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## ESTIMATE OF YIELD AND ECONOMIC RENT FROM PHILIPPINE DEMERSAL STOCKS (1946-1984) USING VESSEL HORSEPOWER AS AN INDEX OF FISHING EFFORT\*

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### ABSTRACT

*This study presents time series of annual demersal landings,  $y(t)$ , and fishing effort,  $f$  (trawl horsepower), on Philippine demersal fishery resources for the period 1946-1984 as derived from published statistics. Derivation of the  $Y$  time series involved aggregation by year of catches of demersal species groups. For the  $f$  time series, this involved (i) derivation of aggregate trawl horsepower (HP) by year,  $f'$ , corrected for effects of "learning" and addition of carrier vessels in fishing operations, and (ii) extrapolation of  $f$  from  $f'$  for each year using the ratio of total to trawl demersal landings as raising factor.*

*The consequent plot of  $Y$  versus  $f$  (fitted with the Fox model) was used to assess harvestable potential and status of exploited demersal stocks. It appears that the demersal resources, which have a maximum sustainable yield (MSY) of  $340-400 \times 10^3$  t, are capable of generating at maximum economic yield ( $300-325 \times 10^3$  t) a maximum economic rent (MER) corresponding to  $125-200 \times 10^3$  t worth approximately P2.0 - 3.2 billion or US \$100-160 million per year. These indicate that exploited demersal stocks are possibly biologically and economically overfished, and that effort on these resources would have to be reduced either by about 1/5 or 3/5 of 1983-1984 levels to realize MSY or MER, respectively. The results of the study are compared with previous assessments and the policy implications of the findings are briefly discussed.*

### INTRODUCTION

Assessments of Philippine fishery resources have traditionally relied upon indirect methods, such as comparisons of landings vs. estimates of productivity per unit of fishable area or indirect measures of fishing pressure, to infer harvestable potential and status of exploitation. This is because the available statistics are insufficient, especially with respect to information on fishing effort, to allow analysis using conventional production models. Smith et al, (1980) and NRMC-FIDC (1980) provided a compilation of these studies conducted in the 1970s. Estimates of potential annual yield country-wide varied between 1.0 and 3.7 million t although expert consensus in 1980 narrowed down the range considerably to  $1.65 \pm 0.20$  million t (see Pauly 1986). This figure consisted of  $250 \pm$

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50 thousand t of oceanic pelagic fish,  $800 \pm 75$  thousand t of coastal pelagic fish and  $600 \pm 75$  thousand t of demersal resources.

In the specific case of the demersal resources, studies during the late 1970s (e.g., SCSP 1976, 1977, 1978) indicate that most of the soft/tractable grounds of the Philippines were either fully exploited or overfished. In the 1980s, both country-wide and area-specific assessments of the demersal stocks (e.g., McManus and Arida 1987; Munro 1986; Pauly and Mines 1982; Silvestre et al. 1986, Silvestre and Pauly 1986; Silvestre 1987; Spoehr 1984) confirm the trend of overfishing in the soft/tractable grounds, with the addition of nearshore hard/coral bottoms. Hence, more recent assessments, relying on a variety of methods and indirect inferences, indicate biological overfishing of exploited demersal resources.

Analyses of economic performance of Philippine fisheries and attempts to estimate rent, i.e., total revenue above all costs including opportunity cost of labor and capital, have been few such as Chong et al. (1987) for the small pelagic fishery; Silvestre et al. (1987) for the Manila Bay area demersal fishery; and Smith and Mines (1982) for the San Miguel Bay capture fishery. For the demersal fishery country-wide, Silvestre and Pauly (1986) estimated annual rent from the exploited demersal stocks to be 100-190 thousand t worth US\$50-95 million. In addition, they provided estimates of annual maximum sustainable yield (MSY) and economic yield (MEY) of 280-300 thousand and 340-390 thousand t respectively. Their study relied on an indirect index of overall fishing mortality ( $F = Y/B$ ) based on time series of demersal landings (Y) and biomass (B) computed from over 1,200 trawl hauls analyzed via the swept area method.

This contribution represents a follow-up study to that conducted by Silvestre and Pauly (ibid.), using information on fishing effort derived from published statistics of the Bureau of Fisheries and Aquatic Resources (BFAR). We use (i) essentially similar time series of demersal landings as Silvestre and Pauly (ibid.) derived from Silvestre et al. (1986); (ii) the time series of annual aggregate trawl horsepower (HP) derived by Dalzell et al. (1987) from BFAR statistics and adjusted for the effects of "learning" and addition of carrier vessel HP; and (iii) a set of assumptions that had to be made to estimate the rent. Using a time series for 1946-1984, of demersal landings, Y (t), and fishing effort, f (trawl HP), thus derived, this study provides estimates of MSY, MEY, and rent from the country's exploited demersal stocks.

