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PREPARATION OF THIS REPORT

This is the report of the ACMRR Working Party on the Management of Living Resources in Near-shore Tropical Waters, held in Rome, 28 February - 4 March 1983, as approved by the Working Party on 4 March 1983. Annexed to this report are selected and revised working papers presented to the meeting. The working paper from ICLARM is included under the authorship of Pauly and Smith.

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1983

THE RESEARCH PROCESS AND COMMUNICATION OF RESULTS: LESSONS LEARNED FROM A MULTIDISCIPLINARY ANALYSIS OF A TROPICAL SMALL-SCALE FISHERY[1/]

by

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1. INTRODUCTION

Along with an increase of their relative share of the total world catch, most tropical countries have experienced in the last decades an expansion of their fisheries research activities. These activities, whether based solely on the funding of national institutions, or on international institutions, multilateral or bilateral cooperative projects, have produced noticeable insights into the nature of the factors which determine fishery yields in the tropics. Yet, the complex nature of the fisheries resources and the overall scarcity of the human resources that have been devoted to applied fisheries research are such that large gaps in our understanding remain concerning tropical fisheries and their management.

In an effort to address some of these questions, the Institute of Fisheries Development and Research (IFDR) of the University of the Philippines in the Visayas and the International Center for Living Aquatic Resources Management (ICLARM) conducted a multidisciplinary investigation of the fisheries of San Miguel Bay in the Bicol region of the Philippines, from 1979 to 1981. Detailed results of this study have been published in several technical reports (see Table 1). In this paper, therefore, we will mainly address the issues of why we did what we did, and how we went about it rather than elaborate on the results obtained. Our aim is to identify an approach generally applicable to the multidisciplinary study of tropical multispecies multigear fisheries, through a presentation of our research process and discussion of lessons learned regarding research methodologies and communication of results.

Table 1

Publications based on San Miguel Bay Project data

Emphasis on	Biology, stock assessment	Economics	Sociology
Methodologies; background paper:	Mines (1982) Mines *et al.* (1982)	Smith, Mines and Beñacia (1982)	Yater (1983a) Bailey (1982a)
Special topics:	Pauly (1982) Cinco (1982) Navaluna (1982) Pauly (1982) Vakily (1982)	Yater, F. (1982) Supanga and Smith (1982) Supanga (1982) Tulay and Smith (1982) Navaluna and Tulay (1982) Cruz (1982) Yater, Esporlas and Smith (1982)	Esporlas (1982) Villafuerte and Bailey (1982) Yater, L. (1982a) Yater, L. (1982) Bailey (1982) Bailey (1982a)
Synthesis of results:	Pauly (1982a)	Smith and Mines (1982)	Bailey (1982a)

1/ ICLARM Contribution No. 142

2. THE LOCATION OF THE STUDY: WHY WE CHOSE SAN MIGUEL BAY

San Miguel Bay, located on the southeastern (Pacific) coast of Luzon Island is one of the major fishing grounds of the Philippines (Figure 1).

The physical characteristics most relevant to the historical expansion of fisheries there are:

- the surrounding area is heavily populated and few non-agricultural employment opportunities exist;
- the Bay, because it is sheltered, is the only fishing ground along the Pacific coast of the Philippines where fishing operations continue throughout the year, in spite of the heavy monsoon winds;
- the Bay is extremely productive, due to its extreme shallowness and to the fact that it is an estuary of the Bicol River whose waters are heavily silt laden; and
- the Bay is highly accessible and is connected by road to Manila, the final destination of a significant part of the catch from the Bay, especially high-valued shrimp.

Because of the physical features of the Bay itself, the fisheries of San Miguel Bay are rather isolated from the surrounding fisheries, thus providing us with a "unit fishery". The estuarine nature of the Bay, moreover, has the effect that the Bay's fish communities are rather easy to separate from the fish communities outside the Bay, which consist predominantly of rocky bottom and coral reef communities. The relatively small amount of interchange between these fauna thus provided us with a more or less homogeneous (multispecies) "unit stock".

The major motive for studying San Miguel Bay, rather than any other fishing ground resulted, however, from our interest in a fishing ground reported to be overfished (Simpson 1978). Also, it was perceived that given the large number of poor fishermen around San Miguel Bay, the primary objective of our study should be to conduct:

> "an in-depth study of the San Miguel Bay fisheries to facilitate this sector's inclusion in the Bicol integrated area development programme, a plan from which fishing communities have been generally excluded". (Maclean 1980, p. 98).

The study was therefore designed to help in deciding what degree of emphasis, if any, should be placed on programmes which encourage the movement of small-scale fishermen into other economic activities. This focus on the possible need for reducing fishing effort was, when it was formulated, in stark contrast to Government policy at that time (1979) which was geared toward fishery development and the provision of loans to fishermen (including those around San Miguel Bay) to facilitate the purchase of improved vessels, engines and gear.

The San Miguel Bay fisheries are exploited with a variety of small-scale gear (such as gillnets and fixed gears) and by a fleet of small trawlers. Under current Philippine law, these trawlers must fish in water deeper than 7 fath. A number of petitions submitted to the President of the Philippines by small-scale fishermen protesting the illegal operation of trawlers in the shallow waters of the Bay provided a certain sense of urgency to our study.

