional level whereas implementation will be the responsibility of the provincial and municipal governments.
2. Local institutions, entrepreneurs, church councils and NGOs will be tapped to assist in the implementation and monitoring of projects under CRM.

Table 5. Issue-oriented, special area management plans ranked according to various criteria.

	Plan	Criteria			
		Implementability[a]	Urgency[b]	Potential benefits[b]	Mean[c]
1.	Coral reef resources management	3	1	1	1.7
2.	Commercial and municipal fisheries	3	1	1	1.7
3.	Alternative livelihood	2	1	1	1.3
4.	Water quality	3	2	1	2.0
5.	Social/educational action plan	2	1	1	1.3
6.	Aquaculture area management	1	2	1	1.3
7.	Afforestation	2	1	1	1.3
8.	Marine parks	1	1	2	1.3
9.	Appropriate tourism	2	2	2	2.0
10.	Legal/institutional program	2	1	1	1.3
11.	Human resources development	2	1	1	1.3

[a]Scores indicate easy(1), hard(2) or difficult(3).
[b]Scores indicate high(1), medium(2) or low (3).
[c]Mean score varies between 1.0 and 3.0, the lower limit indicating highest priority ranking (i.e., most implementable, urgent and beneficial), and vice-versa.

and fruit-bearing trees; and (3) an educational program which will develop a lecture package on environment for elementary and high school students in La Union and Pangasinan.

Apart from the Hundred Islands National Park, other areas should be set aside as replenishment or seed zones (e.g., Poro Point, Darigayos, Binabalian Turtle Nesting Area) all over the gulf.

The development of tourism should be highly selective, that is, activities should not destroy the ecological or cultural environment. Resource use conflicts in areas to be declared as tourist spots should first be resolved.

The issue-oriented and special-area management schemes were prioritized using the following criteria and rank scores:

1. Implementability - easy (1), hard (2), difficult (3);
2. Urgency - high (1), medium (2), low (3); and
3. Potential benefits - high (1), medium (2), low (3).

The group came up with rankings as shown in Table 5. The lower the mean score for a given plan/scheme, the higher priority it shoud get and vice versa.

Identification of Management Plan Group. Regional and provincial expertise should be tapped in the development of the management plan. Specifically, the agencies include NEDA-Region I, the Provincial Development Staff (PDS) for La Union and Pangasinan and the other line agencies in the region (e.g., DECS and BFAR-DA). NGOs will also be potential resource agencies. The Ilocos Regional Development Council can help in policy formulation.

The group unanimously recommended NEDA-Region I as the lead agency for the CRMP plan formulation. The present cooperating agencies - UPV-CF, UP-CSWCD, UP-MSI, BFAR-Aquaculture Division--will remain to constitute the technical support panel for this activity.

Summary of Plenary Session Discussions

In the light of the workshop's set objectives, the following were facilitated: (1) presentation and evaluation of the research findings on the coastal resources of Lingayen Gulf; (2) determination of long- and short-term strategies necessary to remedy the coastal resources depletion and environmental degradation and to offer alternative programs to sustain livelihood in the affected coastal communities; and (3) identification of the government and nongovernment agencies that will either take active part in the management plan formulation and implementation, or serve as resource agencies.

The workshop participants, in plenary session, adopted and endorsed the reports of the four working groups. The following are the conclusions and recommendations stressed during the plenary session of the workshop:

On the formulation of the CRM plan for Lingayen Gulf:

1. NEDA-Region I and RDC shall take active part in the drafting of an integrated management plan together with the CRMP group. Other line agencies, staff bureaus, educational institutions and NGOs shall serve as resource agencies.
2. Alternative livelihood program, social/educational action plan, upland/coastal afforestation, marine park establishment, legal/institutional program and human resources development are priorities based on the criteria of implementability, urgency and potential benefits. Though management of coral reef resources and of commercial and municipal fisheries are primary in terms of urgency and potential benefits, their implementability becomes difficult due to the legal and political problems attached to them.
3. The planning group will have to come up with a set of criteria for selecting the pilot areas where management actions may be implemented. Among the suggested considerations are density of population, number of beneficiaries, volume of production and existence of necessary facilities and physical structures.
4. During the course of management plan formulation, review and finalization, the direct beneficiaries of the program must be well-informed and enjoined to participate in the decisionmaking through the conduct of symposia, consultative meetings, and/or public hearings. Some projects do not succeed because a top-down approach fails to give emphasis on the real needs and aspirations of the people. Participatory planning and implementation must be encouraged to stimulate the enthusiasm of the local communities in CRM.