## MATERIALS AND METHODS

The data consists of the following: (i) time series of annual demersal landings, Y (t), derived from BFAR statistics published since 1951, following the procedure described by Silvestre et al. (1986) with minor modifications; and (ii) time series of annual fishing effort on the demersal resources, (trawl HP units), estimated using the annual aggregate trawl HP derived by Dalzell et al. (1987) from BFAR statistics (corrected for the effects of "learning" and the addition of carrier vessels in fishing operations) and the ratio of total to trawl demersal landings as raising factor.

The term "demersal" as used in this study refers to fish and associated invertebrates which live on the sea bottom (whether soft/tractable or coral/hard grounds). The species/groups herein considered as demersal follow the listing given in Silvestre (1987, Table 1) as modified from Silvestre et al. (1986, Appendix Table 1.2). The list is based on available information on the biology of each species/group, drawn from, for example, Fischer and Whitehead (1974), Chullasorn and Martosubroto (1986), and various FAO species catalogues. In cases where the life history fluctuates between demersal and pelagic phases, classification into demersal or pelagic (i.e., fishes and invertebrates inhabiting the surface water layers) is based on whether the species/group is more abundant in the 1983-1984

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catch of demersal (e.g., trawl) or pelagic (e.g., purse seine, bagnet) fishing gears.

Briefly, derivation of the Y time series consists of the following steps: (i) aggregation of catches by year given in BFAR statistics for species/groups classified as demersal to obtain (a) the commercial demersal landings of 1952-1984, and (b) the municipal (taken by vessels smaller than 3 gross tons) demersal landings of 1976-1984; (ii) estimation of municipal demersal landings from 1946-1975 by multiplying the total municipal catch for each year in this period by 0.308 (representing the average proportion of demersals in the municipal catch of 1976-1979); (iii) extrapolation of commercial demersal landings from 1946-1951 through a backward projection of the linear trend of increase of the demersal component of commercial landings of 1952-1956; and (iv) addition of the municipal and commercial demersal landings by year obtained via (i) through (iii) to obtain the Y time series for the period 1946-1984.

Derivation of the f time series proceeds from the annual aggregate trawl HP (henceforth referred to as raw trawl effort, f1) for the 1948-1984 period given by Dalzell et al. (1987, Table 9). The procedure used in deriving the f1 values from BFAR statistics consists of the following steps: (i) estimation of annual trawl gross tonnage (GT) from 1962 to 1984 using the number of trawlers by GT class multiplied by the GT class midpoint for each year (as given in the statistics for the said time period); (ii) estimation of annual trawl GT from 1948 to 1961 using the trawler numbers recorded in the statistics for these years and the relationship between GT and trawler numbers for the 1962-1984 period; and (iii) estimation of f1 for the period 1948-1984 via conversion of trawl GT (from i and ii above) to HP, using the relationship derived for the 1978-1985 period relating trawl GT to HP. The f1 value for 1947 was obtained using records of trawler numbers for this year (see Silvestre et al, 1986, Table 1) and the relationship between GT and both trawler numbers and HP in steps (ii) and (iii) above;

The f1 values for the 1947-1984 period were subsequently used to obtain standard trawl effort, f' (trawl HP), values corrected for the effects of "learning", the doubling of trawl engine HP beginning in 1958 (see Silvestre et al. 1986, Appendix II) and the addition of carrier vessels in fishing operations starting in 1964. The f' value for each year j between 1947-1984 was computed using the equations

$$f2(j) = f1(j) / x1(j) \quad \dots (1)$$

$$f3(j) = f2(j) / x2(j) \quad \dots (2)$$

$$f'(j) = f3(j) + x3(j) = ((f1(j) / x1(j)) \cdot x2(j)^{-1}) + x3(j) \quad \dots (3)$$

where f2(j), referred to as adjusted trawl effort, is the aggregate trawl HP for year j adjusted for "learning" effects; x1(j) is the learning factor for year j (taking on values given by Silvestre et al. 1986, Table 8); f3(j), referred to as corrected trawl effort, is f2(j) corrected for the doubling of trawl engine HP; x2(j) the engine doubling correction factor taking on values of 2 for j < 1958, or 1, for j > 1958 (i.e., correcting the GT to HP relationship based on 1978-1985 data used by Dalzell et al. 1987 in deriving f1 values); and x3(j) the trawl demersal carrier vessel HP for year j representing a rough estimate to account for the fact that since 1964, the addition of carrier vessels in fishing operations allows trawlers to remain in the fishing grounds for longer periods (thereby effectively increasing fishing effort). The values of x3(j) are computed from the equation:

$$x3(j) = C \cdot x(j); x(j) = YTr(j) / (YTr(j) + Y'Ps(j) + Y'RN(j)) \quad \dots (4)$$

where C is the total carrier vessel fleet HP for year j taking on values given by Dalzell et al. (1987, Table 16) for the period 1964-1984; and x(j) is a conversion factor equal to the ratio of the trawl demersal catch (YTr) to the sum of the total trawl (Y'Tr), purse

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seine (Y'Ps) and ring net (Y'RN) catches for year j. The trawl, purse seine, and ring net vessels of the commercial sector appear to be the main users of carrier vessels in fishing operations.

