Working Paper Series

Working Paper No. 4
"Status of Philippine Demersal Stocks:
An Overview"

by
Geronimo T. Silvestre
UPV College of Fisheries
and
Salud Ganaden
Bureau of Fisheries and Aquatic Resources

Fisheries Stock Assessment
Title XII
Collaborative Research Support Program

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

This Working Paper has been produced by the University of Rhode Island research component in collaboration with the University of the Philippines and in association with the International Center for Living Aquatic Resources Management. Additional copies are also available from:

International Center for Marine Resource Development
The University of Rhode Island
126 Woodward Hall
Kingston, Rhode Island 02881

STATUS OF PHILIPPINE DEMERSAL STOCKS: AN OVERVIEW

by

Geronimo T. Silvestre and Salud Ganaden

ABSTRACT

The fishery based on demersal stocks (i.e. fishes and invertebrates living on or close to the sea bottom, both soft and hard/coral grounds) has contributed a considerable portion (25% - 40%) of Philippine marine landings since the late 40s. Demersal landings showed a steady increase from 78,000 mt in 1947 to 416,000 mt in 1975. Landings after 1975 decreased steadily until 1980 (326,000 mt), but an upward trend has been noted lately with 1984 landings totalling 385,000 mt. The demersal fishery is considerably area-limited, the productive shelf area (0-200 m depths) comprising only 13% or 225,000 sq. km. of the country's vast marine waters.

Currently available information pertaining to the potential yield and state of exploitation of Philippine demersal resources indicate the following: (1) MSY of the demersal stocks is about 600 ± 200 thousand mt/year, the lower limit of which has been essentially reached by present landings; (2) harvests have largely reached the limits that the resources can sustain in the nearshore areas, especially the traditional fishing grounds, and; (3) future increases in demersal landings would come primarily from the Palawan, Tawi-Tawi and Lamon Bay areas, as will as from better management of the demersal fisheries. Although the data utilized in making the above conclusions have been criticized as inadequate, more recent and reliable area-specific studies confirm the prevalence of biological and economic overfishing of nearshore demersal stocks. The economic loss (i.e. rent dissipation) resulting from lack of management of the demersal fisheries could be as much as US $90 million annually.

INTRODUCTION

The present contribution attempts to give a brief review of available materials dealing on the state of exploitation and potential of Philippine demersal stocks. It is neither intended to be an exhaustive nor rigorous treatment, but rather a non-technical overview of the state of the country's demersal resources in the 0-200 m depth ranges covering both soft and hard bottoms. Thus, it draws selectively from the available literature to give a composite picture.

It should be made clear at the outset that the assessment and management of fisheries in the Philippine setting has suffered for some time from the lack of appropriate biological information. This inadequacy in the fisheries management process has posed considerable difficulties in the assessment of the "health" and productivity of the stocks, and the prescription of requisite corrective or optimization measures. The Philippines, as is true for most developing countries, has a relatively short history of quantitatively oriented fisheries research. The country, hence, does not have many of the elements needed for conventional resource assessment typical of high latitude fisheries. The existing statistical baseline information on the fisheries of the country has often been characterized as inadequate and unreliable for stock assessment purposes (e.g. Chakraborty, 1976; Juliano and Yutuc, 1977).

The criticisms on the nature and quality of the data base notwithstanding, most of the studies cited below have relied on the existing statistical information and/or indirect inferences to assess the status and potential of the country's fishery resources. Most are concededly preliminary in nature, and some critics have argued that it is nct possible to be very confident of these assessments. For all their limitations, however, these works represent attempts to make the best possible use of the available data given the range of alternative analyses inherent to the nature of the data base.

The term "demersal resources" as used in the present study refer to fishes living on or close to the sea bottom (whether soft or hard/coral ground) and associated invertebrates. Presentation of available information on the potential yield and state of exploitation of the country's demersal resources is put into perspective through a preceding overview of the extent of the Philippine shelf (where the demersal stocks and fisheries are concentrated) and the contribution of demersals to the country's marine landings from the late 40's to early 80's.

AREA OF THE PHILIPPINE SHELF

Philippine marine waters cover an area of 1,666,300 square km., including areas covered by the 200 mile exclusive economic zone. Despite the vast expanse of the country's marine waters, the productive shelf areas (i.e. 0-200 m depth) are quite limited. Estimates available in the literature as to the extent of the Philippine shelf vary widely. These include, among others, the following figures: 185,000 sq. km. (AID, 1977), 200,000 sq. km. (Kvaran, 1971), and 266,000 sq. km. (Yutuc and Trono, 1977). Recent estimates from more detailed planimetry of bathymetric charts issued by the Philippine Bureau of Coast and Geodetic Survey indicate that the shelf area is more around 225,000 sq. km., Munro (1986) estimates the Philippine shelf to be about 224,400 sq. km., while Silvestre et al. (1986) estimate the shelf area to be about 225,800 sq. km. It is apparent that the productive shelf area (inhabited by Philippine demersal stocks) is only about 13% of the total marine area of the country.

The areal definitions used by Silvestre et al (1986) are given in Table 1 and Figure 1. The estimates of the surface area of the Philippine shelf by area (A to J) and depth range (0-9.9, 10-19.9, 20-49.9, 50-99.9, and 100-200 m) are given in Table 2. Note that 75% of the shelf is in the 0-99.9 m depth range while 25% is in the 100-200 m depth range. The larger shelf areas are found in area I (PALAWAN), area J (Philippine Inland Seas), area H (Soutneastern Sulu Sea) and area D (Central Pacific). The shelf areas are most limited in areas B (NW Luzon), C (NE Luzon) and F (Eastern Mindanao). The estimates of shelf area for the 24 BFAR statistical regions (Fig. 2) computed by Munro (1986) are also given in Table 3, and indicate close agreement with those given by Silvestre et al. (1986).

Delineation of the shelf area estimates between soft (i.e. trawlable) and hard (i.e. rocky, coral) grounds have not been made to an acceptable level of accuracy and scope. Carpenter (1977) estimated the total coral reef area within the 10-fathom contour line as 12,171 sq. *km. and to the 20-fathom contour as 33,088 sq. km. Murdy and Ferraris (1980), however, point out that the reef area could not be determined accurately at this time citing, for instance, a new estimate of reef area to 10-fathoms of 27,044 ^{2}km proposed by MSI (1979). Figure 3 gives the distribution (albeit preliminary) of soft and hard bottom fishing grounds within the 200 m contour line.

DEMERSAL COMPONENT OF MARINE LANDINGS

The marine fisheries sector has consistently contributed the bulk of the country's total fisheries production since the end of the second world war. Statistics from BFAR underscore the significance of the sector, reflecting landings which have increased from about 80,000 mt in 1946 to 1,303,300 mt in 1984, i.e. a sixteen-fold increase during the post-war period. Despite the lack of statistics covering the pre-war period, it is quite safe to assume that the marine landings were of similar importance at that time.

The fisheries statistics of BFAR, published since 1952, provides annual landings for the marine fisheries components. Details on the contribution of the species/species groups comprising the marine commercial catch were also included since that time. The same information, however, in the case of the municipal fisheries began to be available only since 1976. Silvestre et al. (1986), utilized these annual statistics to estimate the demersal component (municipal, commercial and total demersal) of the Philippine marine catch. The species/species groups categorized as demersal and aggregated by Silvestre et al. on an annual basis (with various interpolations for missing years) are given in Table 4. They acknowledge that the delineation into demersal and pelagic involves a certain degree of subjectivity and stress that the manner in which the species/groups were classified is more operational/technological rather than ecological (i.e. whether the species/species group is more abundant in the catch of demersal (e.g. trawl) or pelagic (e.g. purse seine, bagnet, fishing gears). Table 5 gives the time series (1946 to 1983) of marine and demersal landings in the Philippines that they computed. The marine catch excludes inland municipal and aquaculture production; the values in brackets indicate the use of extrapolations in arriving at the value. The table shows that demersals comprise between 25% to 40% of the total marine landings on an annual basis since the late 40's. The 1984 BFAR statistics indicate that demersal landings total about 385,000 mt (commercial demersal - 109,700 mt, municipal demersal - 275,300 mt) of the total marine landings of 1,303,300 mt (marine commercial - 513,300 mt, marine municipal - 790,000 mt) for the year.