To summarize, we chose San Miguel Bay as the site of a multidisciplinary fishery research project because of:

(i) its importance as a fishing ground;

(ii) its physical characteristics which provided relatively isolated unit stocks and unit fisheries;

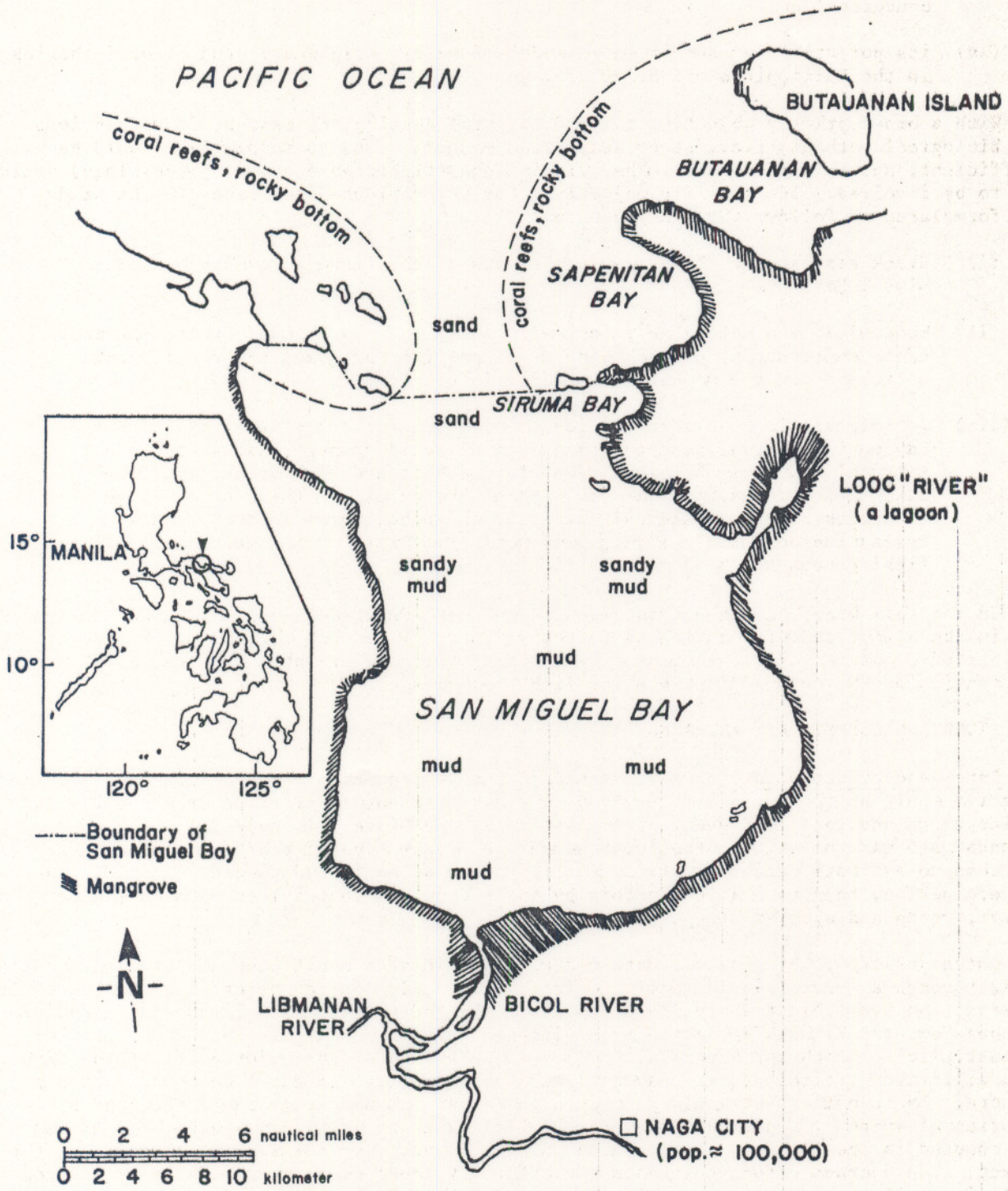

Figure 1 San Miguel Bay, Philippines

(iii) the socio-economic and political relevance of the issues to the area concerned, and

(iv) its potential for serving as a model of multidisciplinary studies of fisheries in the Philippines and elsewhere.

With a broad primary objective related to rural development issues, it was obvious that biological methods (i.e., stock assessment methods *sensu stricto*) alone would be insufficient, and that therefore, other disciplines (fisheries economics, sociology) would have to be involved. The specific objectives for the various disciplines in the study were formulated as follows (Maclean 1980, p.100):

(i) Stock assessment: To assess the status of the fishery resources of San Miguel Bay;

(ii) Economics: To determine catch, effort and incomes of municipal fishermen, costs and returns for the major municipal fishing gears and the economic efficiency of the marketing and distribution system;

(iii) Sociology: To assess the socio-economic development of the six San Miguel Bay municipalities, and to analyse in selected communities, social and external linkages, attitudes and preferences toward fish production, processing and marketing; and to examine the nature of the flow of human resources between municipal fisheries and other rural sectors, and to assess the potential of programmes that seek to reduce the dependence of fishing households on capture fishing.

In the following, an account is given of the methods of data collection and analysis used in the study, and of the reasons for using them (Tables 2,3,4). During the course of the study, our focus shifted from the long-term objective related to rural development to attention on the need and options for fisheries management.

3. STOCK ASSESSMENT DATA AND ANALYSIS

Catch and effort data: It was assessed at the very onset of the project that a primary objective would be to obtain a reliable estimate of present total catch from the Bay, by species group and gear, and every effort was made to achieve this objective. The basic approach used was to estimate the total numbers of every type of gear in use around the Bay, then to estimate catch-per-effort (c/f) by gear by month and species group over a 12-month period, then to multiply effort by the c/f to obtain total catch from the Bay, by gear, month and species group.