The resulting values of  $f'$  from equation 3 were used in computing  $f$  from 1947 to 1984 using the ratio of  $Y$  to  $Y_{Tr}$  as raising factor, i.e.:

$$f'(j) = (Y(j) / Y_{Tr}(j)) \cdot f'(j) \quad \dots (5)$$

$$f(j) = (f'(j-2) + f'(j-1) + f'(j)) / 3 \quad \dots (6)$$

where  $f'(j)$  is the standard fleet effort for year j prior to averaging over 3 years (i.e., the mean exploited lifespan of demersals included in this study) to account for non-equilibrium situations (e.g., Gulland 1983; Pauly 1984); and the rest as previously defined. The  $f$  value for 1946 is computed via equation (5) using the  $Tr$  and  $f'$  values for 1947 with the 1946  $Y$  value.

The appropriateness of using the resulting 1946-1984  $f$  time series in production modeling rests upon the assumptions made in the derivation of the time series via equations (1) - (6). The use of trawler HP as an acceptable measure of fishing effort has already been demonstrated by Beverton and Holt (1957), who found a proportional relation between fishing power and engine HP of North Sea trawlers. Dalzell et al. (1987) made similar use of vessel HP in the assessment of Philippine small pelagic fisheries.

Empirical observations of exploited stocks indicate that stock abundance (e.g.,  $Y/f$ ) usually declines in an exponential manner with increasing fishing pressure (Garrod 1969; Fox 1970). In this study, the Fox model was applied to the plot of  $Y/f$  versus  $f$ , using the time series of  $Y$  and  $f$  from 1946 to 1984 obtained as described above. The model is of the form

$$Y/f = e^{a+bf} \quad \dots (7)$$

where  $a$  and  $b$  are parameters computed by least squares approximation, and  $e$  is the base of natural logarithm. From this expression, estimates of  $MSY$  and  $f_{MSY}$  are obtained from the equations:

$$MSY = e^{a/-b} \quad \dots (8)$$

and

$$f_{MSY} = 1/-b \quad \dots (9)$$

The estimation of maximum economic rent (MER) and MEY requires the following: (i) an expression of revenue as a function of  $f$ , and (ii) derivation of a cost function. In the case of the former,  $Y$  from equation (7) was converted from weight (t) to value/monetary units (Philippine ₱ and US\$) by simple multiplication with the mean price/t ( $V$ ) of the Philippine demersal catch for the 1980-1984 period (i.e., about ₱16,000/t or US\$ 800/t). The  $V$  value was estimated from 1984 prices by species/groups given in Signey (1987), and landings by demersal species/groups between 1980 and 1984 from BFAR statistics. In the latter, three variants of a linear cost function were used, assuming that: (i) equilibrium was reached by the open access fishery at the mean 1983-1984  $f$  level; (ii) fishing costs were 10% above revenues at the mean 1983-1984  $f$  level; and (iii) revenues were 10% above fishing costs at the mean 1983-1984  $f$  level. The equations used to compute  $f_{MER}$ , MEY and MER for each of these three variants are:

$$e^{a+bf_{MER}} (1 + bf_{MER}) - S = 0 \quad \dots (10)$$

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$$MEY = f_{MER} e^{a + bf_{MER}} \quad \dots (11)$$

$$MER = MEY - Sf_{MER}; f_{MEY} = f_{MER} \quad \dots (12)$$

where MEY and MER are in weight (t) units, S the slope of the linear (weight unit) cost function, and the rest as previously defined. The Newton-Raphson iteration technique was used in estimating  $f_{MER}$  in equation (10).