The demersal resources of the country are exploited using a multiplicity of gears. The commercial fishery mainly employs the trawl in soft bottom areas, and the muro-ami and hook and line in hard/coral grounds. The municipal fishery uses primarily baby trawls, bottom gill nets, beach seines and push nets in the soft, trawlable grounds, and employ drive-in nets, traps, spears and set longlines in the rocky areas. The multispecies nature of the Philippine fishery resources does not restrict the demersal gears mentioned above to catch solely demersal fish, but also catch pelagics especially in the shallow nearshore areas.

ASSESSMENTS OF POTENTIAL YIELD AND EXPLOITATION

Assessments of the potential yield from Philippine fishery resources has been undertaken by a number of authors and agencies in the past. Smith et al. (1980) give a review of assessments conducted during the 70's, indicating potential yield from the country's pelagic and demersal resources ranging from 1-3.7 million mt per year. Estimates of demersal potential covered by the said review include those given by Kvaran (1971) and Aoyama (1973) who provided estimates of 700,000 and 420,000 mt/yr, respectively. Results of a workshop utilizing the

"Delphi" approach (held in Baguio in November 1980) under the auspices of NRMC/FIDC indicate a consensus that the total potential yield from the country's fishery resources is about 1,650 $\pm$ 450 thousand mt/yr. The corresponding demersal potential was placed at about 600 $\pm$ 200 thousand mt/yr (Table 6). The demersal potential estimates were highest for the W. Sulu Sea, Palawan, Mindoro area (i.e. 128-268 thousand mt/yr) and the lowest for the North and Northwest Luzon area (i.e. 28-68 thousand mt/yr).

Results of the NRMC/FIDC workshop also provide an assessment of the state of exploitation of the demersal resources vis-a-vis the estimated potential (utilizing primarily results of BFAR/SCSP workshops conducted in the 70's). Table 7 compiles this information which indicates that almost all soft/trawlable areas were either fully exploited or over exploited with the exception of Palawan waters. Hard grounds or reef areas were generally considered to be underfished, with the exception of the Lingayen Gulf, Antique and Cuyo East Passage, South Negros to Bohol, and the Northern Mindanao coast. Munro (1986) in his review of Philippine fishery resources compared the demersal potential with 1981 production statistics. He noted that based on such comparison, demersal landings could still be increased by about 270,000 mt/yr (primarily from the West Sulu Sea and Palawan area). If we consider the 1984 demersal landings of about 385,000 mt/yr, then such could still be increased by about 215,000 mt/yr (although it should be noted that landings have essentially reached the lower limit of the NRMC/FIDC demersal potential estimate of 400,000 mt/yr). Munro (1986) sums up the prospects of increasing demersal landings as follows:

> "The waters surrounding Palawan, the Tawi-Tawi area between the South Sulu Sea and Moro Gulf, and the Lamon Bay area offer the best potential for increased demersal catches - mostly of reef (or other hard bottom) associated fishes. However, technological problems must be overcome such as better boats and better coral reef fishing techniques.
>
> Most other areas, particularly those in the enclosed seas, are heavily exploited and additional effort might cause decreases in the total catch and will certainly decrease the profitability of those vessels already in the fishery."

As noted in the introduction, the assessments given above are acknowledged to be approximate, based principally as they are on available production statistics (whose reliability has been criticized by a number of authors) as well as estimates of area productivity. In fact, all studies dealing on the status and potential of the country's fishery resources have referred to the inadequacy of exisitng information to allow strong, reliable inferences to be made. It can be noted however, that the available assessments indicate a general consensus that harvests have largely reached (if not exceeded) the limits that could be sustained by the demersal resources in the nearshore areas, especially in the traditional fishing grounds. The validity of this observation is further reinforced by more recent studies. For instance, Silvestre et al. (1986) estimate that the biomass of nearshore (0-100 m depth) demersal stocks have declined to about 30% of their biomass levels in the late 40's. Silvestre and Pauly (1986) estimate that the economic loss (i.e. rent dissipation) that such lack of management entails could be as much as US $90 million per year. Fox (1986) found that the relative fish density is low in shallow areas where municipal vessels are dense compared to deeper areas where vessels are less dense. Plotting the density of municipal fishermen based on a 1977 census (Fig. 4), he also identifies the area where increases in landings can possibly be obtained (which incidentally are largely compatible with those given by Munro 1986). Studies by other investigators in specific areas (e.g. Lingayen Gulf, Manila Bay, San Miguel Bay, Samar Sea, etc.) also support the observation of excessive fishing pressure in the nearshore traditional fishing grounds.

The problem of excessive fishing effort in the exploitation of the country's demersal resources is compounded by the problem of growth overfishing due to the use of small-meshed nets, as well as the use of explosives. For instance, Silvestre (1986) and Silvestre and Soriano (1987) found that the 2 cm minimum mesh size limit is too small to maximize the biological yield for the mix of trawl-caught species in the Samar Sea area. Considering the basically consistent/uniform faunal composition of the country's demersal resources, it can be assumed that the problem of growth overfishing is widespread. The use of fine-meshed nets smaller than 2 cm (e.g. push nets) is also prevalent, and the consequent loss could, therefore, be far more serious.

In sum, the country's nearshore demersal fisheries suffer from biological overfishing due to the capture or destruction of young/juvenile fish (e.g. the use of small-meshed nets and explosives). Some cursory evidence of recruitment and ecosystem overfishing are also available (e.g. Fox, 1986) aside from the anecdotal complaints in the literature. Aside from these forms of biological overfishing, the extent and magnitude of economic overfishing is also believed to be considerable (e.g. Smith et al. 1980, Silvestre and Pauly 1986 and the contributions of A. Librero and collaborators in Panayotou 1985). The scope of this paper is not the place to explore ways by means of which maximization of benefits from the country's demersal resources could be effected. Hopefully, these measures would crystalize within the larger framework of questions that the present workshop seeks to address. We would like to point out, however, that the available information reflects the need for better management of the country's demersal fisheries, and the apparent inability of existing institutional structures and strategies to realize proper management.

REFERENCES

AID. 1977. The Philippines: fisheries sector study. Report of the USAID/Philippines Fisheries Mission. Manila. 79 p.

Aoyama, T. 1973. The demersal fish stocks and fisheries of the South China Sea. SCS/DEV/73/3. FAO/UNDP. Rome. 80 p.

Carpenter, K. 1977. Philippine coral reef fisheries resources. Philipp. J. Fish. 15 (1): 95-126.

Chakraborty, D. 1976. Fisheries statistics in the Philippines: A plan for a new and expanded data collection programme. SCS/76/WP/44. Manila. 61 p.

Fox, P. 1986. A manual of rapid appraised techniques for Philippine coastal fisheries. Research Division, Bureau of Fisheries and Aquatic Resources, Q.C. 43 p. + appendices.

Juliano, R. and S. Yutuc. 1977. An evaluation of fishery statistics toward the construction of statistical benchmark data for fish production. pp. 1201-1247. In PREPF, Volume II-3B. Dev. Academy of the Philippines. Manila.

Kvaran, E. 1971. Marine fisheries potential in the Philippines and Southeast Asia. Fisheries Newsletter, Philippine Fisheries Commission. July-December 1971. Manila p. 8-17.

MSI. 1979. Investigation of the coral resources of the Philippines, Phase II-Final Report. Univ. of the Philippines, Diliman, Q.C. 300 p. (mimeo).

Murro, J. 1986. Marine fishery resources of the Philippines: catches and potentials. pp. 19-46. In D. Pauly, J. Saeger and G. Silvestre (Eds.). Resources, management, and socio-economics of Philippine marine fisheries. Tech. Rep. Dept. Mar. Fish. (10): 217 p. College of Fisheries, UP Visayas, Diliman, Q.C.

Murdy, E. and C. Ferraris, Jr. 1980. The contribution of coral reef fisheries to Philippine fisheries production. ICLARM Newsletter 3(1): 21-22.

NRMC-FICD. 1980. Assessment of Philippine fishery wealth (marine sector): A Delphi approach. Natural Resources Management Center and Fisheries Industry Development Council, Q.C. (mimeo).

Panayotou, T. (Ed.). 1985. Small-Scale Fisheries in Asia: Socio-economic Analysis and Policy. Ottawa, Ontario. IDRC. 283. p.

Silvestre, G. 1986. Assessment of the multispecies demersal stock of the Samar Sea, Philippines. Tech. Rep. Dept. Mar. Fish. (7): 65 p. College of Fisheries, UP Visayas, Diliman, Q.C.