Catch per effort by gear was obtained mainly by direct monitoring at selected landing places through a record-keeping activity (see next section on economics). In the case of trawlers, the available fishery statistics as collected by Philippine fisheries agencies were supplemented by data collected by project assistants who made trips on the trawlers at least twice a month for a period of one year. Numbers of the major gears of the fishery (e.g., gillnetters, fixed gears, trawlers) were obtained from counts along the beaches and offshore. These numbers were always much higher than the number of those licensed by fisheries officers or municipal treasurers. Smaller gears (e.g., push nets, handlines) were counted in the course of a household survey conducted by the sociology module of the project. The average effort and catch per effort of these gears were obtained both from recall interviews and by direct monitoring.

The catch estimates by species group obtained by the project personnel for the Bay as a whole (Table 5) were generally 3-4 times higher than those given in official statistics. As discussed in detail (Pauly and Mines 1982), we consider our catch estimates more accurate than those reported in the official statistics.

Historical data: A special effort was made to acquire historical data, i.e., unpublished reports or data collected earlier on the Bay's fisheries by various groups of researchers dating to the 1940s. We had the complete cooperation of the Research Division of the Bureau of Fisheries and Aquatic Resources, which provided data from commercial and

Table 2

San Miguel Bay Project: Major data sources and sampling methodology of "stock assessment module"

Phase		Duration	Data collected	Frequency	Sampling methodology	Sample size
I	a) Catch and effort	2 years	catch, effort and catch/effort data for all gears	continuous	– small-scale fishery: actual gear counts and beachside sampling of catch-per-trip data	very large, i.e., giving c/f on daily basis for some, and on monthly basis for most gears
				continuous	– trawl fishery: sampling on board trawlers, complemented with in-depth analysis of adjusted catch statistics	about 2 trips per month
	b) Length-frequency data	2 years	length-frequency data on 15 different species of fish	continuous	measurement of length-frequency samples on board trawlers	about 2,500 fish measured
II	Bathymetric survey	1 day	present depth contours of San Miguel Bay	once	echosounding of San Miguel Bay with portable echosounder	40% of the Bay's surface area was covered
III	Survey of previous literature and historical data	2 years	list of fish and general hydrography of San Miguel Bay. Reviews estimates of effort and of catch/effort of trawlers. Previous catch composition and anecdotal information on changes in the Bay's fishery	continuous	scanning of all likely sources of primary and secondary data; including files containing unanalyzed data, theses, published and unpublished reports, etc.	not applicable

Table 3

San Miguel Bay Project: Data sources and sampling methodology of "economics module"

Phase		Duration	Data collected	Frequency	Sampling methodology	Sample size
I	Household inventory	3 months	Assets and no. of fishermen per household; sources of financing for owned assets; gears used	Single visit per household in target community	Census of all households in target community	Established sample frame (430 households) for subsequent data collection
II	Landing survey	1 year	Ex-vessel prices of major species. Catch per vessel landing. Number of vessels/gear types landing	3 times weekly at each landing site in target communities	Data collected from all vessels landing through observation and personal interviews of fishermen, wives, and buyers	Varied depending upon number of vessels landing
III	Market price survey	1 year (concurrent with landing survey)	Prices of fresh and processed products in 4 markets	2-3 times weekly	Data collected from all sellers in each market, supplemented by secondary price data of government	Varied depending upon number of sellers in the markets
IV	Costs and earnings record keeping	1 month	Assets, investment costs, life of assets, age and education level of fishermen, sharing system used	Single interview	20% purposive sample (see below) of fishing units in 2 target communities	62 fishing units
		1 year	Catch, operating costs, value of catch per trip/day. Repair and maintenance costs, sharing system modifications	Daily record keeping	20% purposive sample of respondents willing to cooperate	62 fishing units
V	Middlemen and processors cost survey	2 months	Fixed and variable costs, estimated life of fixed assets, daily volume, cost of purchases and receipts, attitudinal data regarding ease of entry	Single recall interview	20-50% random sample of middlemen and processors in target communities	64 firms

Table 4

San Miguel Bay Project: Data sources and sampling methodology of "sociology module"

Phase		Duration	Data collected	Frequency	Sampling methodology	Sample size
I	Community inventory	5 months	Infrastructure, social services, population, no. of fishing households	Single visit to all fishing communities	Key informants interviewed; secondary data from municipalities	Established sample frame for Phase II
II	Socioeconomic survey	7 months	Household characteristics, assets, income, education, attitudes, role of women, sharing systems, marketing practices, occupational and geographic mobility. Physical count of all gears in all communities	Single interview of fishing households	30% sample of fishing households in 22 out of 41 fishing communities; mix of purposive and random sampling	641
III	Participant observation	1-6 months	In-depth information on marketing practices, role of women and children, sharing systems and kinship, occupational and geographic mobility, labor absorption capabilities of other non-fishing sectors.	"Live-in" in single community	Participant observation and in-depth interviews with key informants Examination of census population and migration data	n/a

Table 5

Total annual catch, and trawl fishery and non-trawl catches by taxonomic groups for San Miguel Bay, 1980-81[a/]