### RESULTS AND DISCUSSION

The trawl demersal carrier vessel HP (X3) for the period 1964-1984 obtained via equation 4 are given in Table 1, together with the total carrier vessel fleet HP (C) and conversion factor (X) values for the same period utilized in their computation. Table 2 provides the time series of standard trawl effort (f') from 1947-1984 (corrected for

**Table 1. Estimated total and trawl demersal carrier vessel horsepower (HP) for the period 1964-1984.**

Year	Total Carrier Vessel Fleet HP (C) <sup>a</sup>	Conversion Factor (X) <sup>b</sup>	Trawl Demersal Carrier Vessel HP (X3) <sup>a</sup>
1964	6,005	0.775	4,652
1965	11,167	0.615	6,864
1966	16,325	0.597	9,740
1967	52,516	0.521	27,366
1968	24,771	0.510	12,627
1969	21,165	0.449	12,656
1970	32,383	0.418	13,549
1971	51,546	0.346	18,951
1972	92,523	0.348	32,202
1973	28,261	0.273	7,703
1974	128,955	0.336	43,364
1975	116,990	0.412	48,168
1976	119,111	0.352	41,920
1977	116,294	0.327	38,034
1978	84,133	0.366	30,826
1979	101,485	0.344	34,919
1980	153,200	0.321	49,222
1981	199,571	0.268	53,416
1982	214,337	0.230	49,383
1983	241,717	0.209	50,564
1984	221,504	0.234	51,742

<sup>a</sup> from Dalzell et al. (1987) based on the relationship between vessel horsepower and gross tonnage for the period 1978-1985.

<sup>b</sup> ratio for each year of demersal trawl catch to the aggregate catch of trawls, purse seines and ring nets, i.e.  $X = Y_{Tr} / (Y_{Tr} + Y_{PS} + Y_{RN})$ , where  $Y_{Tr}$  is the demersal trawl catch,  $Y_{Tr}$  the total trawl catch,  $Y_{PS}$  the total purse seine catch and  $Y_{RN}$  the total ring net catch, for each year.

<sup>c</sup> total carrier vessel HP multiplied by X.

**Table 2. Estimated standard trawl effort ( $f'$ ) time series for the period 1947-1984 showing standardizations from raw trawl effort for "learning", doubling of engine HP, and carrier vessel HP.**

Year	Trawl Effort (HP)				Year	Trawl Effort (HP)			
	Raw (f1) <sup>a</sup>	Adjusted (f2) <sup>b</sup>	Corrected (f3) <sup>c</sup>	Standard (f') <sup>d</sup>		Raw (f1) <sup>a</sup>	Adjusted (f2) <sup>b</sup>	Corrected (f3) <sup>c</sup>	Standard (f') <sup>d</sup>
1947	2,495	1,155	578	578	1966	146,920	87,452	87,452	97,192
1948	4,016	1,575	788	788	1967	180,466	113,501	113,501	140,867
1949	15,518	6,086	3,043	3,043	1968	221,785	146,036	163,036	175,692
1950	34,512	13,534	6,767	6,767	1969	234,772	163,036	163,036	175,692
1951	50,829	19,933	9,966	9,966	1970	233,939	170,758	170,758	184,307
1952	62,597	24,548	12,274	12,274	1971	223,349	171,259	171,259	190,210
1953	60,726	23,814	11,907	11,907	1972	240,266	192,213	192,213	224,415
1954	82,664	32,417	16,208	16,208	1973	263,503	219,586	219,586	227,289
1955	80,526	31,579	15,790	15,790	1974	228,997	197,411	197,411	240,775
1956	83,736	32,838	16,419	16,419	1975	194,625	175,338	175,338	223,556
1957	75,711	29,691	14,846	14,846	1976	189,690	177,280	177,280	219,200
1958	93,367	36,614	18,307	18,307	1976	189,690	177,280	177,280	219,200
1959	111,162	43,614	18,307	18,307	1977	162,824	156,562	156,562	194,596
1960	119,048	46,686	46,686	46,686	1979	188,977	188,977	188,977	223,896
1961	123,596	52,594	52,594	52,594	1980	150,633	150,633	150,633	199,855
1961	123,596	62,757	62,757	62,757	1981	162,119	162,119	162,119	215,535
1962	136,810	62,757	62,757	62,757	1981	162,119	162,119	162,119	215,535
1963	136,610	67,296	67,296	67,296	1982	174,682	174,682	174,682	224,065
1964	135,145	71,129	71,129	75,781	1983	199,949	199,949	199,949	250,513
1965	154,194	86,626	86,626	93,490	1984	159,854	159,854	159,854	211,596

<sup>a</sup> from Dalzell et al. (1987), based on the relationship between vessel horsepower and gross tonnage for the period 1978-1985.

<sup>b</sup> Raw trawl effort, f1 adjusted for "learning effects" using learning factor values given in Table 8 of Silvestre et al. (1986)

<sup>c</sup> f2, corrected for the doubling of engine horsepower of trawlers which started in 1958. (see Silvestre et al., (1986), Appendix II).

<sup>d</sup> f3, with the addition of demersal carrier vessel horsepower, (see last column of Table 1).

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Table 3. Estimated standard fleet effort,  $f$  (trawler HP), time series for the period 1946-1984, showing its derivation from total and trawl demersal landings and standard trawl effort data, and averaging over 3 years (see text).