Silvestre, G. and D. Pauly. 1986. Estimate of yield and economic rent from Philippine demersal stocks (1946-1983). Paper presented at the IOC-WESTPAC Symposium on Marine Science in the Western Pacific, Townsville, Australia. 1-6 Dec. 1986. 10 p.

Silvestre, G. and M. Soriano. 1987. Effect of incorporating sigmoid selection in estimation of optimum mesh size for the Samar Sea multispecies trawl fisheries. Paper prepared during the FAO/DANIDA Follow-up Training Course on Fish Stock Assessment in the Tropics. Manila, 12 Jan.-6 Feb. 1987. FAO Fish. Rep. (In Press).

Silvestre, G., R. Regalado, and D. Pauly. 1986. Status of Philippine demersal stocks - inferences from underutilized catch rate data. pp. 47-96. In D. Pauly, J. Sager and G. Silvestre (Eds.). Resources, management and socio-economics of Philippine marine fisheries. Tech. Rep. Dept. Mar. Fish. (10): 217 p. College of Fisheries, UP Visayas, Diliman, Q.C.

Smith, I., M. Puzon, and C. Vidal - Libunao, 1980. Philippine municipal fisheries: a review of resources, technology and socio-economics. ICLARM Studies and Reviews (4): 87 p.

Yutuc, S. and G. Trono. 1977. A review of the Philippine fishery resources and their productivity. pp. 1138-1200. In PREPF, Volume II-3B. Dev. Academy of the Philippine, Manila.

Table 1. Area definitions used by Silvestre et al. (1986) in estimating the area of the Philippine shelf (0-200 m).

CODE	AREA	POLITICAL REGIONS	BFAR STATISTICAL REGIONS	MAJOR FISHING GROUNDS
A	West Central Luzon	National Capital Region, III, IV in part	2 - Manila 3 - Batangas Coast	Manila Bay, Subic Bay, Zambales Coast, Balayan Bay, Batangas Coast, Verde Island passage
B	Northwest Luzon	I	1 - Lingayen Gulf	Banqui Bay, Dasol Bay, Ilocos Coast, Lingayen Gulf, Pasaleng Bay
C	Northeast Luzon	II	23 - Palanan Bay 24 - Babuyan Channel	Divilican Bay, Palanan Bay, Babuyan Channel, Balintang Channel
D	Central Pacific	IV in part V VIII in part	20 - Lagonoy Gulf 21 - Lamon Bay 22 - Casiguran Sound	Albay Gulf, Cabungao Bay, Lagonoy Gulf, San Bernardino Strait, Alabat Sound, Lamon Bay Baler Bay, Casiguran Sound, Dilasag Bay, Dingalan Bay
E	Eastern Visayas	VIII in part X in part	13 - Leyte Gulf	Caballan Bay, Dinagat Sound, Samay Bay, Leyte Gulf, Matarinao Bay, Oras Bay, San Pedro Bay, Surigao Strait
F	Eastern Mindanao	XI in part	11 - Davao Gulf	Baculin Bay, Bislig Bay, Carael Bay, Davao Gulf, Lanuza Bay, Mayo Bay, Pujuda Bay, Dumaguilas Bay,
G	Southwest Mindanao	IX-A in part IX-B in part XII	10 - Moro Gulf	Illana Bay, Linao Bay, Maligay Bay, Moro Gulf, Pagadian Bay, Sarangani Bay, Sibuguey Bay.
H	Southeastern Sulu Sea	IX-A in part IX-B in part IV in part VI in part	8 - Southern Sulu Sea 6 - East Cuyo Pass 9 - Eastern Sulu Sea	Basilan Strait, Tawi-Tawi Bay, Southern Sulu Sea East Cuyo Pass, Coronado Bay, Dapitan Bay, Dipolog Bay, East Sulu Sea, Sibuco Bay, Slocon Bay, Sindangan Bay
I	Palawan	IV in part	5 - West Palawan Waters 6 - Cuyo West Pass 7 - West Sulu Sea	Bacuit Bay, Balabac Strait, Imuruan Bay, Malampaya Sound, Caron Bay, West Cuyo Pass, Dumaran Channel, Linapacan Strait Minooro Strait, Taytay Bay, Green Island Bay, Honda Bay, Island Bay, San Antonio Bay, West Sulu Sea
J	Philippine Island Seas (North & South)	IV in part V in part VI in part VII in part VIII in part X in part	4 - Tayabas Bay 15 - Visayan Sea 16 - Guimaras Strait 17 - Sibuyan Sea 18 - Ragay Gulf 19 - Samar Sea 12 - Bohol Sea 14 - Camotes Sea	Mogpog Pass, Tayabas Bay, Asid Gulf, Asuncion Pass, Tanon Strait Visayan Sea, Agusan Bay, Banate Bay, Guimaras Strait, Iloilo Strait, Panay Gulf, Jintotolo Channel, Nin Bay, Pilar Bay, Romblon Pass, Sapian Bay, Sibuyan Sea, Tablas Strait, Burias Pass, Ragay Gulf, Biliran Strait, Carigara Bay, Maqueda Bay, Samar Sea, Sorsogon Bay, Ticao Pass, Butuan Bay, Iligan Bay, Macajalar Bay, Murcielago Bay, Panguil Bay, Sogod Bay, Camotes Sea, Cebu Strait, Maribojoc Bay, Ormoc Bay.

Table 2. Surface area of the Philippine shelf, by depth range and area. (Source: Silvestre et al., 1986).

Area (km^2)	Depth range 0-9.9	10-19.9	20-49.9	50-99.9	100-200	TOTAL
A	1150	950	1150	1950	2900	8100
B	900	600	1000	1300	1000	4800
C	400	550	1150	1100	1500	4700
D	2400	1800	8400	12800	4600	30000
E	1000	1000	4600	5800	4600	17000
F	650	650	1200	2000	1000	5500
G	1000	1100	2300	3850	850	9100
H	2900	3200	9000	15800	11900	42800
I	3000	3500	13500	20000	15000	55000
J	6600	6300	12650	10000	13250	48800
TOTAL	20000	19650	54950	74600	56600	225800

Table 3. Estimate of Shelf Area (0-200 m) for the 24 BFAR Statistical Regions. (Source: Munro, 1986).

No.	Statistical Area	Shelf Area (km^2)
1	Lingayen Gulf	4800
2	Manila Bay	6200
3	Batangas Coast	300
4	Tayabas Bay	2500
5	West Palawan Water	29345
6	Cuyo Pass	29097
7	West Sulu Sea	28154
8	South Sulu Sea	21581
9	East Sulu Sea	580
10	Moro Gulf	12378
11	Davao Gulf	3087
12	Bohol Sea	523
13	Leyte Gulf	13147
14	Camotes Sea	5335
15	Visayan Sea	11460
16	Guimaras Strait	4415
17	Sibuyan Sea	7020
18	Ragay Gulf	3076
19	Samar Sea	7218
20	Lagonoy Gulf	5308
21	Lamon Bay	21308
22	Casiguran Sound	2902
23	Palanan Bay	1934
24	Babuyan Channel	2766
Totals		224434

Table 4. List of species / species groups (as used in BFAR statistics) categorized as demersal to derive demersal landings estimates given by Silvestre et al. (1986).

Species / Species Group	Species / Species Group
Flatfish	Therapon, grunts
Sea catfish	Red bullseye
Eels	Butterfly fish
Groupers	Threadfin (mamali)
Sea bass	Sergeant fish
Snappers	Leaf fish
Threadfin bream	Sharks, skates, rays
Whiting	Pufforfish
Perchlet	Trigger fish
Surgeon fish	Lizard fish
Wrasses/parrot fish	Archer fish
Slipmouths	Siganids
Mojarra	Scolopsid
Goatfish	Macolor
Goby	Silver bar
Moonfish	Amber fish
Sickle fish	Silver perch
Flathead	Cutlass fish
Spade fish	Crabs
Rudder fish	Lobsters
Croaker	Shrimps/prawns
Red Sea harder	Squids, cuttlefish
Porgy	Octopus
Lactarids	

Table 5. Philippine Marine and Demersal Landings, 1946-1983. (Source: Silvestre et al., 1986).