Taxonomic group	Total annual catch (t)	Catch (t) by:		% caught by:	
		Trawl fishery	Non-trawl fishery	Trawl fishery	Non-trawl fishery
Sharks and rays	45	36	9	79.9	20.1
Stolephorus spp.	2 100	1 369	731	65.2	34.8
Sardinella spp.	795	201	594	25.3	74.7
Arius thalissinus	44	6	38	13.0	87.0
Mugilidae	1 190	330	860	27.7	72.3
Otolithes ruber	2 004	409	1 595	20.4	79.6
Sciaenidae (excl. *O. ruber*)	1 468	313	1 155	21.3	78.7
Pomadasydae	34	21	13	61.5	38.5
Carangidae	269	57	212	21.3	78.7
Leiognathidae	112	38	74	33.8	66.2
Trichiuridae	324	254	70	78.5	21.5
Scomberomorus commersoni	75	28	47	37.9	62.1
Misc. spp.	4 406	3 018	1 388	68.5	31.5
Squids	250	235	15	93.9	6.1
Crabs	500	120	380	24.0	76.0
Penaeid shrimps	1 044	461	583	44.2	55.8
Balao	4 473	0	4 473	0	100.0
Total catch (excl. balao)	14 660	6 896	7 764	47.1	52.9

a/ Adapted from Pauly (1982a).

research trawlers operating in the Bay. After checking for accurary and standardization, the data were used to demonstrate a steadily declining trend of trawlable biomass in San Miguel Bay, down to 20% of the original biomass in 1947 when the first survey was conducted (Table 6).

We concluded that historical data are highly valuable in stock assessment and that an active search should always be conducted for such data in the course of any stock assessment project.

Length-frequency data: Length-frequency data were collected with two goals in mind: to contrast the size of fish caught by the non-trawl fishery with those of fish caught by the trawl fishery and to estimate growth and mortality parameters of exploited fishes.

To achieve the first of these goals, it was sufficient to collect only a limited amount of data, since it rapidly emerged that generally the trawlers catch much smaller fish than those caught by the non-trawl fishermen.

It was also possible to achieve the second of these goals with a limited amount of length-frequency data because most length-frequency data were obtained on board trawlers, whose gears are only moderately selective, and because the ELEFAN method used for the analysis is not very demanding in terms of data requirements (Pauly and David 1981; Pauly and Ingles 1981).

Yield-per-recruit analyses: As opposed to the situation prevailing in long-lived, single-species stocks of temperate waters, yield-per-recruit analyses conducted on one or several single species of a tropical multispecies stock is generally insufficient to generate meaningful management options for the fishery as a whole, unless short-cut methods are used to assess the impact of a given mesh size on a given multispecies stock, as shown by Sinoda *et al.*(1979). For this reason, in the San Miguel Bay study, we used the yield-per-recruit approach (Beverton and Holt 1957, 1966) only to illustrate relatively minor points, such as the impact of the extremely small meshes used to trawl for anchovies in the Bay.

Biological and oceanographic data: Little emphasis was given in the San Miguel Bay Project to the collection of biological data *per se*. For example, no fish identification programme was conducted because we had no problem with the identification of the important species. However, a list of fishes occurring in trawl catches was compiled, which, combined with San Miguel Bay records from the taxonomic literature, enabled us to compile a list of fishes from San Miguel Bay containing 188 species, 28 of which were new records.

An exhaustive literature search was then conducted of known biological characteristics of those fishes, which enabled us to group the species into various feeding guilds and to build a model of the trophic interrelationships in the Bay, and hence, to assess the potential impact of the selective exploitation of various groups of species on the multispecies stock as a whole. Also, the list of fishes was divided into various groups depending on the reported extent of their euryhalinity, with the result that it was possible to characterize the San Miguel Bay fish fauna as typical estuarine fauna, markedly separated from the hard bottom reef fish fauna off the mouth of the Bay. The species list thus helped us define the multispecies "unit stock" exploited by the San Miguel Bay fishery.

Similarly, very little emphasis was given to the collection of oceanographic or hydrological data. Rather, available secondary data on tidal amplitudes, river discharge into the Bay, rainfall, wind and scattered measurements of salinity were combined, such that a coherent picture of the Bay's water budget emerged, further characterizing the Bay's estuarine properties.

Also, one day was devoted to conducting a bathymetric survey of the Bay, using a simple battery-operated echosounder attached to a fisherman's boat. The results were used to quantify the rate of siltation of the Bay (using the best available nautical chart as reference), which has implications both for the biological productivity of the Bay and to the accessibility of certain parts of the Bay to fixed and mobile gears, hence, to fishery management issues.

Table 6

Estimates of trawlable biomass in San Miguel Bay, 1947-81[a/]

Year		Apparent density (t/km^2)	Trawlable biomass (t)	Number of hauls	Vessels used	Source of data
1947	July	10.6	8 900	5	THEODORE N. GILL	Warfel and Manacop (1950)
1957/58	8 months	5.20	4 370	100	ARCA I, ARCA II	daily reports of a private operator to BFAR Research Division
1967	July	3.91	3 280	2	R/V MAYA MAYA	logbook of R/V MAYA MAYA (BFAR Res. Div.)
1977	September	3.49	2 930	6	"a baby trawl"	Manuscript, BFAR Research Division
1979	July	1.84	1 560	3	F/B GEMMA	Manuscript, BFAR Research Division
1980	February	1.89	1 590	25	F/B SANDEMAN	Manuscript, BFAR Research Division
1980/81	year-round	2.13	1 790	whole fishery	average small trawler	Vakily (1982)

a/ From Pauly (1982a); the biomass estimates are based on standardized catch-per-effort data and application of the swept-area method.

