SIMPLE METHODS FOR THE MULTIDISCIPLINIARY INVESTIGATION OF TROPICAL MULTISPECIES MULTI-GEAR FISHERIES

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The methodologies which were used in a two year multidisciplinary investigation of the fisheries of San Miguel Bay, Philippines are presented.

Major methods used were:

— socio-economic survey of fishing households to count fishing assets and determine the factors and attitudes which affect sharing systems, the role of women and children , marketing arrangements, and labor mobility

— cost and earnings analysis of major small-scale gears and of the trawlers with which they compete.

— production function estimations to determine factors explaining catch variability among major small-scale gears.

— cost and earnings analysis of major processing activities and determination of marketing margins for fresh and processed products.

— total annual catch estimation derived from numbers of major gears, daily catch per effort by species or group of species and number of days fished per year.

— detailed analysis of length frequency data of selected fish species to extract growth and mortaility parameter estimates and yield per recruit analyses to assess impact of mesh sizes.

— miscellaneous low input biological methods to describe prevailing ecological conditions.

The various methods used in this multidisciplinary study are compared to those used by a University of Rhode Island research group in a similar setting in Costa Rica. Recommendations are made regarding appropriateness of certain methodologies for data acquisition and analysis, such as record-keeping or self-enumeration to supplement surveys, multiple rather than single models for stock assessment, and maximum use of historical and secondary data.

It is argued that overly sophisticated models are not necessary in the early stage of analysis in order to improve one's understanding of the fishery or to provide information useful for fisheries management. However, it is concluded that inter-disciplinary monitoring of time-series data on catch, effort, catch composition, costs, earnings, supply and prices, will be necessary if research is to adequately clarify options for management of tropical, multi-species, multi-gear fisheries given alternative management objectives such as economic efficiency, maximum output, maximum employment or equity of income distribution.

Table 1. 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 2. San Miguel Bay Project: Data sources 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
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 market
IV	Costs and earning 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
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 3. 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 of 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 4. Comparison of goals of the "stock-assessment modules" of two multidisciplinary small-scale fisheries research projects conducted in Costa Rica and the Philippines.

Stated goals	Study area	
	Nicoya Gulf, Costa Rica [a]	San Miguel Bay, Philippines [b]
Overall:	. . . "to test systems of data collection and analysis useful for the assessment of individual stocks harvested by tropical artisanal fisheries	"to help in deciding what degree of emphasis, if any, should be placed on programs which encourage the movement of small-scale fishermen into other economic sectors"
Specific:	"the assessment of objective was the determination of maximum sustainable yields by means of the mathematical yield model of Beverton and Holt, modified for use with tropical fish populations"	"to assess the status of the fishery resources of San Miguel Bay"

[a] From Stevenson (1981a)
[b] From Anon. (1980)

Table 5. Comparison of data collected for the "stock-assessment modules" of multidisciplinary small-scale fisheries research projects conducted in Costa Rica and in the Philippines.

Type of data collected	Study area	
	Gulf of Nicoya, Costa Rica (1500 km², Eastern Central Pacific)[a] 3 major gear types	San Miguel Bay, Philippines (840 km², Western Central Pacific) 18 major gear types
hydrographical and biological data on ecosystems (estuaries)	some data obtained from key informants (fishermen)[b]	low emphasis on collection of new data; a 1-day bathymetric survey was conducted
fish taxonomy	collection of local common names of fish from key informants, because "data gathered without an understanding of [. . . .] linguistic phenomena would surely result in unusual size distribution for the fishery biologists to analyze"[b]	low emphasis; one list of scientific names compiled from the literature (i.e., records of occurrence in San Miguel Bay) and complemented by *ad hoc* collections
historical data on fishery (catch, effort, c/f, misc. data)	quantitative data not available (?); "history of exploitation and equipment used" obtained through interviews of key informants[b]	high emphasis on extensive search for old publications, unpublished manuscripts (e.g., theses and raw data)
total catch during period of investigation, by species groups and gears	not estimated	high emphasis, but mainly based on effort and c/f data obtained for all modules of project
total effort during period of investigation, by gears	not estimated	high emphasis, but mainly based on gear counts and annual number of trips, by gears obtained from socioeconomic modules of project
catch-per-effort (c/f) of major gears	not estimated	high emphasis; data of stock-assessment module complemented with data from socioeconomic modules of project
length-frequency data	high emphasis, more than 40,000 fish (6 species) measured	low emphasis, about 2,500 fish (15 species) measured
tagging data	high emphasis, 2,264 fish tagged and released	not collected

[a] From ICMRD (1981)

[b] Data collected by URI anthropologist R.B. Pollnac (see section of this paper entitled Sociology Module)

Table 6. Comparison of results obtained by the "stock-assessment modules: of two multidisciplinary small-scale fishery research projects, conducted in Costa Rica and the Philippines.