YEAR	MARINE CATCH (tonnes)			DEMERSAL CATCH (tonnes)		
	Total	Municipal	Commercial	Total	Municipal	Commercial
1983	1,290,300	771,000	519,300	379,200	264,800	114,300
1982	1,234,300	708,000	526,300	343,800	236,300	107,500
1981	1,204,800	710,000	494,800	354,300	233,600	120,700
1980	1,135,800	647,300	488,500	326,300	186,700	139,671
1979	1,136,300	635,500	500,800	343,300	188,900	154,400
1978	1,192,700	686,900	505,800	350,400	195,400	155,100
1977	1,229,000	710,800	518,200	344,700	188,300	156,300
1976	1,126,900	618,700	508,200	366,800	197,400	169,400
1975	1,230,300	731,700	498,600	(415,900)	(225,100)	190,800
1974	1,155,200	684,500	470,700	(368,400)	(210,552)	157,336
1973	1,105,200	639,800	465,400	(333,500)	(196,801)	136,704
1972	1,023,500	598,700	424,800	(325,900)	(184,200)	141,700
1971	925,200	542,900	382,300	(278,500)	(167,000)	111,500
1970	892,400	510,500	381,900	(272,100)	(157,000)	115,000
1969	846,200	477,500	368,700	(269,200)	(146,900)	122,300
1968	851,000	444,200	406,800	(314,700)	(136,500)	178,100
1967	682,200	351,200	330,900	(234,900)	(108,000)	126,900
1966	641,600	326,700	314,900	(213,300)	(100,500)	112,800
1965	604,300	303,900	300,400	(198,200)	(93,500)	104,800
1964	540,800	282,700	258,100	(191,300)	(87,000)	104,400
1963	485,300	276,600	208,700	(170,900)	(85,100)	85,800
1962	422,500	272,500	150,000	(151,000)	(83,300)	67,200
1961	394,100	268,400	125,600	(147,600)	(82,600)	65,000
1960	384,500	264,500	120,000	(153,200)	(81,400)	71,800
1959	378,400	260,600	177,800	(150,100)	(80,200)	70,000
1958	369,000	257,200	111,900	(142,200)	(79,100)	63,100
1957	347,800	253,800	94,000	(142,800)	(78,100)	64,700
1956	355,200	248,500	106,700	(142,300)	(76,400)	65,300
1955	326,200	219,000	107,200	(127,200)	(67,400)	59,800
1954	308,600	205,400	103,200	(121,900)	(63,200)	58,700
1953	272,200	199,300	72,900	(101,000)	(61,300)	39,700
1952	282,000	208,700	73,300	(101,300)	(64,200)	37,100
1951	266,400	197,400	69,000	(94,500)	(60,700)	(33,300)
1950	194,700	146,300	47,900	(67,682)	(45,200)	(22,500)
1949	213,500'	158,700	54,800	(73,800)	(48,800)	(25,000)
1948	172,000	130,000	42,000	(58,500)	(40,000)	(18,500)
1947	230,700	167,600	63,000	(78,000)	(51,600)	(26,500)
1946	79,900	64,000	15,900	(26,100)	(19,700)	(6,400)

Table 6. Estimated Potential of Philippine Marine Waters. (Source: Munro, 1986, as cited from NRMC/FIDC, 1980)

Area	Specie	Estimated Potential Yield ('000 tonnes)
TOTAL MARINE AREA	All Fish	1,650 ± 450
A. Coastal Waters	All Fish	1,400 ± 200
	Demersal	600 ± 200
	Pelagic	800 ± 200
Region I (Tayabas Bay, Sibuyan Sea, Visayan Sea, Samar Sea & related bays)	All Fish	210 ± 30
	Demersal	90 ± 30
	Pelagic	120 ± 30
Region II (Bohol Sea, E. Sulu & related bays)	All Fish	196 ± 30
	Demersal	84 ± 30
	Pelagic	112 ± 30
Region III (Moro Sea, Davao Gulf, SE Mindanao Coast)	All Fish	140 ± 20
	Demersal	60 ± 20
	Pelagic	80 ± 20
Region IV (W. Sulu Sea, Palawan, Mindoro)	All Fish	462 ± 70
	Demersal	198 ± 70
	Pelagic	264 ± 70
Region V (N and NW Luzon)	All Fish	112 ± 20
	Demersal	48 ± 20
	Pelagic	64 ± 30
Region VI (Pacific Coast except SE Mindanao)	All Fish	250 ± 40
	Demersal	120 ± 40
	Pelagic	120 ± 30
B. Oceanic Water	Pelagic	250 ± 50

Table 7. Demersal Resources Potential of Different Fishing Grounds. (Source: NRMC/FIDC, 1980, as compiled from various authors).

Fishing Grounds	Estimated Potential	State of Exploitation
I. Soft Grounds		
1. Visayan Sea	At least 100,000 MT	Over-exploited
2. Samar Sea	Around 8,000 MT	Over-exploited
3. Tayabas Bay	6,000 MT	Fully-exploited
4. Ragay Gulf	2,400 MT	Fully-exploited
5. Bohol Strait		Fully-exploited
6. Palawan Waters		Under-exploited
7. Hinobaan & Sinapalay Area	Very limited Trawable Area	Fully-exploited Fully-exploited
8. Sibuguey Bay		Fully-exploited
9. Illana Bay		Fully-exploited
10. Turtle Island to Lumoucan Island	More than 2,000 MT	?
11. San Miguel Bay		Over-exploited
12. Leyte Gulf	Limited Trawable Area	? -
13. North Coast		Fully-exploited
14. Lingayen Gulf		Fully-exploited
15. Manila Bay		Over-exploited
II. Hard Grounds		
1. Lingayen Gulf		Over-exploited
2. Babuyan and Batan Group		Under-exploited
3. Western Coast of Ilocos Region		Under-exploited
4. Catanduanes coastal water		Under-exploited
5. Surigao del Norte Coast		Under-exploited
6. Eastern coast of Samar		Under-exploited
7. Coron and Taytay area	Very extensive area	Under-exploited
8. Antique and East Passage	less than 1,500 MT a year	Nearing full exploitation
9. South Negros to Bohol	Narrow and limited in area	Fully-exploited
10. North Coast of Mindanao	Narrow and limited in area	Nearing full exploitation
11. Illana Bay	More than 10,000 MT	Under-exploited
12. Sulu Archipelago	MSY may be reached at 8,000 MT/yr	Under-exploited
13. Turtle Island to Lumoucan Channel	More than 300 MT	Under-exploited