4. ECONOMICS DATA AND ANALYSIS

No previous economic research had been conducted on the San Miguel Bay fisheries; nor were any secondary data on costs, earnings or ex-vessel prices available. Consequently the economic analysis depended entirely on primary data collected during the study.

Cost and earnings: In the study, we gave the highest emphasis to obtaining annual costs and earnings data from a sample of the major trawl and non-trawl gears operating within the Bay.

Initially, through a combination of trip interviews and observation at major landings, we collected data on various gears per fishing trip (costs, value of the catch, fishing location, age and education of major fishermen). We abandoned this approach to costs and earnings, however, when we realized that we could not monitor any particular sample of fishermen in this manner to obtain costs and earnings by individual fishing units over time. For example, if a particular fisherman did not appear at the landing on a given day, we did not know if he had fished with another fishing unit, used a different landing or simply not fished at all. Instead of trip interviews, therefore, we instituted 12 months of record-keeping with a smaller sample (62 fishing units) of the major gears. Landing observations were continued for one year to collect catch, effort and ex-vessel price data.

One may question the usefulness of record-keeping techniques because participants must often be selected non-randomly. However, we believe that it is better to obtain highly reliable data from a smaller sample of respondents selected to approach representativeness than to collect poor quality data from a larger random sample.

The costs and earnings data collected through record-keeping were aggregated manually by research assistants at the end of each month. Although some details were lost in the process, aggregation was especially important for us in the San Miguel Bay study because access to huge computers was both distant and expensive, and because the project's young research assistants could be better trained in the analysis of the data by actually tabulating it using programmable calculators as the project proceeded.

Inventory of fishing assets: The participants in the costs and earnings study were interviewed at the beginning of the record-keeping activity to collect data on investment and fixed costs. Total number of gears operating in the Bay was provided by the sociology module, based on counts in all 41 fishing communities that surround the Bay.

Income of boat owners and crew: As in most small-scale fisheries around the world, income of boat owners and crew are determined by the sharing system for the gear in question. There are many variations on the basic 50-50 sharing system in San Miguel Bay depending upon the gear, fishermen's kinship ties and location. For example, we found that the crewmen of gillnetters in one community in proximity to Naga City, the major commercial centre of the area, had been able to shift the sharing system 60-40 in their favour because of the higher opportunity costs for labour prevailing in that area. The vast majority of the small-scale gears used the 50-50 sharing system however, so fishing income for boat owners and crewmen was determined from the costs and earnings data provided by the record-keeping activity (e.g., as for the gillnetters shown in Figure 2). Pure profit (resource rent) for each gear type was determined by deducting all remaining costs (including opportunity costs of capital and labour) from the respective income shares of owner and crewmen.

The opportunity cost data were particularly important to us because in addition to being a necessary component of costs to compute pure profit or resource rents by gear type, they also provided a basis of comparison of fishing incomes with the next best employment alternatives in the area. The sociology module assisted with the collection of data on income to labour in alternative activities, such as carpentry, piece-work for fish processors, or in the more accessible communities, tricycle driving. Our results showed that the majority of fishermen in the Bay are earning their opportunity costs or slightly more, implying that entry to the fishery will continue. The fact that in absolute terms fishing income is very low simply implies that the opportunity costs of labour are also very low due to the limited non-fishing alternatives in the immediate area; this is confirmed by the sociological studies (see below).