Year	Demersal Landings Y (t)	Trawl Demersal Landings Y (t)	Standard Trawl Effort $f^T$ (HP)	Standard Fleet Effort $f^F$ (HP)	Standard Fleet Effort $f$ (HP)
1946	(25,614)	—	—	20,823	20,823
1947	(76,464)	(711)	578	62,161	41,492
1948	(57,610)	(969)	788	46,849	43,278
1949	(73,104)	(2,425)	3,043	91,734	66,915
1950	(67,501)	(3,778)	6,767	120,905	86,496
1951	(94,551)	(7,749)	9,966	121,602	111,414
1952	(101,401)	(10,091)	12,274	123,337	121,948
1953	(101,163)	(16,089)	11,907	74,868	106,602
1954	(122,071)	(26,090)	16,208	75,835	91,347
1955	(127,304)	(27,878)	15,790	72,104	74,269
1956	(142,425)	(29,655)	16,419	78,856	75,598
1957	(132,275)	(23,139)	14,846	84,868	78,609
1958	(142,400)	(30,246)	18,307	86,190	83,305
1959	(150,415)	26,012	43,594	252,083	141,047
1960	(153,621)	29,896	46,686	239,897	192,723
1961	(150,288)	34,294	52,584	230,485	240,822
1962	(152,777)	55,450	62,757	172,909	214,430
1963	(174,208)	71,012	67,296	165,092	189,495
1964	(198,153)	87,980	75,781	170,678	169,560
1965	(205,831)	91,398	93,490	210,542	182,104
1966	(220,761)	94,523	97,192	226,994	202,738
1967	(241,726)	96,138	140,867	354,191	263,909
1968	(300,092)	11,073	159,505	430,943	337,376
1969	(278,810)	96,248	175,692	508,942	431,359
1970	(276,198)	93,882	184,307	542,226	494,037
1971	(284,035)	97,080	190,210	556,513	535,894
1972	(331,664)	101,774	224,415	731,330	610,023
1973	(341,455)	105,030	227,289	738,922	675,588
1974	(373,619)	131,846	240,775	682,297	717,516
1975	(419,068)	174,506	223,556	536,859	652,693
1976	378,620	154,947	219,200	535,625	584,927
1977	360,003	139,931	194,596	500,641	524,375
1978	369,200	140,470	186,861	491,130	509,132
1979	360,603	132,030	223,896	611,509	534,427
1980	344,099	116,120	199,855	592,231	564,957
1981	370,730	96,454	215,535	828,429	677,390
1982	366,009	90,058	224,065	910,633	777,098
1983	381,057	86,890	250,513	1,098,627	945,896
1984	408,680	94,015	211,596	919,801	976,354

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the effects of "learning", the doubling of trawl engine HP, and the addition of carrier vessel HP via X1, X2, and X3, respectively) using equations (1) through (3). Estimates of standard fleet effort,  $f$  (trawl HP), on the demersal stocks for 1946-1984 obtained from the  $f$  time series via equations (5) and (6) are given in Table 3. The  $Y$  time series obtained using procedures described in the previous section are also given in column 2 of Table 3. Table 4 gives a summary of the time series of  $Y(t)$ ,  $f$  (trawl HP), and  $Y/f$  ( $t$  / trawl HP) for the period 1946-1984 thus derived.

The plots of the data given in Table 4 are illustrated in Figs. 1 and 2. Fig. 1 shows the decline of  $Y/f$  in the demersal fisheries with increasing  $f$ , covering the period 1946-1984. Note that the scatter of points about the computed line is greater for the earlier years (i.e., lower  $f$  values). This indicates that the published statistics, together with the assumptions and approximations discussed in the methods section to obtain the data in Table 4, become increasingly less accurate in reflecting the demersal fisheries situation as one goes back in time. The 95% confidence limits of intercept  $a$  were (0.165, 0.391), and for  $b$  ( $-1.082 \times 10^{-6}$ ,  $-1.599 \times 10^{-6}$ ). The estimates of MSY and  $f$  giving MSY using equations (8) and (9) were  $360 \times 10^3$  t (95% confidence limits =  $340 - 400 \times 10^3$  t) and  $745 \times 10^3$  HP (95% confidence limits =  $625-925 \times 10^3$  trawl HP), respectively.