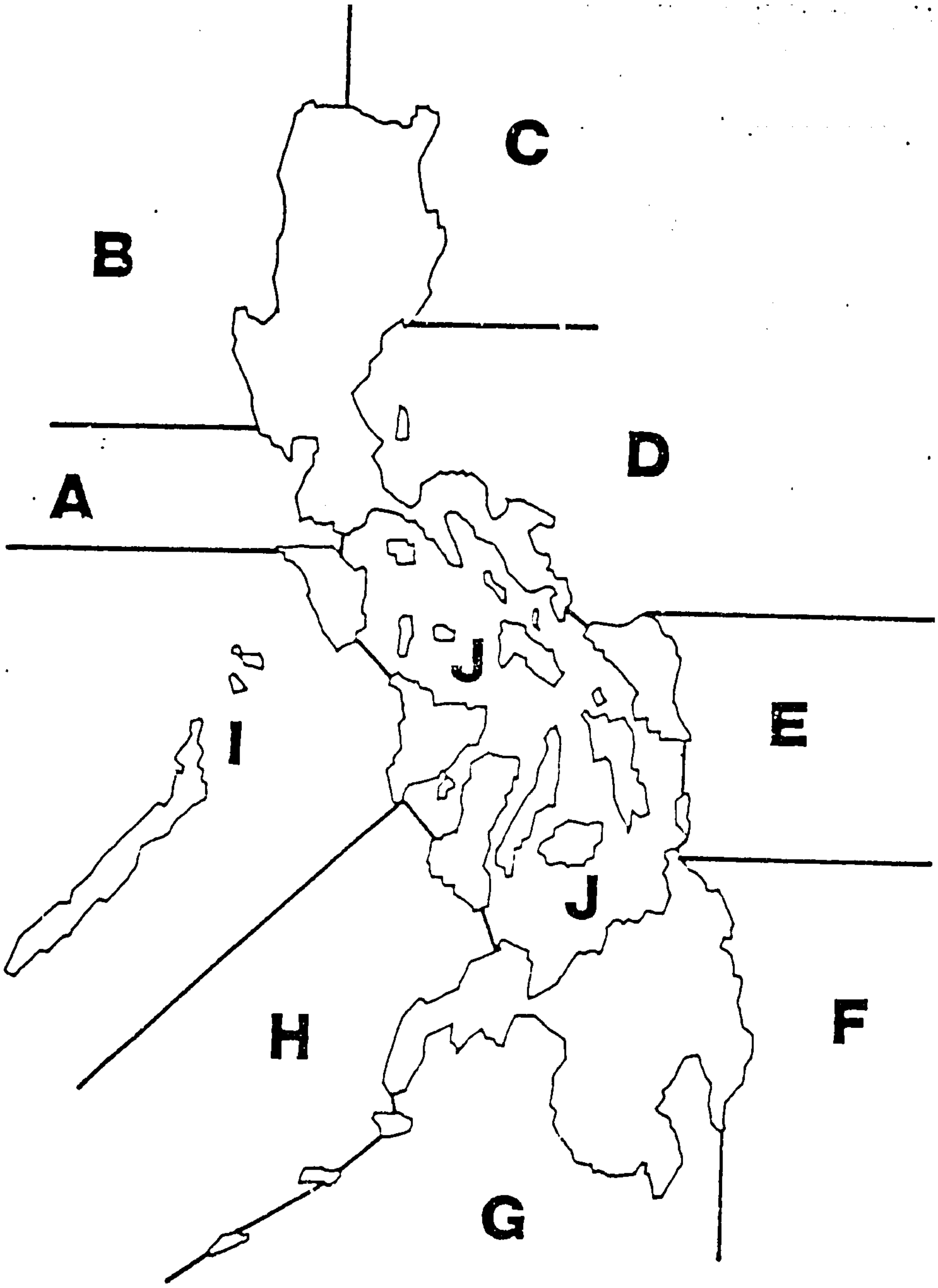

Fig. 1. Definition of Areas A to J (see also Table 1).
(Source: Silvestre et al., 1986).

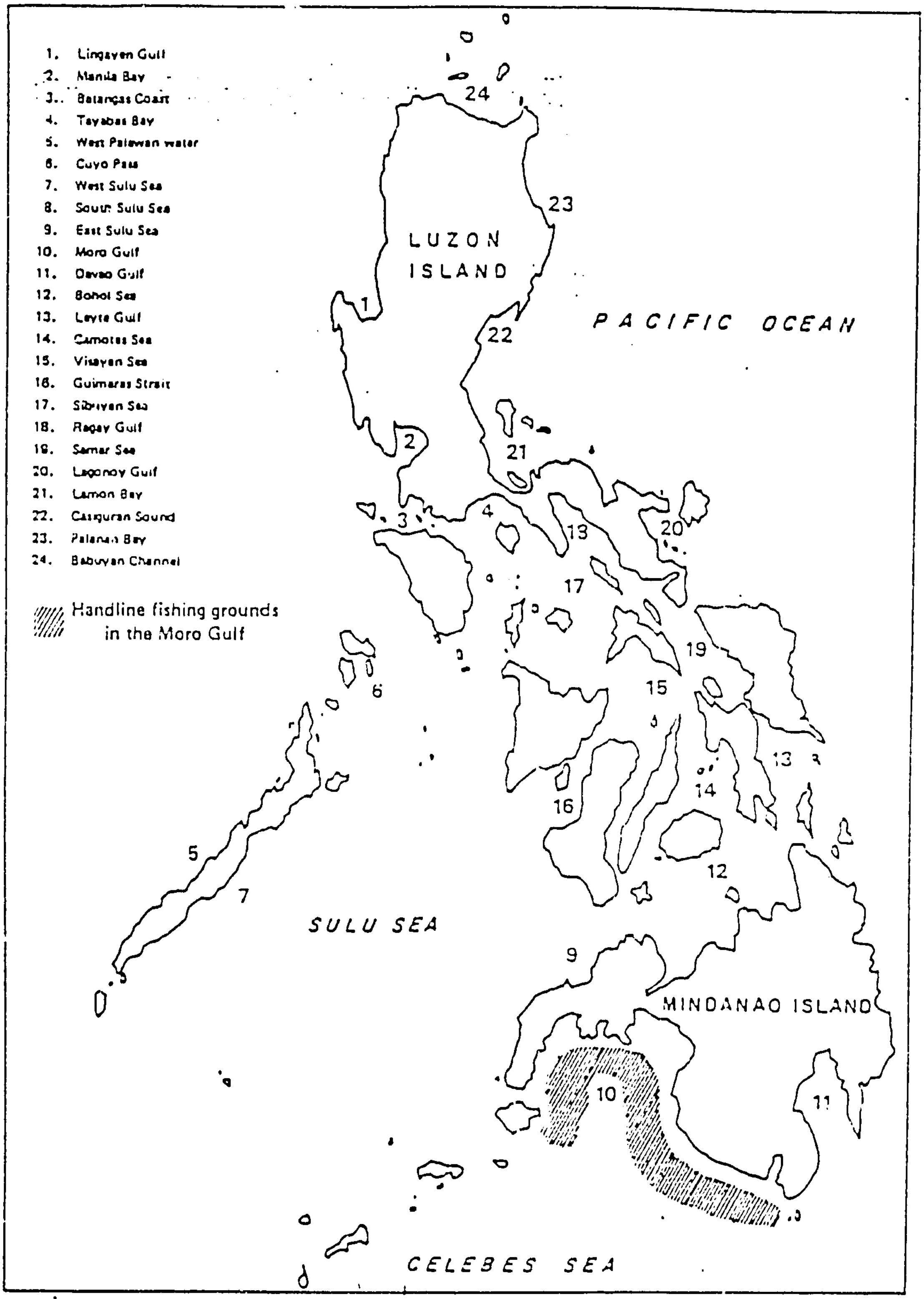

Fig. 2. BFAR statistical areas. (Source: Munro, 1986).

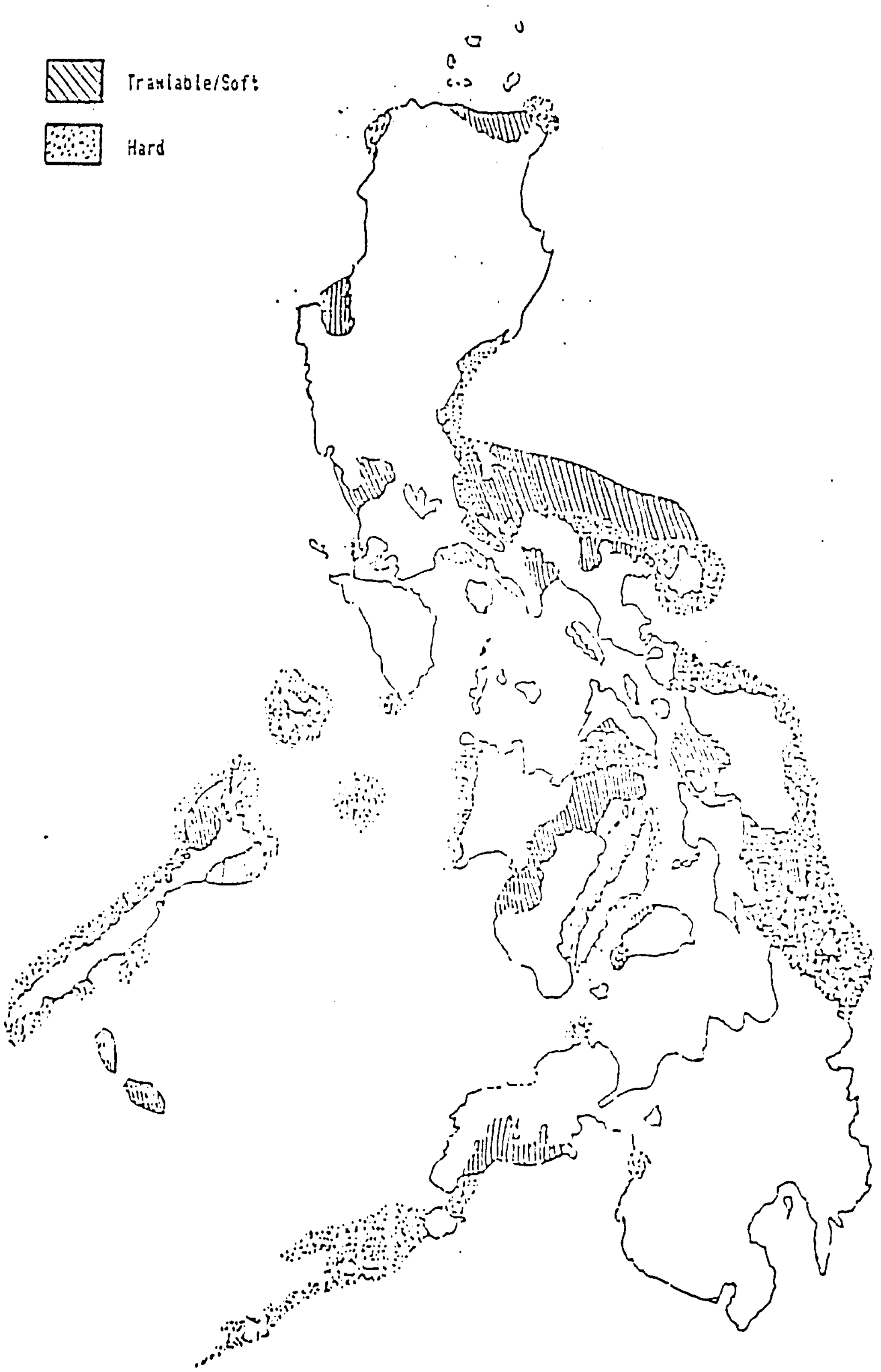

Fig. 3. Soft and Hard Grounds within the coastal areas. (Source: NRMC/FIDC, 1990, as compiled from various works).