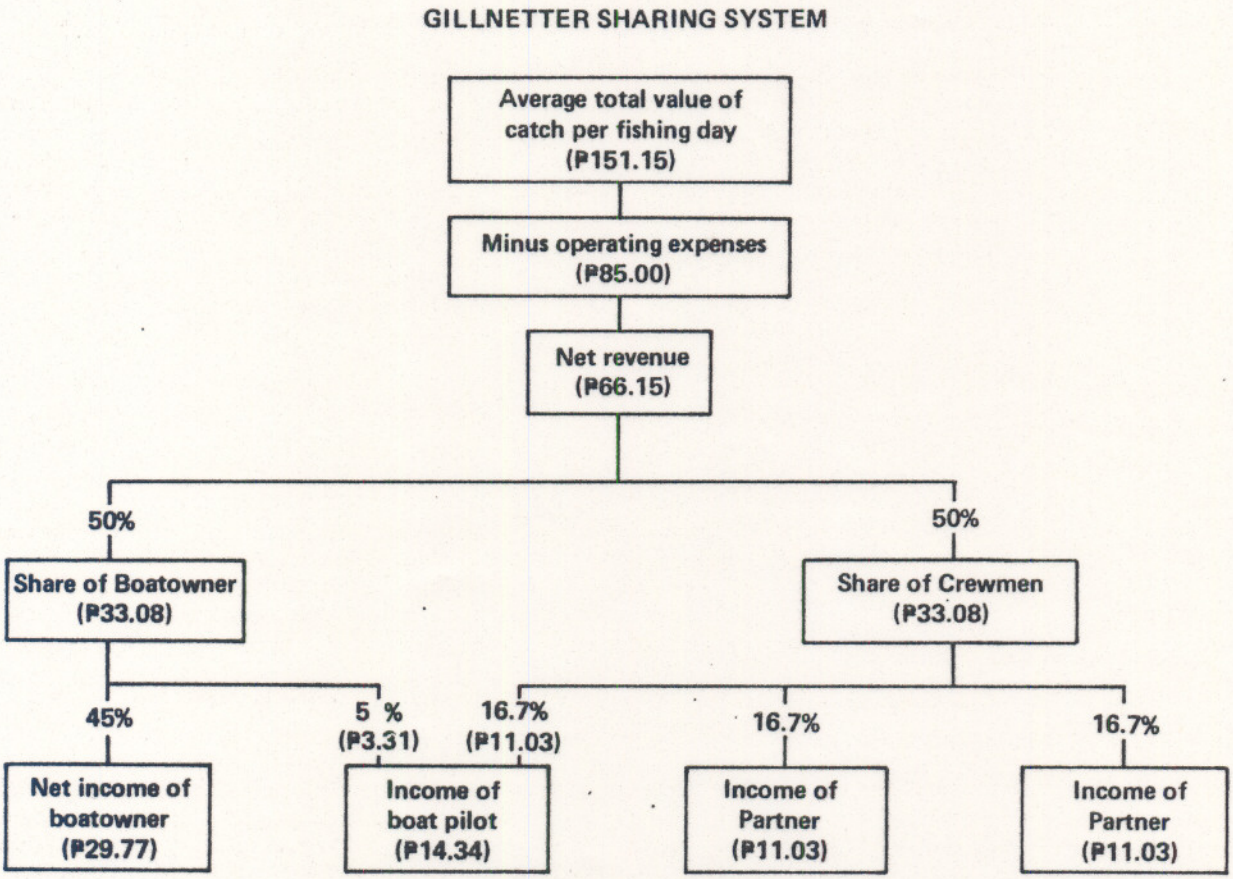

Figure 2 Example of a daily sharing system in San Miguel Bay (gillnetters based on 1980-81 data). Fixed costs and repair and maintenance costs have not been deducted yet from net income of the boat owner

Prices received by fishermen: The landing survey discussed above under "cost and earnings" was the source of ex-vessel price data for the San Miguel Bay study. Because most catch in the Philippines is sold unsorted by volume (a variety of containers is used), collection of accurate ex-vessel price data presented the economics module personnel with more difficulties than any other activity during the 2-year study. We eventually devised a weighting system to estimate prices by major species based on the following information: total value of the transaction; number and weight of containers (we had earlier devised a conversion table of containers to weight); approximate species composition; and relative prices that middlemen would be willing to pay for each species by weight. We could not use the relative prices from nearby markets as a weighting factor because there too, sales are by volume or number of fishes not by weight. This method gave us crude ex-vessel price estimates by major species over the one year that the landing survey was conducted. These data were supplemented by observed prices when particular species were sorted and sold by weight. Unfortunately, this method of sale was less frequently practiced.

To examine the economic efficiency of the marketing sector, we elected to concentrate upon spatial and form price analysis based on data for the major processed and fresh fish from three major landings and three major retail markets. We believe our price data are reasonably accurate and were pleased with the general price relationships which support the hypothesized spatial relationships among markets, though correlation of prices among markets is very low. The observed prices also supported the hypothesized relationships between prices of fresh and processed products, though again correlation was low. Our major problem occurred in the collection of marketing costs because we left this aspect of our work until too late in the project. The marketing survey of processors and middlemen costs was conducted only once at the beginning of the peak season, and covered only the previous day's activities. Though the results demonstrated the expected economies of scale, the same survey should have been repeated at regular intervals through a full year. Where possible, we strongly recommend the inclusion of the marketing sector in record-keeping activities as early as possible in any multidisciplinary study.

5. SOCIOLOGICAL DATA AND ANALYSIS

Primary data: Three techniques were used for collecting primary data: household surveys, interviews of key informants and participant observation. In terms of time and resources spent, the household survey received considerably more emphasis than the participant observation. If we were to do the study again, we would want to bring more of a balance to these two methods and, above all, reduce the number of variables collected through survey techniques. The household survey was designed to serve part of the data needs for the economics, biology and sociology modules; instead, it should have been limited to basic socio-cultural attributes, asset ownership and attitudinal questions. In particular, we found we were unable to make much use of the fishing income and cost data that were collected other than to estimate roughly the percentage of households exclusively dependent upon fishing.

Participant observation, which required the research assistants to live in selected fishing communities for up to one month, produced a rich mosaic of information on the various fishing and marketing activities. In addition to proving educational for the research staff involved, many dimensions of the sharing and marketing systems, for example, would not have been fully appreciated without the information collected using this method.

Secondary data: The most extensive use of secondary data in the sociology module was for the study of occupational and geographical mobility and assessment of income opportunities in local non-fishing activities. Census data of the last four decades, including as yet unpublished data from the most recent (1980) census, were examined. The census survival method was used to determine migration patterns as far down as individual barangays (village administrative units). Supplemented by interviews with families in the San Miguel Bay area, many of whom have family members living elsewhere, the study showed strong outmigration as a response to actual and perceived differentials in economic opportunities. In absolute terms, fishing communities in the San Miguel Bay area still grew at 2.04% per year (1948-80), though less than the national average of 2.71% per year over the same period.

6. MAJOR RESULTS OF THE STUDY

Some of the results obtained through the application of the above described methods were already mentioned. The study's major findings regarding appropriate methods are two-fold. First, our main result is that it appears unnecessary to develop overly sophisticated bio-economic models in the first instance to improve one's understanding of a given fishery. Indeed, given the paucity of high quality time-series data on most tropical fisheries, sophisticated model building would seem to be particularly inappropriate. The important key to a comprehensive research process, it seems to us, is to make clear statements at the onset of the project about manageable objectives and plan how these goals are to be reached by listing data requirements, including quantity and quality, data sources and analysis planned.