On the immediate courses of action:

1. The NEDA and RDC, through their functions of reviewing and approving the budget proposals of the government projects in Region I, shall suggest the incorporation of the urgent CRMP action plans. This is to allow implementation prior to the

preparation of an integrated management plan as envisioned under ASEAN-US CRMP.

2. NGOs must also be mobilized to take on the early implementation of small-scale (but impact) action plans through the assistance of the local communities. This is to address the more serious problems of the gulf residents which cannot wait until the finalization and implementation of the overall management plan.
3. The ongoing projects in the region which are in accordance with the proposed CRMP action plans must be accelerated. Such activities are implemented by line agencies (e.g., afforestation project of DENR), staff bureaus (e. g., fisheries resource enhancement through the artificial reef program of BFAR), and non-governmental entities (e. g., upliftment of human conditions by the Center for Development of Human Resources in Rural Asia; artificial reef projects of fishermen's associations). It is necessary that isolated efforts for similar goals be well-coordinated for an accelerated delivery of results.
4. Task forces for some pressing issues (to be composed of selected project staff and NGOs and government entities identified to take part in the management planning) may now be formed. These task forces can later on become the nucleus for actual implementation of the plan.
5. The issues affecting Lingayen Gulf and the efforts exerted by the different sectors to bring solutions to these must be popularized. This can be achieved through the conduct of symposia, and the distribution of the CRMP publications and information materials to improve or stimulate the awareness of the people. For these activities, educational institutions, particularly the Pangasinan State University and the Don Mariano Marcos Memorial State University, must be tapped.

Annexes

Annex I

Program of Activities

25 May 1988

Morning

Registration
Welcome Address - Dir. Joseph Alabanza (NEDA Region I)
Opening Remarks - Dr. Rafael Guerrero III (PCAMRD) and Dr. Chua Thia-Eng (ASEAN-US CRMP)

Break

Session I: Coastal Resource Utilization

A. Status of Capture Fisheries in Lingayen Gulf - Nygiel Armada
B. Sociocultural Dynamics of Blast Fishing and Sodium Cyanide Fishing in Two Fishing Villages in Lingayen Gulf - Ma. Theresa Tungpalan
C. Status of Coralline Resources in Lingayen Gulf - Dr. Liana McManus and Lambert Anthony Meñez
D. Patterns and Levels of Aquaculture Practices in the Coastal Municipalities of Lingayen Gulf - Aida Palma
E. Water Quality Baseline Study in Lingayen Gulf - Mary Ann Leah Maaliw
F. Land Use Patterns and Physical Characteristics of Provinces and Municipalities Bordering Lingayen Gulf - Leonardo Quitos

Open Forum: Chairman - Dr. Virginia Aprieto; Moderator - Dr. Edgardo Gomez; Rapporteur - Lambert Anthony Meñez

Lunch Break

Afternoon

Session II: Habitat Restoration/Enhancement and Alternative Livelihood

A. Artificial Reefs: A Fisheries Management Tool for Lingayen Gulf - Ramon Miclat
B. Community-based Marine Parks - Dr. Alan White
C. Tourism - Arch. Edwin Barcia
D. Mariculture as an Alternative Source of Livelihood for Fishermen in Lingayen Gulf - Rizalina Legasto
E. Mariculture of Giant Clams and Sea Urchins - Marie Jo Trinidad-Roa

Open Forum: Chairman - Dr. Reynaldo Trino; Moderator - Dr. Liana McManus; Rapporteur - Mary Ann Leah Maaliw

26 May 1988

Morning

Session III: Socioeconomic, Cultural and Legal/Institutional Framework
A. The Economics of Municipal Fisheries: The Case of Lingayen Gulf - Carlito Añonuevo
B. Legal and Institutional Arrangement for Territorial Use Rights in Fisheries in Lingayen Gulf - Elmer Ferrer
C. Management Plan Formulation - Dr. Alan White
D. Development Plan for the Provinces of Pangasinan and La Union (1987-1992) - Leonardo Quitos

Open Forum: Chairman - Dir. Joseph Alabanza; Moderator - Roberto Ferrer; Rapporteur - Roberto Galvez

Afternoon

Workshop: Integration of Days 1 and 2; Discussions/Recommendations

27 May 1988

Morning

Work Group Presentations of Results/Recommendations from Day 2

Plenary Session to Synthesize and Discuss the Results of Four Working Groups (No consensus is expected but discussion should focus on conflicts and overlaps of group outputs.)