Results obtained	Study area	
	Gulf of Nicoya, Costa Rica [a]	San Miguel Bay, Philippines
basic description of ecosystem	-	one paper on hydrography of San Miguel Bay, one paper on the ecology of San Miguel Bay fishes
fish taxonomy	one paper on the "ethnoichthyology" of Puntarenas fishermen, i.e., analysis of information content of local common names	list of fish occurring in San Miguel Bay, including 28 new records by project staff
vital statistics of fish (growth, mortalities)	growth parameters (L , K) estimated for 3 species total mortality (Z) estimated for 2 species	growth parameters and total mortality (L , K, K) obtained for 4 species; growth parameters computed with data from stock elsewhere in the Philippines also used in assessments
yield-per-recruit assessment	conducted for one abundant species of croaker (*Cynoscion labus*)	conducted for 1 species of croaker, 1 species of penaeid shrimp, and 3 species of anchovies to make minor points only
assessments based on surplus yield models	-	used to demonstrate overexploitation of trawlable biomass
assessment based on comparisons of yield-per-area	-	used to suggest that increased effort will not increase catch, due to overcapitalization of fishery (confirming results obtained by other methods, and by the other modules of project)
management-related statements based on results of stock assessment module	statement that reduction in fishing mortality by 50% would result in the same yield of *C. Albus*; statement that the large-meshed gill nets used by artisanal fishermen are "the most effective gear for obtaining maximum yield for this species without depleting the resource"	main statement is that "the available evidence suggests that the Bay is overfished in the sense that an increase in effort by either the trawl or the small-scale fishery would not result in an increased catch from the San Miguel Bay as a whole, but rather exacerbate the present allocation problems between the small-scale and trawl fisheries"

[a] From ICMRD (1981)

Table 7. Comparison of goals of the "economics modules" of two multidisciplinary small-scale fisheries research projects conducted in Costa Rica and the Philippines.

Stated goals	Study area	
	Nicoya Gulf, Costa Rica [a]	San Miguel Bay, Philippines [b]
Overall:	"To design and implement an information system to serve the process of fisheries development and management"	. . . "to determine the economics of production and marketing of the San Miguel Bay fishery"
Specific:	. . ." to test and refine alternative methods for collecting and processing data"	"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 systems"
	. . . "focused on . . . the costs and earnings of the fishing operation"	
	"To analyze the current market structure of the wholesale sector . . . and discuss its influence on market conduct and performance"	
	"To examine potential economies of scale . . . at the wholesale level"	
	"To analyze the services, profitability, determinants of profitability and potential contribution of the Costa Rican fresh fish retailing sector in fisheries development"	

[a] From Sutinen and Kolberg (1981); Schied and Sutinen (1981); Epler and Lampe (1981)

[b] From Anon. (1980)

Table 8. Comparison of economic data collected in URI Gulf of Nicoya study and in the IFDR-ICLARM San Miguel Bay study.

	Nicoya Gulf, Costa Rica [a]	San Miguel Bay, Philippines [b]
1. Capture sector		
Cost and earnings of major gears	Data from 400 trips of 3 major gears collected through interviews over 5 month period. 58 fishermen provided trip records over 6 month period	Highest emphasis: daily record-keeping data collected over 12 months from 62 fishing units representing 6 major gear types
Inventory of fishing assets	Interview of subset of owners keeping trip records	Interview of all respondents keeping daily records; gear counts provided by "sociology module"
Catch and effort	Collected for 5-6 months only	Observations at landings for 1 year and separate record-keeping for 1 year
Income of boat owners and crew	Interview of subset of owner keeping trip records	Inter of all respondents keeping daily records; annual income based on sharing system used
Prices received by fishermen	Data from 400 trips of 3 major gears collected through interviews of boat captains over 5 month period	Observations at landings 2-3 times weekly for 1 year
Opportunity costs of labor and capital	Not collected	Collected for alternative occupation in fishing communities, supplemented by other publications and data collected by "sociology module"
2. Marketing Sector		
Quantities purchased and sold	High emphasis: Used daily purchasing receipts from primary buyers covering 5 months; interviews of wholesalers and retailers (see below)	Low emphasis: Single interview of middlemen and processors to collect data on previous day's activity only
Wholesale and retail prices	From daily purchasing receipts	High emphasis: monitored prices of fresh and processed products for period of 1 year in nearby retail markets. Secondary price data used for more distant wholesale and retail markets
Marketing costs of wholesalers	Interviews of 12 buyers and 23 transporter-wholesalers	Interviews of 33 processors (salting and drying) in 2 target communities only
Marketing costs of retailers	Personal interviews of 35 retailers over 5 month period; remaining 9 retailers also observed	Interviews of 31 retailers in 2 target retail markets only
Market structure, conduct and performance	High emphasis; detailed examination of concentration of buyers and sellers, barriers to entry, product differentiation and vertical integration in wholesale and retail markets	Low emphasis: from interviews only
Economies of scale	High emphasis: from interviews and data on volume handled	From interviews only