A second result is that the simultaneous application of methods from several disciplines lowers the overall costs of data acquisition, and provides extremely useful checks, confirmation and further insights to the findings of any one discipline. The advantages of a multidisciplinary approach can be demonstrated by the following summary presentation of specific research findings.

The stock assessment work, total biomass and single-species methods led to the conclusion that overfishing takes place in the Bay in the sense that further increases of effort will not increase catches. If, as appears likely, increased effort comes in the form of additional trawlers, there will be a transfer of a further proportion of that catch away from the non-trawl fishery (about 3 000 households) to the trawl fishery (about 40 households) (Table 7).

The economic analysis confirmed this competition between non-trawl and trawl gears. The fishery, which is worth approximately P 53 million per year produced a resource rent (pure profit) of only P 3 million (excluding the Government's revenues generated by its taxes on gasoline and diesel) in 1980-81 (Figure 3). Unless entry is limited, expected additions to the trawler fleet will probably completely dissipate this rent in the next few years. Moreover, the present resource rent is distributed very unevenly, with the trawlers earning 85% of the pure profits, while the non-trawl fishery earns the balance. Data on concentration of fishing asset ownership provided by the project sociologists indicated the highly skewed distribution of benefits from the fishery.

The sociological studies, particularly the studies on the occupational and geographical mobility of the San Miguel Bay fishermen, added another dimension to these results by showing that employment opportunities outside the fishing sector are rather poor and that there is a high rate of migration out of fishing communities. This migration, however, is more than offset by population growth so the absolute number of small-scale fishermen will continue to increase.

The Bay can be characterized as having a growing number of fishermen but finite fish resources. Thus, all three disciplines gave the San Miguel Bay fishery the same bill of health; namely that it sorely needs management to address the twin problems of overfishing and inequitable distribution of benefits from the fishery.

7. COMMUNICATION OF MANAGEMENT OPTIONS

Our initial primary objective was to determine the extent to which the fishing communities of San Miguel Bay can be incorporated into the Bicol region's integrated area development planning. Implied in this objective is the belief that long-term solutions to problems of overfishing in the Bay and low levels of income in fishing communities would lie primarily outside the fisheries sector *per se*. As our research study progressed, however, it became apparent that short-term solutions to these problems could also be sought through management of the Bay's resources and possible redistribution of the prevailing catch and benefits among the competing trawl and non-trawl fisheries. Because the problems uncovered during the course of the study increasingly revolved around issues of equity and income distribution, a sociopolitical dimension was injected into the study. This dimension had not been foreseen when the study was initiated.

Table 7

Summary of data on the San Miguel Bay Fishery (1980-81)

Characteristics	Trawl	Non-trawl
Number of fishing units	95	2 300
Number of fishermen	600	5 000
Number of households owning fishing units	40	2 000
Percent of total catch[a/]	56%	44%
Percent of total value	55%	45%
Percent of pure profits (resource rent)	85%	15%

a/ This differs slightly from the percentages in Table 5 because of non-inclusion of balao in Table 5 and slight differences in computation of total catch between the stock assessment and economic modules.