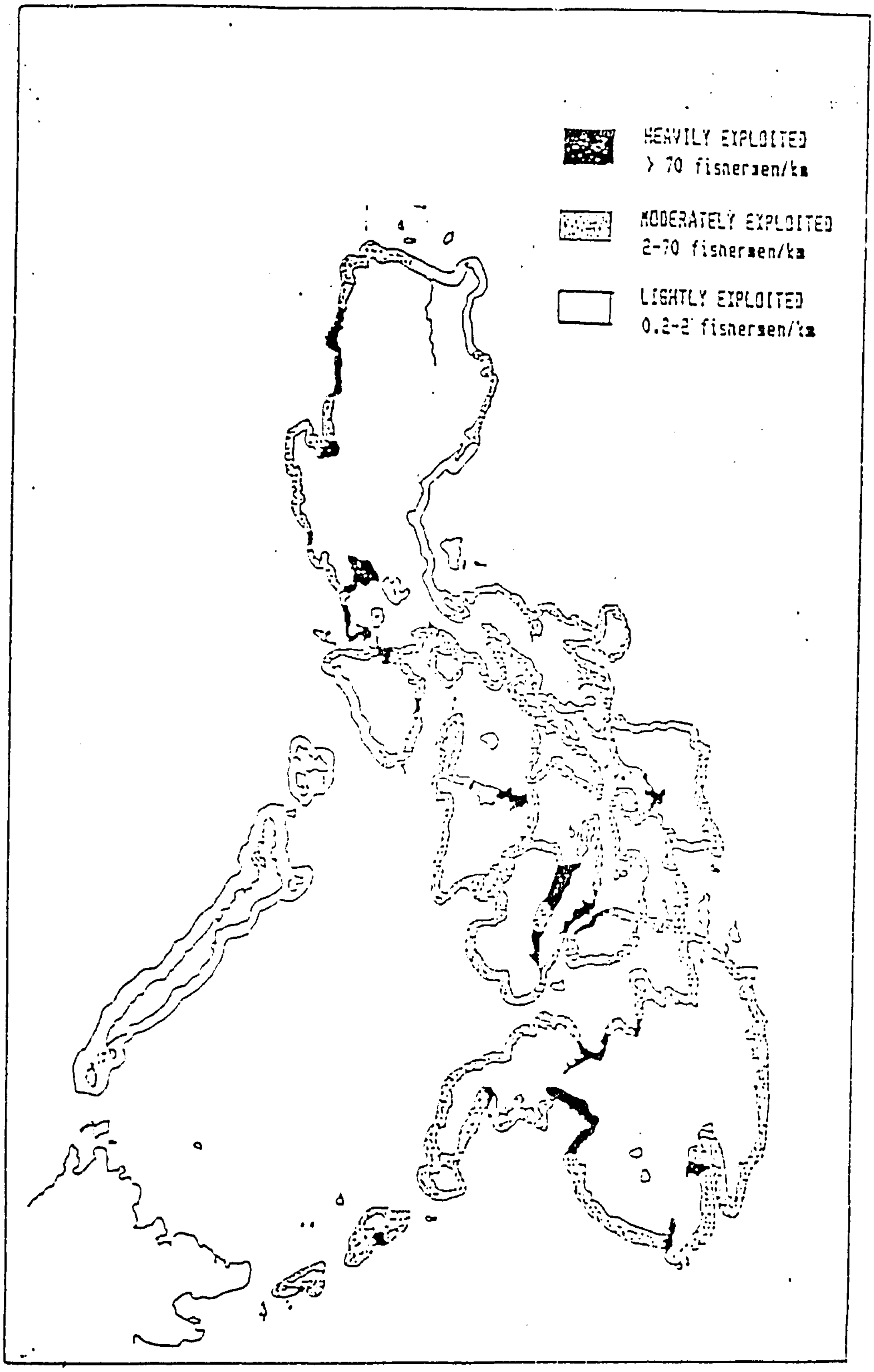

Fig. 4. Philippine Municipal Fisheries. Distribution of heavily and lightly fished areas. (Source: Fox, 1986).

Introduction

Fisheries is one of the important elements of the Philippine agricultural sector. In 1983, the fisheries sector supplied 54% (i.e. 1.93×10^6 mt) of the country's animal protein requirements, accounted for 4.4% (i.e. P16.2 billion) of GNP and earned the equivalent of PI.48 billion in foreign exchange (in 1983, 10 Philippine Pesos were about equal to 1US$). Together with related ancillary industries, the sector employs a large number of people and it is estimated that over 10% of the population are dependent on fishing in various degrees for their subsistence.

Research in support of this important sector has traditionally been biologically oriented and largely descriptive (see entries in bibliographies by Gomez 1980 and Ronquillo and Gabral-Llana 1985) although a trend more quantitatively oriented, analytical approaches is apparent (see contributions in Aprieto et al. 1986).

Economic analyses of the performance of the Philippine fisheries have been few, however, and there have been to date only two attempts to estimate the rent (i.e. the total revenues above all costs, including opportunity costs of labor and capital) in Philippine fisheries - one for the milkfish fry fishery (Chong et al. 1982), one for the multi-species, multigear San Miguel Bay fishery (Smith and Mines 1982).

In this contribution, a rough estimate of economic rent for the Philippine demersal fishery is presented, i.e. the fishery for bottom fishes (soft bottom, "trawl" and rocky bottom, i.e. coral reef fishes) and associated invertebrates.

This attempt relies heavily on (a) time series of demersal biomass and landings derived by Silvestre el al. (1986), and (b) on a set of assumptions which some may view as questionable, but which, given the scanty data base at hand, had to be made for any estimate of rent to be arrived at.

Materials and Methods

Data utilized in the present study to estimate the potential yield of Philippine demersal stocks consist of the following: (i) estimates of demersal biomass for the Philippine shelf (0-100m) from 1946 to 1984, and (ii) annual landings of demersal species from published statistics of the Bureau of Fisheries and Aquatic Resources for the same period. The former was taken from text Fig. 5 of Silvestre et al. (1986), while the latter was obtained from tabular data presented in Appendix II of the same paper. The demersal biomass time series given in said paper was estimated via the "swept area method" (see Guiland, 1983; Pauly, 1984) utilizing over 1200 individual trawl catch-per-effort (c/f) values from the late '40s to early '80s and covering most of the Philippine shelf.

Briefly, the method consists of the following: (i) stratification of the Philippine shelf into 10 areas (A to J) by depth range (0-9, 10-19, 20-49 and 50-100m), or 40 strata in all; (ii) estimation of the area of each strata; (iii) distribution of the over 1200 trawl c/f data among strata by year; (iv) estimation of density and biomass for each stratum by year (with interpolation for missing years, area and depth range); (v) aggregation of strata biomass estimates by year, and (vi) correction of (v) for "learning effects" and/or gear improvements to give estimates of Philippine demersal biomass by year.

The annual landing statistics published by BFAR covering the years 1946-1984 were summarized by Silvestre et al. (1986). They reduced the original "species" groupings used by BFAR into only 3 categories (demersals, tunas and other pelagics) and aggregated the catches for these by year. The distinction between pelagic and demersal species admittedly involves a certain degree of subjectivity in some instances, and Silvestre et al. (loc. cit.) stresses that the criteria for categorization is more operational/technological rather than ecological. The data used for this contribution are summarized in Table 8.