[a] From ICMRD (19810

[b] From Smith and Mines (In press)

Table 9. Comparison of results obtained by the "economic modules" of two multidisplinary small-scale fisheries research projects conducted in Costa Rica and the Philippines.

	Study area	
Results	Nicoya Gulf, Costa Rica [a]	San Miguel Bay, Philippines [b]
1. Capture Sector		
Evaluation of alternative methods of data collection on costs and earnings	Used a general cost function to evaluate cost effectiveness of interview and self-enumeration methods, concluding that the latter were best when less than 50 variable are being measured. Recommended improvements in record keeping	Not an explicit objective of the research project for the capture sector, though done indirectly through experience for observation and self-enumeration (bookkeeping) techniques
Cost and earnings	Not reported	Separate paper prepared on each major gear type, reporting on cost and earnings, determinants of catch, and returns to owners and crew according to various sharing systems practiced. Used to show that for some gears (esp. trawlers), owners and crew earn significantly more than their opportunity costs
Production and revenue functions	Cobb-Douglas production and revenue functions estimated for all 3 major gear types based on 805 trip records. Value of marginal products then compared to show "that fishing effort on average is allocated efficiently within the fishery"	Production functions based on monthly data by gear type used only to test importance of gasoline expenditures, age and education levels of fishermen on catch
Resource rents in the fishery	Not estimated	Based on costs and earnings study and number of gears counted by "sociology module", the share of resource rents being earned by each major gear type was estimated. The concentration of current resource rents in the hands of the small number of trawlers was thus demonstrated. Most of the small-scale gears were earning no resource rents; therefore there is a very skewed distribution of benefits from the fishery
2. Market Sector		
Performance and economies of scale in wholesale market	The elimination of firms with higher average costs of marketing may have little impact on prices because it may reduce the level of competition among buyers, significant marketing cost savings could be achieved	Significant economies of scale found for processors only. In target communities, a small number of processors control the bulk of the volume handled
Performance and economies of scale in retail market	"Competition . . . is an effective force limiting the opportunities of private firms to promote their self interest at the expense of the public. Entry is relatively easy . . . the industry appears to be responsible and flexible. Economies of scale do not present a deterrent to entry." Recommends government provide regular market information; quality standards; modernize markets	Significant economies of scale in fresh fish marketing from target communities. Large number of middlewomen earn only slightly more per day than the fishermen from whom they buy; reducing their number to achieve scale economies may be possible activity for a cooperative (of female members of fishing households) but may be difficult because middlewomen come from same communities

[a] From ICMRD (1981)

[a] From Smith and Mines (In press)

Table 10. Comparison of goals of the "sociology-anthropology modules" of two multidisiplinary small-scale fisheries research projects conducted in Costa Rica and the Philippines.

Stated goals	Study area	
	Nicoya Gulf, Costa Rica[a]	San Miguel Bay, Philippines[b]
Overall:	. . . "focus on aspects of obtaining data from local fishermen and the usefulness of the type of data they can provide	"To assess the socioeconomic development of the six San Miguel Bay municipalities and to analyze in selected communities, social and external linkages, and attitudes and preferences towards fish production, processing and marketing"
Specific:	To present an account of selected aspects of the knowledge system that the small-scale fishermen . . . have developed concerning marine fish"	" To examine the nature of the flow of human resources between municipal fisheries and other rural sectors:
	"To examine small-scale fishermen's perception of the occupation of fishing"	"To assess the potential of programs that seek to reduce the dependence of fishing households on capture fishing"
	"To examine the socio-cultural correlates of perceptions of farmers and fishermen by small-scale fishermen"	"To determine the economic role of women and children in the fishing communities . . ."
	"To [describe} the role of kinship in crew structure and recruitment to the industry . . . and examine variance in the role of kinship among different age and residential groups"	"To examine sharing systems for the major small-scale gears and determine the factors that influence the division of revenues between owners and crewmen"
	"To understand factors associated with investment orientations among small-scale fishermen in areas where development programs are anticipated"	"To determine the sociological elements that influence the marketing system and the effect of fishing seasonality on marketing arrangments and distribution patterns"
	"focus on the relationship between psychocultural characteristics of small-scale fishermen and cooperative formation"	
	"focus on the interrelationships between beliefs about cooperatives and their planning and development"	
	"to examine fishermen's perceptions of middlemen and the role that they play in the small-scale fishery . . ."	