Fig. 2 illustrates the fit of the Fox model to the scattergram of  $Y$  versus  $f$  and provides a concise summary of the approach used to estimate the parameters investigated in the study. The mean value of the 1980-1984 demersal landings, computed from data in Table 5, was used to provide the monetary/value axis given on the right hand side of Fig. 2. It is apparent from Fig. 2 that the mean 1983-1984 effort level of about  $960 \times 10^3$  trawl HP is beyond which could provide MSY, despite the very wide range of the 95% confidence limits of  $f_{MSY}$ . It appears that MER was probably reached in the late 1960's (1968-1969 in Table 4) and was equivalent to about  $125-100 \times 10^3$  t per year (worth about P2.0-3.2 billion or US\$ 100-160 million at 1984 prices and exchange rates). This rent is about half of the MEY range of  $300-325 \times 10^3$  t per year (worth US\$ 240-260 million). The fishing effort corresponding to MEY, and hence to MER, ranges between  $370$  and  $420 \times 10^3$  trawl HP (95% confidence limits  $360-450 \times 10^3$  trawl HP), and is equivalent to about 40% of the 1983-1984 level of fishing effort.

We note that the results herein obtained are not very sensitive to whether the demersal fishery was operating within the three variants relating gross returns to total costs in the 1983-1984 period (i.e., equalization of costs and returns, returns 10% above costs, and costs 10% above returns in 1983-1984). This matches the results of other authors (e.g., Gulland 1982; Silvestre and Pauly 1986) who found their estimates of economic losses to be fairly robust with respect to the assumptions made in the estimation procedure. Whether the fishery was already operating within 10% of equalization (between costs and returns) in 1983-1984 is uncertain, but is supported by the following: (i) the fact that the vast majority of fishermen are well below the "official poverty level"; (ii) the failure of large-scale fisheries loan programs, due to lack of repayment, to improve fishermen's income; (iii) the complaints of low catches and economic returns from both the commercial and municipal sectors (see, for example, the proceedings and recommendations of two recent national fisheries policy workshops discussed in Silvestre 1987a); and (iv) the increased competition between (and among) municipal and commercial fishermen.

The available country-wide and area-specific assessments mentioned in the introduction, suggesting that economic and biological overfishing occurs on most Philippine demersal fishing grounds, lend additional credence to the assumption that the fishery was operating within 10% of equalization in 1983-1984. These studies indicate that the fully exploited/overfished areas include all soft/trawlable and nearshore hard/coral grounds. Demersal grounds which can sustain expansion in fishing effort are limited to

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Table 4. Annual demersal landings (Y), standard fleet effort (f) and demersal catch per unit effort (Y/f) for the period 1946-1984.

Year	Demersal Catch, Y (t)	Standard Fleet Effort (trawler HP)	Y/f (t/HP)
1946	25,614	20,823	1.230
1947	76,464	41,492	1.843
1948	57,610	43,278	1.331
1949	73,104	66,915	1.092
1950	67,501	86,496	0.780
1951	94,551	111,414	0.849
1952	101,401	121,948	0.832
1953	101,163	106,602	0.949
1954	122,071	91,347	1.336
1955	127,384	74,269	1.714
1956	142,425	75,598	1.884
1957	132,275	78,609	1.683
1958	142,400	83,305	1.709
1959	150,415	141,047	1.066
1960	153,621	192,723	0.797
1961	150,288	240,822	0.624
1962	152,777	214,430	0.712
1963	174,208	189,495	0.919
1964	198,153	169,560	1.169
1965	205,831	182,104	1.130
1966	220,761	202,738	1.089
1967	241,726	263,909	0.196
1968	300,092	337,376	0.889
1969	278,810	431,359	0.646
1970	276,198	494,037	0.559
1971	234,035	535,894	0.530
1972	331,664	610,023	0.544
1973	341,455	675,588	0.505
1974	373,619	717,516	0.521
1975	419,068	652,693	0.462
1977	360,003	524,375	0.686
1978	369,200	509,132	0.725
1979	360,603	534,132	0.725
1979	360,603	534,427	0.675
1980	344,730	677,390	0.547
1981	370,730	677,098	0.471
1982	366,009	777,098	0.471
1983	381,057	945,896	0.403
1984	408,680	976,354	0.419

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Table 5. Mean value (₱/t) of Philippine demersal catch, V, for the period 1980-1984.

Year	Demersal Catch (t) <sup>a</sup>	Total Value (₱ x 10 <sup>3</sup> ) <sup>b</sup>	Mean Value (₱/t)
1980	344,099	5,502	15,989
1981	370,730	2,967	16,095
1982	366,009	2,776	15,780
1983	381,057	6,180	16,218
1984	408,680	6,666	16,312
Mean – (80-84)	–	–	(V =) 16,079 <sup>c</sup>

<sup>a</sup> from Table 4.

<sup>b</sup> computed using the 1984 average price/t by species group given by Signey (1987).