Conventional fisheries theory implies that the yield (Y) from a stock at a given time is proportional to the product of fishing mortality (F) exerted on the stock and the size/biomass of the stock (B) at that time, i.e. Y = FB (Gulland 1983, Pauly 1984). The time series of Y and B described above were used to derive estimates of fishing mortality using the equation

$$F_i = Y_i/B_i \qquad (1)$$

where i is a group of 5 successive years (Table 1). Empirical observations of exploited stocks indicate that stock abundance (i.e. c/f) usually declines in an exponential manner (Garrod, 1969; Fox, 1970). In this study, Fox' model was applied to the plot of $Y_{i/Fi}(B_i)$ versus F_i, i.e.

$$Y/F = B = e^{a-bF} = B_{oo}e^{-bF} \qquad (2)$$

where a and b are parameters computed by least squares approximation. From the above expression, estimates of MSY and F_{MSY} are given by

$$MSY = B_{oo}/be \tag{3}$$

$$F_{MSY} = 1/b. \tag{4}$$

The estimation of maximum economic rent (MER) and maximum economic yield (MEY) require the following: (i) expression of revenues as a function of F, and (ii) derivation of a cost function. In the case of the former, yield in weight (mt) was converted to value/monetary units (Philippine P and US$) by simple multiplication with the weighted average 1983 price/mt of the Philippine marine catch (about P5,000/mt or US$500/mt).

In the case of the latter, two variants of a linear cost function were used, assuming that: (i) equilibrium was reached by the open access fishery at the 1975-79 F level, and (ii) equilibrium was attained during the 1980-84 period. The equations used in computing F_{MER}, MEY and MER, based on derivatives are:

$$a^{a-bF} MER[1-bF_{MER}] - C = 0 \tag{5}$$

$$MEY = F_{MER}\ e^{a-bF_{MER}} \tag{6}$$

$$MER = MEY - CF_{MER} \tag{7}$$

where MEY and MER are in weight (mt), C the slope of the linear (weight unit) cost function, and the rest as previously defined.

Results and Discussion

Plots of the data of Table 8 are presented as Fig. 5 and 6. The former plot illustrates the steady decline of the demersal biomass of the Philippines from 1946 to 1984; the linear plot has an r^2=0.987. The other parameters obtained from the linear regression were: (i) a (intercept) = 14.061, (ii) b (slope) = - 1.332. The 95% confidence limits were (i) for a = [13.900, 14.222] and (ii) for b = [-1.648-1.016]. The estimates for MSY and F_{MSY} were 350 x 10^3 mt (95% confidence limits = 340-390x10^3 mt) and 0.75 (95% confidence limits = 0.61-0.98), respectively. The second figure shows the fit of the Fox model to the available data and provides a graphic illustration of the crude but, we believe, realistic approach we have used to estimate economic rent.

As might be seen, MER was probably reached in late '60s - early '70s, and amounted to the annual value of 1.0x10^5 to 1.9x10^5 metric tons, equivalent (in 1983) to 50-90 million US$, and representing approximately half of the gross value of the fishery at MEY. The fishing mortality corresponding to MEY and hence to MER appears to range from 0.34 to 0.43, i.e. approximately one third of the 1980-84 value.

These results are not very sensitive to whether we choose the late '70s or the early '80s as the period during which equalization of gross returns and total cost occurred. [This matches results by Gulland (1982), who found his estimate of losses due to mismanagement of the North Atlantic fisheries to be fairly robust with regard to the assumptions used to derive his one-billion US$ estimate.

The failure of several large-scale fisheries loan programs (due to lack of repayment) in the above-mentioned period provides evidence for such equalization to have occurred, as does the fact that the overwhelming majority of Filipino fishermen's annual income is well below the current "poverty level". Specific studies of individual fisheries also suggest that economic and biological overfishing occur in most Philippine demersal fishing grounds (Cases-Borja 1975, SCSP 1970, 1977, 1978, Smith et al. 1980, Pauly & Mines 1982, Spoehr 1984).

We note also that the ratios of MER to MEY observed here (i.e. approx. 1:2) and of F_{MEY} TO F level at equilibrium (i.e. approx. 1:3) correspond to values observed elsewhere in Southeast Asia (Nahan 1982). Hence, we feel we are on safe ground when proposing that a massive reduction of fishing effort may lead, in the Philippines, to a large increase of fishermen income (for those who remain, see Smith 1981) but have only a modest impact on absolute catch levels.

Here is not the place to discuss how fishing mortality (i.e. fishing effort, or number of fishermen) could be actually rolled back in a depressed socio-economic context such as presently prevailing in the Philippines (but see Garcia and Demetropoulos 1986 for a ray of hope, and Beddington and Rettig 1983 and Mackenzie 1983 for rigorous treatments).

Rather, we wanted to show here that the benefits involved in managing the Philippine demersal fisheries could be very large, and could indeed provide much of the money needed to relocate displaced fishermen (if the taxing authority chose to extract part of the rent and use it in this fashion) or to generate other economic activity in fishing communities (if left to those fishermen who remain to reinvest, but not in fishing).

Acknowledgements

We wish to thank our colleagues at BFAR for their assistance in locating crucial statistical information, to Ms. Mina Soriano for her help with various computation, and to Prof. H. Lampe and Dr. I.R. Smith for their comments on an early draft of this contribution.

References

Aprieto, V., J. Saeger and D. Pauly (Eds). 1986. Selected papers on Philippine marine fisheries resources. University of the Philippines in the Visayas, College of Fisheries, Tech. Rep. Dept. Mar. Fish. No. 9, Quezon City, xx + 436 p.

Beddington, J.R. and R.B. Retting. 1983. Approaches to the regulation of fishing effort. FAO Fish. Tech. Pap. 243. Rome, 39 p.

Cases-Borja, P. 1975. On the ability of other trawl to catch pelagic fish in Manila Bay. Philipp. J. Fish 10(1&2):39-56.

Chong, K.C., I.R. Smith and M.S. Lizarondo. 1982. Economics of the Philippine milkfish resources system. Resource Systems Theory and Methodology Series, No. 4. The United Nations University.

Garcia, S. and A. Demetropoulos. 1986. Management of Cyprus fisheries. FAO Fish. Tech. Pap. 250, Rome, 40 p.

Garrod, D.J. 1969. Empirical assessment of catch/effort relationships in North Atlantic cod stocks. Res. Bull. I.C.N.A.F. No. 6:26-34.

Gomez, E.D. 1980. Bibliography of Philippine marine science. Filipinas Foundation, Makati, Metro Manila, 178 p.

Gulland, J.A. 1982. Long-term potential effects from management of the fish resources of the North Atlantic. J. Cons. Int. Explor. Mer 40(1):8-16.

Mackenzie, W.C. 1983. An introduction to the economics of fisheries management. FAO Fish. Tech. Pap. 226, Rome, 31 p.

Nahan, M. 1982. Bionomic investigation of the Malaysian large-scale fishing sector: a case study of Kedah/Perlis. Ph.D. dissertation, Australian National Univ., xii + 283 p.

Pauly, D. 1984. Fish population dynamics in tropical waters: a manual for use with programmable calculators. ICLARM Studies & Reviews 8, Manila, 325 p.

Ronquillo, I.A. and M.A. Gabral-Llana. 1985. A bibliography of BFAR's researches and popular writings (1947-1984). Bureau of Fisheries and Aquatic Resources, Tech. Pap. Ser. 8(1):1-104.

SCSP. 1976. Fishery resources of the Visayan and Sibuyan Sea areas. Report of the BFAR/SCSP Workshop, 18-22 October 1976. SCS/GEN/76/7. South China Sea Fishery Development and Coordinating Programme, Manila, 26 p. plus appendices.

SCSP. 1977. Fishery resources of the Sulu Sea, Bohol Sea and Moro Gulf areas. Report of the BFAR/SCS Workshop, 25-29 April 1977. SCS/GEN/77/11. South China Sea Fishery Development and Coordinating Programme, Manila, 23 p + appendices.

Silvestre, G., R. Regalado and D. Pauly. 1986. Status of Philippine demersal stocks: inferences from underutilized catch rate data In D. Pauly, J. Saeger and G. Silvestre (Eds.). Resources, Management and Socio-Economics of Philippine Marine Fisheries. Univ. of the Phil. in the Visayas, College of Fisheries, Tech. Rep. No. 10.

Smith, I.R., M.Y. Puzon and C.N. Vidal-Libunao. 1980. Philippine Municipal Fisheries: A review of resources, technology and socioeconomics. ICLARM Studies and Reviews No. 4, Manila. International Center for Living Aquatic Resources Management and Fishery Industry Development Council.