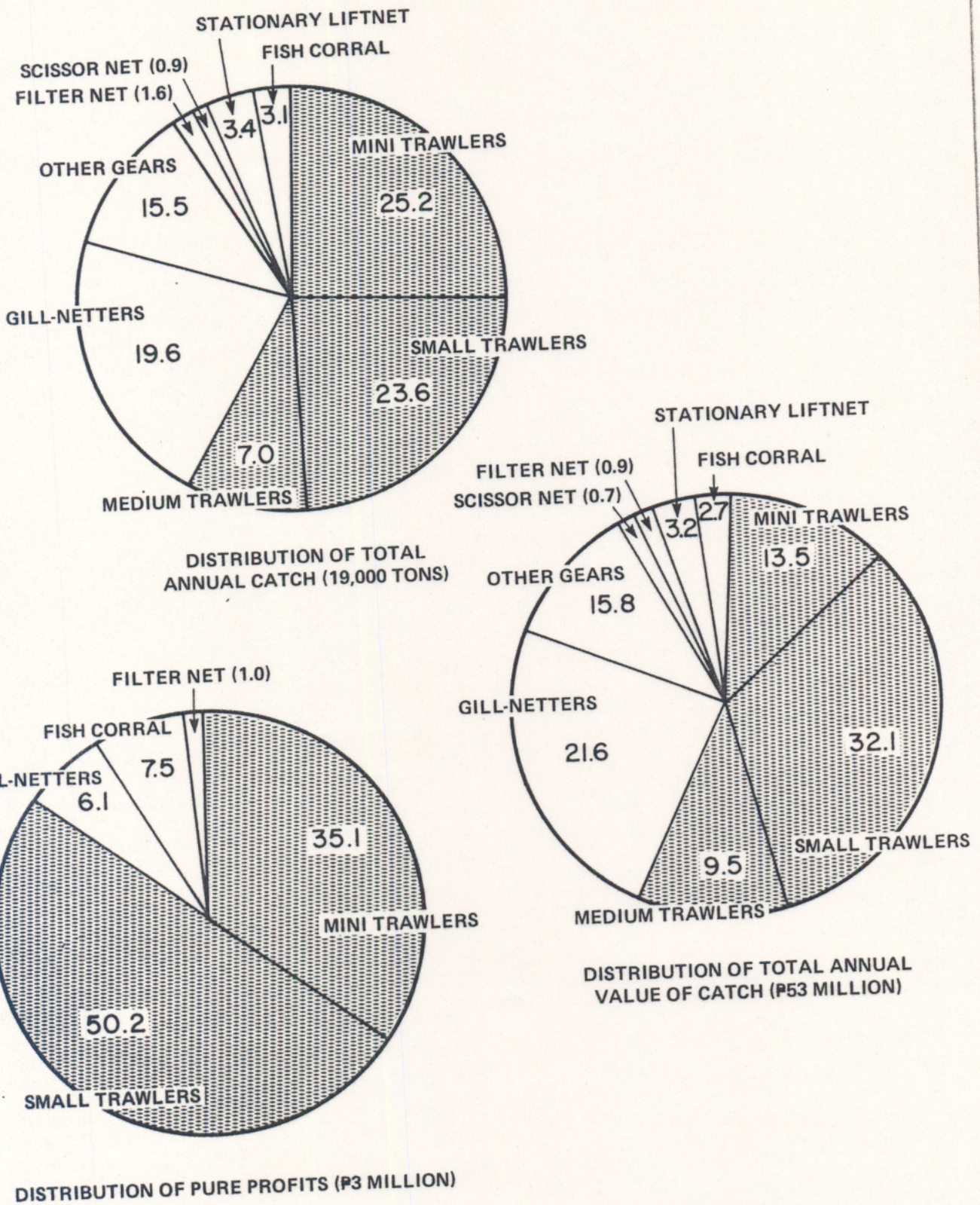

Figure 3 Distribution of annual total catch, total value of catch and pure profits between different gears and between the trawl (shaded) and the non-trawl fisheries of San Miguel Bay, 1980-81

With this shift in focus as a background, we view the process of communicating the results of the IFDR/ICLARM San Miguel Bay study as containing two distinct elements:

(i) formal communication of technical results to the scientific community; and

(ii) formal and informal communication of the results and their policy implications to fishermen, concerned fisheries agencies and other governmental bodies with jurisdiction over the Bay's fisheries.

The first of these elements can be accomplished quite readily through publication of technical reports and wide dissemination of these both within the Philippines and elsewhere. Commenting upon the need for such communication may seem unnecessary, but unfortunately, the number of fisheries projects worldwide that produce extremely limited documentation is distressingly high. Table 1 gives a listing of the formal publications produced during the IFDR/ICLARM study.

The second element of communicating research results is much more problematic for several reasons. The first problem facing fisheries researchers is that all too often no one is listening. Failure to integrate research findings with development planning is common, and the researcher is often faced with the uphill task of having to wait until the research is completed before being able to convince the fisheries planners of the usefulness of such integration. This is especially the case when the study has been conducted by a university-based group, as was the case with our San Miguel Bay study.

A second aspect of this lack of integration of research and planning is that research is seldom seen as part of the necessary continuing process of data collection and analysis required for rational management of fisheries. Most tropical countries concentrate their statistics collection efforts upon catch and possibly prices, and are thus a long way from appreciating the value of management-oriented research. Researchers themselves contribute to this problem with their concentration upon partial analyses, whether biological or socio-economic, that stop short of evaluating management options. Indeed, our initial primary objective for the San Miguel Bay project led us away from a more productive working relationship with the local fisheries office; instead we were in contact primarily with the regional development planning body which has no explicit role in fisheries management.

A third problem facing researchers regarding communication of their results is that they are often expected by fisheries agencies to come up with a list of recommendations on what should be done by way of follow up. If the researcher is examining a narrow issue such as vessel or gear efficiency, then recommendations for improvement may be appropriate. In the case of studies as broad as the IFDR/ICLARM San Miguel Bay study, however, where the major issues are those of overfishing and inequity, it is unreasonable to expect researchers to make explicit recommendations. This is because any action that redistributes income should be the result of a political process, a process that should not be pre-empted by the researcher.

Fisheries management thus contains an inherent political element. Our approach in the San Miguel Bay study has been to outline management options and present the likely trade-offs of each. In this sense, we are letting our findings "speak for themselves". A combination of: (1) written reports; (2) seminars with appropriate fisheries agencies, municipal and provincial officials; and (3) translation of research results into more popular forms of communication such as audio-visuals and magazine-type articles has been (or will be) undertaken.

It is obvious from our research results that managing the Bay's resources will require some limitation on fishing effort. Failure to do so will not only contribute to further overfishing, but will also exacerbate the already inequitable distribution of benefits from the fishery between the trawl and non-trawl sectors. This leads to a final problem that relates to the problem mentioned above regarding the integration of research with planning. Possibly the best way of reaching this integration would be to set up a permanent body (e.g., involving fishermen representatives, the Bureau of Fisheries and Aquatic Resources and the municipalities concerned) with clear prerogatives and tasks - one of which should be the continuation of information gathering.

8. CONCLUSION

The cooperation of fishermen will be necessary if reliable catch, effort, costs and returns data are to be collected on a continuous basis, and cooperation of trawler operators is unlikely if they believe their participation in the fishery is threatened. Communication of research results to fishermen and obtaining their support for management should be a function of a management organization; in the absence of such an organization as was the case in San Miguel Bay, these tasks fell upon the researchers who conducted the study, and from our experience, it is unreasonable to expect reseachers to perform these tasks. The success of a continuing research programme for a particular fishery and the usefulness of its results will thus depend in great measure upon the support of an effective fisheries management programme.

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