<sup>c</sup> approximately US\$ 800/t using 1984 exchange rate of P20 to US\$ (IBON Data Bank).

the offshore hard/coral areas, especially off western Palawan and the Pacific coast of Bicol and Quezon. Assessment of harvestable potential from these offshore hard bottom areas (e.g., McManus and Arida 1987) is about  $200 \times 10^3$  t/year. It is worth noting that the MSY estimate presented in this study ( $340-400 \times 10^3$  t/year), when added to the estimated potential of offshore hard bottoms, is equal to an MSY of  $540-600 \times 10^3$  t/year. This figure is quite close to the general consensus on the country's demersal fishery potential of  $600 \pm 75 \times 10^3$  t/year (NRMC-FIDC 1980) based on nonconventional assessment methods.

Additionally, it should be noted that the MSY, MEY, and MER estimates given in this study are in very close agreement with the results given by Silvestre and Pauly (1986), whose study is based on an indirect measure of fishing pressure (i.e.,  $F = Y/B$ ). The only differences are in the value/monetary equivalents of MEY and MER, due to differences in the V values utilized. The V value herein used relies on more reliable and accurate demersal prices and currency exchange rate information. We also note that the ratios of MER to MEY observed here (approximately 1:2) and of  $f_{MEY}$  to  $f$  level at equilibrium (approximately 2:5) are consistent with those observed by Silvestre and Pauly (1986) for the exploited Philippine demersal stocks, as well as those observed elsewhere in Southeast Asia (Nahan 1982).

It is quite apparent from this and the previous studies that the exploited Philippine demersal stocks suffer from both biological and economic overfishing due to excessive fishing effort levels. How fishing can be reduced and/or redirected in a depressed socio-economic situation such as presently prevailing in the Philippines is not readily apparent, and indeed is beyond the scope of this paper (but see Mackenzie 1983; Beddington and Rettig 1983; Garcia and Demetropoulos 1986). We would like to emphasize, however, that a large reduction of fishing effort on the demersal resources could lead to a large increase in fishermen income (at least for those allowed to remain in the fishery) with little change in absolute catch levels. The benefits from better and more effective management of the resources could well offset the costs that such improved management entails, and provide most of the funds to redirect fishing effort to lightly exploited areas/resources or initiate more viable economic activities other than fishing in coastal communities adjacent to heavily-fished resources.

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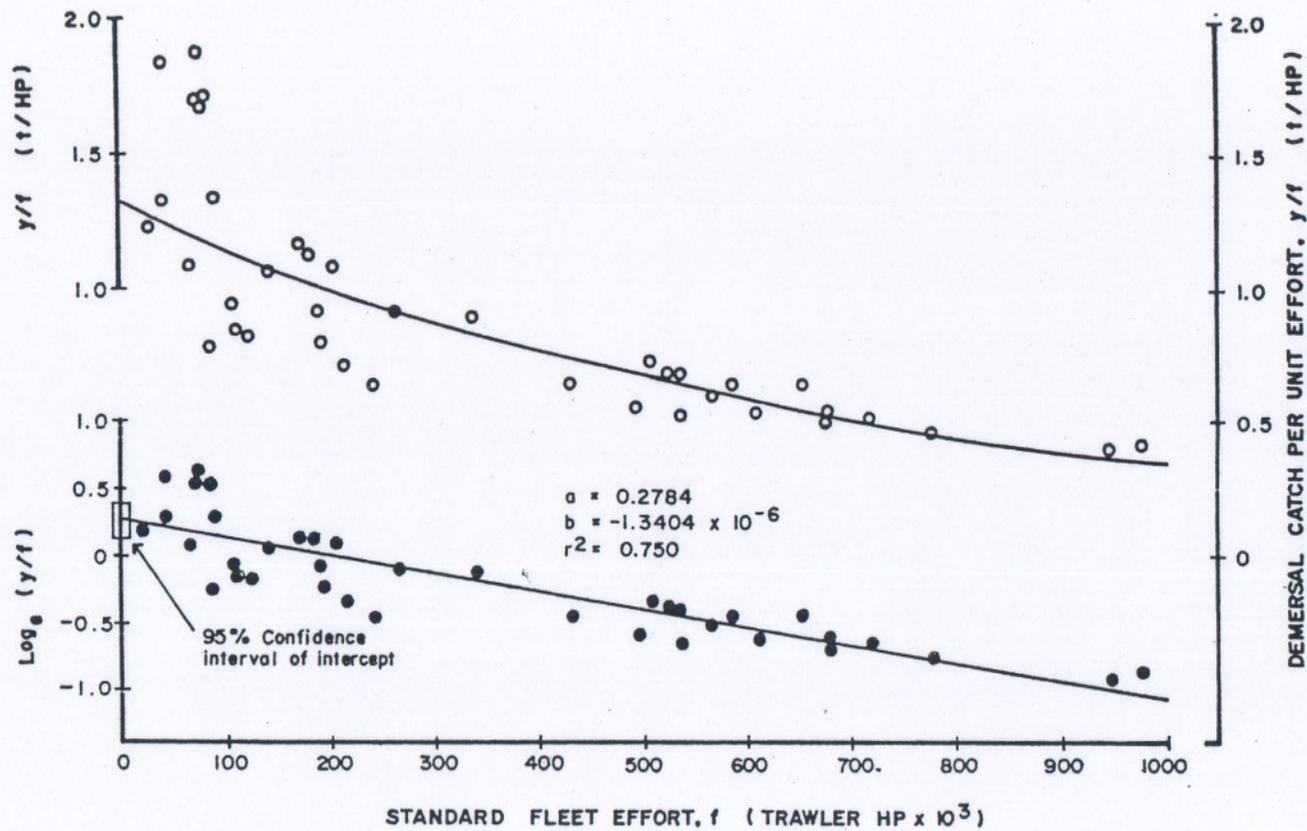