Smith, I.R. and A.N. Mines. 1982. Implications for equity and management. p. 139-143 In Smith and A.N. Mines (eds) Small-Scale fisheries of San Miguel Bay, Philippines: economics of production and marketing. ICLARM Technical Report 8, 143 p. Institute of Fisheries Development and Research, College of Fisheries, University of the Philippines in the Visayas, Quezon City, Philippines, International Center for Living Aquatic Resources Management, Manila, Philippines and the United Nations University, Tokyo, Japan.

Spoehr, A. 1984. Change in Philippine capture fisheries: an historical overview, Philipp. Quart. Cult. & Soc. 12:25-26.

Table 8. Mean annual demersal catch(Y), mean annual demersal biomass (B) and fishing mortality (F) for each five-year period, from the mid-40's to the mid-80's.

Years	Mean annual Demersal Catch[a] (Y), $x10^3$ mt	Mean annual Demersal Biomass[b] (B), $x10^3$ mt	Fishing mortality (F)[c]
1946-49	59	1297	0.05
1950-54	97	1195	0.08
1955-59	141	1071	0.13
1960-64	163	950	0.17
1965-69	246	830	0.30
1970-74	316	561	0.56
1975-79	364	437	0.83
1980-84	351	364	0.96

a) based on annual statistics of the Philippine Bureau of Fisheries and Aquatic Resources and Appendix II in Silvestre *et al.* (1986).

b) based on Fig. 5 in Silvestre *et al.* (1986) and including all Philippine waters from 0 to 100m depth.

c) $F_i = Y_i/B_i$, where i is a group of 5 successive years (or 4 in the case of 1946-1949).

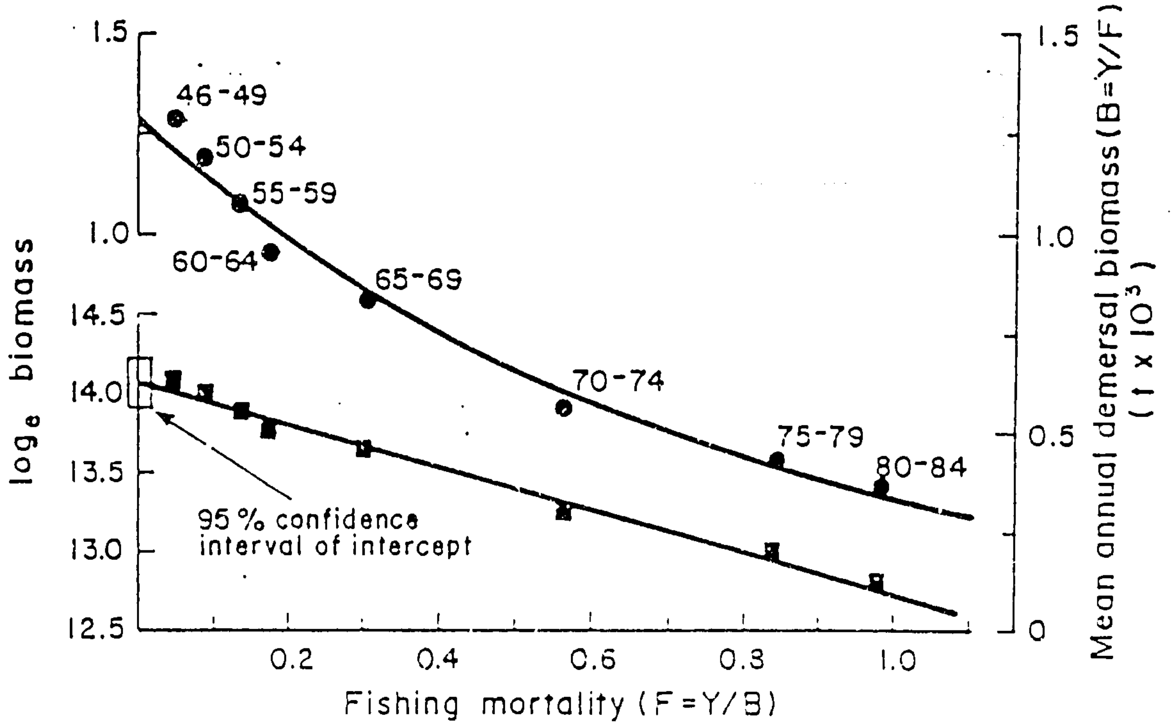

Fig. 5. Mean annual demersal biomass ($\bar{B}$) and its natural logarithm ($\log_e \bar{B}$) versus fishing mortality ($\bar{F}$) for the mid-1940s to the mid-1980s as used to derive the surplus yield model in Fig. 6 (see text).

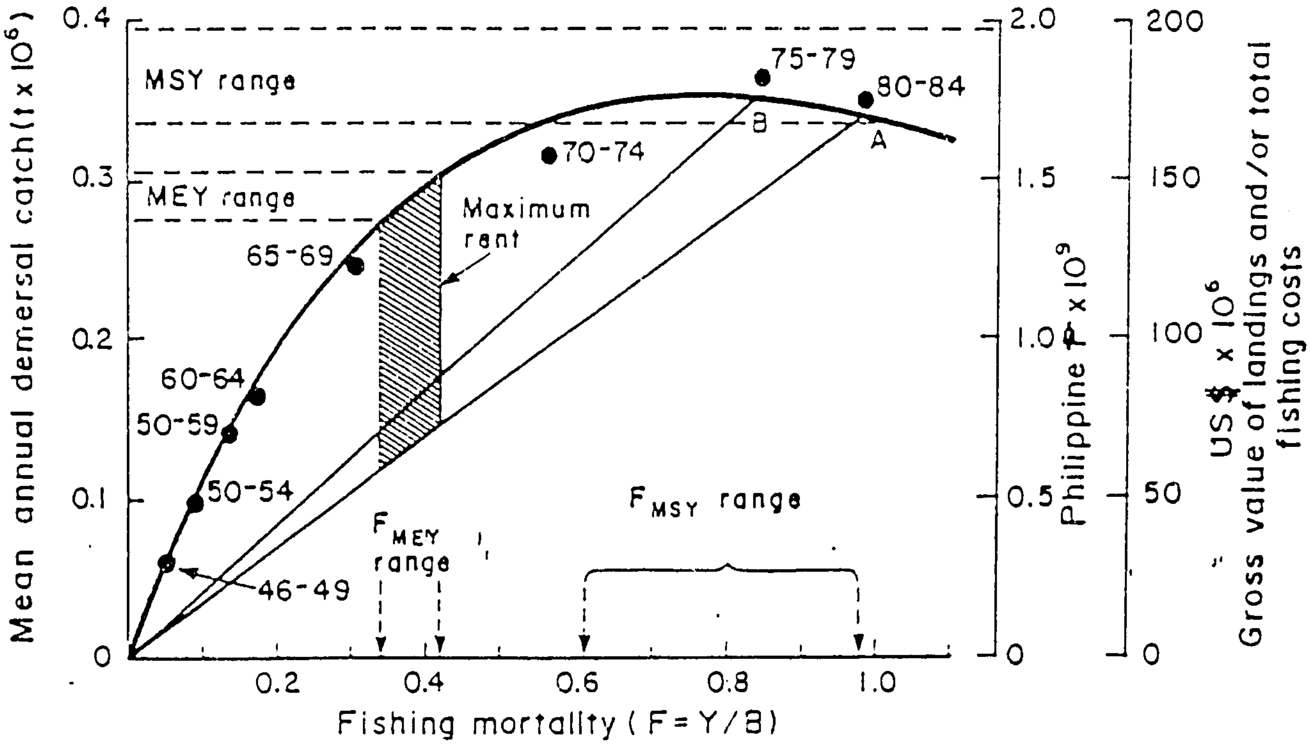

Fig. 6. Mean annual demersal landings ($\bar{Y}$) versus fishing mortality ($\bar{F}$) for eight 5-year periods from the mid-1940s to the mid-1980s. The (asymmetric) "MSY range" and the "F_{MSY} range" are based on the 95% confidence intervals of the intercept and the slope of the linear plot in Fig. 5, respectively. The MEY and F_{MEY} ranges are based on (1) the alternative assumptions that the 1975-1979 and 1980-1984 periods saw the equalization of costs and returns, and (2) the confidence intervals of the parameters of the surplus-production curve (see text).