Chairman - Dr. Rafael Guerrero III

Closing Ceremonies
Awarding of Certificates
Closing Remarks - Roberto Ferrer (Provincial Planning and Development Council, Province of Pangasinan) and Dr. Virginia Aprieto (ASEAN-US CRMP, Philippines).

Annex II

Opening and Closing Remarks

Welcome Address

MR. JOSEPH ALABANZA
Director
National Economic Development Authority (Region I)

I would like to welcome you to Region I.

It is quite symbolic that you hold your meeting in the region. A lot of times we in the regions feel that we are just second class citizens, in the sense that most of the decisions and actions are being made for us at our central offices. But your presence this morning, your concern about decentralization and regionalization, is what we appreciate most.

I have gone over the objectives of this workshop which in particular refer to the proposed management of Lingayen Gulf. I suggest, however, that we bear in mind the other sections of Region I for which our actions and programs for Lingayen Gulf may be replicated and similarly implemented. Hopefully, the same can be replicated in other areas of the country.

Another point that I would like to emphasize is that outputs for this workshop which are action-oriented activities should be within the context of our regional development strategy. On our part we, as regional planners, will utilize the more specific information you provide in order to improve our strategy for development. Let us then work together in coming up with an overall framework for development in the region to which the specific actions that will be generated in the next two days will be inputted.

Opening Remarks

DR. RAFAEL GUERRERO III
Executive Director
Philippine Council for Aquatic and Marine Research and Development

Today we put on focus the heart of ASEAN-US CRMP in the Philippines. We are here to assess the more than two years of research works on various fields in the coastal zone of Lingayen Gulf and to map out our future directions. We have among us our colleagues and friends from the region who will share with us their gut feeling of the issues besetting Lingayen Gulf and perhaps feel the pulse of CRMP. I say this because we are in the site for which the

CRMP efforts are intended. I'm glad to see my colleagues from the implementing agencies notably the UP and BFAR who have worked so hard to make the project what it is today, with the able and valuable support of ICLARM.

We are here to establish contact with our partners in the region who, in the final analysis, will decide whether the CRMP plan we envision to formulate will be practical and implementable. Our three-day workshop here should be as exciting and stimulating as the previous workshops we have had. This one differs from the others, though, in that we shall be exchanging thoughts and ideas with the planners of the region. May I emphasize once more that the main objectives of CRMP are to improve the living conditions of the depressed coastal communities and to manage the coastal resources on a sustainable basis.

I wish to thank Dir. Alabanza and his staff for providing us the support in organizing this workshop. I look forward to fruitful and enlightening discussions among each and everyone of you.

Opening Remarks

DR. CHUA THIA-ENG
Project Coordinator, ASEAN-US CRMP
International Center for Living Aquatic Resources Management

I wish to thank the organizers for giving me the honor and the opportunity to address the workshop this morning.

To me, this workshop is specially significant for three reasons. First, it is being conducted at the site of the present study. Second, its being co-hosted by the Regional Office of NEDA highly signifies the regional interest in this activity. And third, we will be discussing the types of actions most appropriate in managing our coastal resources, the exploitation of which can be sustained environmentally. When we talk about sustainable development we must bear in mind that the resources we are now exploiting and utilizing will still be available in the same quantities, if not more, for the next generation and others to come.

This is the third workshop being conducted by the Philippine National Team of the ASEAN-US CRMP. The first two workshops were conducted in December 1986 and April 1987. The first workshop attempted to determine coastal resource use conflicts in Lingayen Gulf and their causes; identify information gaps; and develop research proposals to obtain the needed data for planning and management. The second workshop focused on the evaluation of data collected by each task. The present workshop will attempt to formulate appropriate management action plans based on the scientific data collected by various teams. The outcome of this workshop will provide recommendations for general policy formulation and the development of area-specific and issue-oriented CRM plans.

You may ask why we go through all these long processes to produce the CRM plans. My only answer is that careful consideration will be needed since the plans we develop have long-term socioeconomic implications on the welfare of the coastal communities. A good CRM plan should be based on sound scientific data and beneficial to the people.