[a] From Pollnac (1981a, b, c, d, e); Pollnac and Poggie (1981); Pollnac et al. (1981) and Poggie (1981)
[b] From Anon. (1980) and Bailey (In press, a and b)

Table 11. Comparison of sociological/anthropological data collected in URI Gulf of Nicoya study in the IFDR-ICLARM San Miguel Bay study.

Data type	Nicoya Gulf, Costa Rica [a]	San Miguel Bay, Philippines [b]
Community infrastructure, social services, and fishing population	Not collected	Key informants in all fishing communities
Sociocultural (age, education, no. of family members, years fishing, no. of dependents, kinship involvement in fishing, material culture, mass media exposure, crew structure)	4 separate surveys of fishermen over 4 years. Total number of respondents was 325. Samples chosen by quota	Survey of 30% of fishing households in 22 of 41 fishing communities, total of 641 households chosen randomly
Fishing and non-fishing assets	4 surveys (see above)	Survey of 30% of fishing households in 22 of 41 fishing communities, total of 641 households chosen randomly
Attitudes, beliefs and values	4 surveys (see above)	Survey and participant observation in selected communities
Attitudes toward cooperatives	4 surveys (see above)	Not evaluated
Attitudes and beliefs regarding fisheries resource and its exploitation	Key informants primarily, particularly for folk-taxonomy ("ethnoichthyology")	Survey and key informants. No folk-taxonomy data collected
Effort, income, personnel	4 surveys (as above)	Survey
Attitudes towards investment	4 surveys (as above)	Not collected, but attitudes towards saving collected in survey
Role of women and children	Not collected	Survey and intensive participant observation
Marketing practices	Survey and key informants	Survey and intensive participant observation
Attitudes towards mobility	One survey question on perceived alternatives if no more fishing in the gulf	Survey and intensive participant observation
Occupational and geographic mobility	Not collected	High emphasis given to examination of census and migration data
Labor absorption capacity of non-fishing sectors	Not collected	High emphasis given to examination of possibilities in agriculture, aquaculture and cottage industries

[a] From ICMRD (1981)
[b] From Bailey (In press, a and b)

Table 12. Comparison of results obtained by the "sociology/anthropology modules" of two multidisciplinary small-scale fishery research projects in Costa Rica and the Philippines.

	Gulf of Nicoya, Costa Rica [a]		San Miguel Bay Philippines [b]
Taxonomy:	122 different categories of fish named by fishermen reflecting complex taxonomies and hierarchical structure ("ethnoichtyology")	Ownership patterns and sharing systems:	little concentration of ownership for non-trawl gears, highly concentrated for trawlers. Kinship important for non-trawl gears; less so for trawlers. Diverse sharing systems determined by kinship and alternative income opportunities
Perceptions of fishing occupation:	documented generally positive attitude of fishermen to fishing; fishermen perceive farmers more negatively than fishermen; environmental factors play role in occupational subculture	Role of women and children:	women control family finances and have important role in fishing investment decisions; women dominate marketing system
Kinship links:	preponderance of kinship links in rural areas; larger proportion of rural fishermen (than urban fishermen) have fathers who were fishermen; "kinship appears to play important role in crew structure and occupational succession"	Perceptions of resource:	three-quarter believe catch declining 1/3 blame trawlers; 1/4 blame increase in all categories of fishermen; 1/4 don't know reason
Future orientation:	"Development programs should . . . create environments favorable to deferred gratification orientations if they are to succeed"	Marketing system:	important socioeconomic role of "suki" system of favored buyer-seller and mutual help implied
Cooperatives:	"We cannot assume that individuals from one area or occupational subculture will respond to increased wealth in the same manner as those from other regions"	Occupational and geographic mobility:	45% of respondents willing to move to different municipality to take up different occupation; 39% willing to move to different province. Willingness cuts across all groups by age, education and asset ownership. 88% want their children out of fishing
Perceptions of middlemen:	"Middlemen make very little profit for the time and energy they expend;" institutions to replace middlemen must also provide services (e.g., loans, supply of parts) to succeed	Alternative occupations:	prospects of full-time local alternatives very dim; some hope of supplementary income through small-scale animal husbandry
		Implications for raising incomes:	short term solution requires re-allocation of benefits from fishery; long term solutions must be sought outside fishery

[a] From ICMRD (1981)

[b] From Bailey (in press, a and b)