Fig. 1. Demersal catch per unit effort ( $Y/f$ ) and its natural logarithm plotted against standard fleet effort ( $f$ ) on Philippine demersal resources for the period 1946-1984. Note the good fit of the  $\text{Log}_e Y/f$  vs.  $f$  relationship derived explaining 75% of the variance, and the greater scatter of points about the derived relationship for earlier years (i.e. lower  $f$  values).

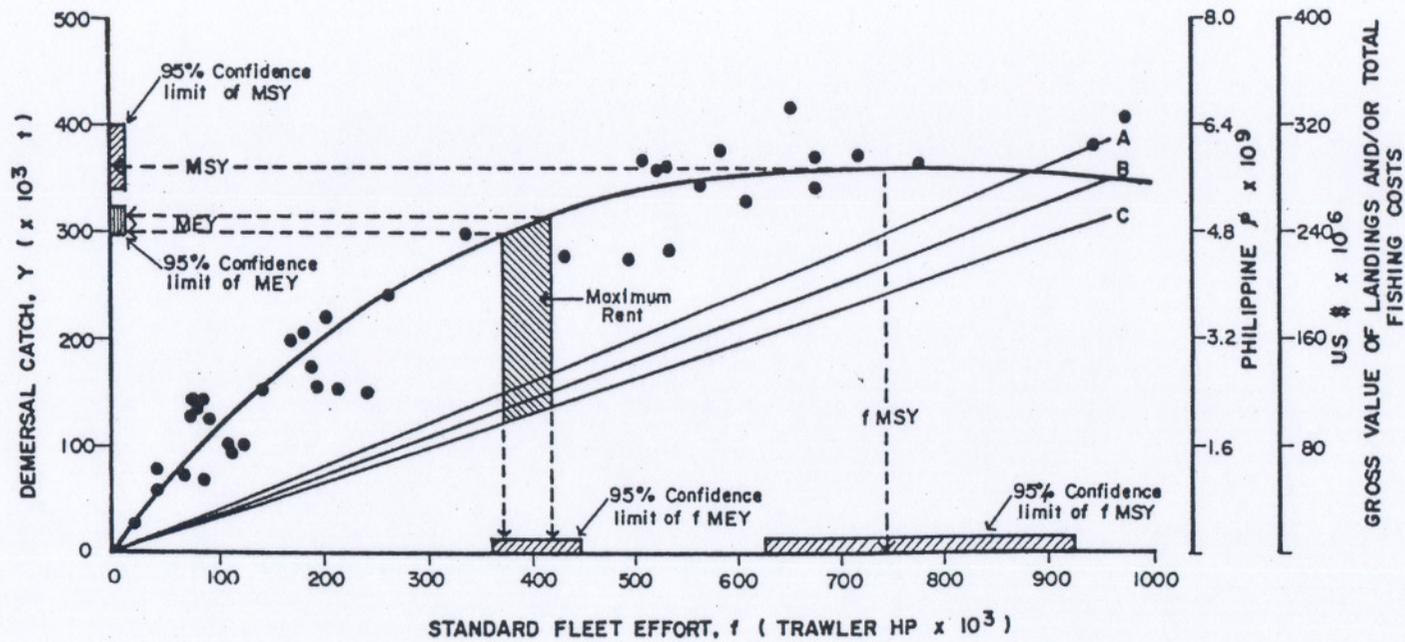


Fig. 2 Annual demersal catch ( $Y$ ) versus standard fleet effort ( $f$ ) on Philippine demersal resources for the period 1946-1984. The range of  $MSY$  and  $f_{MSY}$  are based on the 95% confidence limit of the regression parameters  $a$  and  $b$ . The range of  $MEY$ ,  $MER$  and  $f_{MEY}$  are based on the same 95% confidence limit of  $a$  and  $b$ , as well as the alternative assumptions that (A) costs were 10% above revenues, (B) revenues were equal to costs, and (C) revenues were 10% above costs during the mean 1983-1984  $f$ -level, respectively.