The major functions of this workshop should be to:

- critically assess the data collected for CRM planning;
- comment on the feasibility of action plans recommended by the technical teams;
- identify future information gaps and evaluate the data collection process; and
- set the scope for general and special area management plans to be developed.

At this stage I wish to point out that our role as technical persons is to provide an accurate data base and its scientific interpretation as well as recommend appropriate policy guidelines for

management measures. We should provide the best advice we can think of. It is the political leadership that has to make the policy decisions.

At this workshop, I am pleased to note the participation of relevant representatives from the region. Together with the technical teams, I am sure we will be able to achieve our set objectives.

Closing Remarks

DR. VIRGINIA APRIETO
Program Leader
ASEAN-US CRMP (Philippines)

Closing ceremonies are like saying good-bye. In this undertaking, however, we shall not say good-bye because the results of the present workshop are simply the beginning of the greater task ahead of us -- an operational CRM plan. It must be noted, though, that this workshop has taken us closer to our ultimate goal, and thus the organizers and participants of this meeting deserve our congratulations for a job well done.

The Philippine Council for Aquatic and Marine Research and Development (PCAMRD) is mandated to coordinate and evaluate all marine aquatic research and developmental programs in the country. The ASEAN-US CRMP in the Philippines is presently the biggest project (in terms of personnel, funding, and goals/objectives) being implemented via PCAMRD. The dedication, diversity and quality of the expertise that the CRMP has managed to pool together for its various activities has given PCAMRD both pride and pleasure in coordinating project activities.

We are happy that CRMP has chosen Lingayen Gulf as one of its maiden sites. This is the first time such an integrated management program is being undertaken for an important water body in the country. Over the past days, we have heard of the serious issues affecting sustainable use of the Lingayen Gulf coastal resources. Amidst these problems, however, I am happy to note the genuine enthusiasm and support of the people of the Lingayen Gulf area for sustainable productivity of the gulf. It is quite encouraging that the leaders of Pangasinan and La Union, government agencies, nongovernmental organizations and the fishermen (such as Mr. Joe de Guzman of the local trawlers association) contributed considerably and enthusiastically to the workshop deliberations. We know that many challenges still lie ahead, but with the participation and institutional commitment demonstrated in this workshop and the political will, then an operational CRM plan (that is holistic and optimally sustainable) will soon be a reality.

Closing Remarks

MR. ROBERTO FERRER
Secretary-General
Provincial Planning and Development Council, Province of Pangasinan

The three-day workshop has accomplished quantifiable results. It has successfully (1) identified and delimited data gaps; (2) transformed research results into tangible recommendations; (3) prioritized issues and corresponding action plans; and (4) laid the basis for redirection and/or improvement of local, regional and national government efforts/programs.

Moreover, this meeting has drawn genuine commitments from the local agencies/communities and has made a very good case for concerted action and collaboration. Given the issues affecting sustainable utilization of the Lingayen Gulf coastal resources, we from this region would like to see the following:

- Restoration of the ecology/ecosystems of Lingayen Gulf and peripheral areas;
- Maintenance of water quality by minimizing pollution from domestic, agricultural and mining activities;
- Increased social awareness (through formal and nonformal education) on the causes and effects of habitat destruction/degradation;
- Development of local CRM expertise;
- Increased community involvement/participation to assure continuity of project gains, strengthening of existing social structures;
- Alternative livelihood projects; and
- Scientific but practical solutions.

I would like to thank the ASEAN-US CRMP, the various academic institutions represented here, NEDA-Region I and all government agencies and NGOs for their genuine concern for the welfare of the people in the Lingayen Gulf area, and for their continuing commitment in pushing the CRM concept for the gulf from the realm of intentions closer to the realm of implementation. Let us move now before we lose by default due to inaction.

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Towards sustainable development of the coastal resources of Lingayen Gulf, Philippines. G. Silvestre, E. Miclat and T.-E. Chua, editors. 1989. ICLARM Conference Proceedings 17, 200 p. US$9 surface; $15 airmail.

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The coastal environmental profile of Lingayen Gulf, Philippines. L.T. McManus and T.-E. Chua, editors. Available June 1990. ICLARM Technical Reports 22. $1 surface; $5 airmail.

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- S. Toeche-Mittler GmbH, Versandbuchhandlung, Hindenburgstrasse 33, D-6100 Darmstadt, Federal Republic of Germany (for Europe). **Airmail price must be used.**
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