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CATCH TREND AND MAXIMUM SUSTAINABLE YIELD OF DEMERSAL FISHES OFF MADRAS*

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ABSTRACT

Catch trends fitted for selected groups of demersal fishes and 'all fish' in the zone from 15°40′ N to 10°40′ N revealed that an increasing trend could be expected for all the groups. Estimations of MSY and optimum fishing intensities also indicated that the stocks of these groups could stand 3.5-5.0 times increase in fishing pressure and yield 22-59% more catch. However, available information on commercial fishing suggests that the scope for increasing the yield is marginal. The reason for this difference in the results is discussed with a view to understand the exact status of the fishery potential off Madras.

INTRODUCTION

IN REGIONS where fishing has developed on a commercial scale and where a broad range of categories of fishes are exploited, it is imperative to understnd the current status of the fishery and forecast its status during the ensuing years. Furthermore, a knowledge so gained would help to organise harvesting so that sustainable yields are obtained. In the present study, the data collected from exploratory trawlers based at Madras were analysed and compared with the available information of commercial trawling in order to achieve the cited objectives which are necessary for formulating fishery management policies.

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MATERIAL AND METHODS

Exploratory trawling operations were conducted by the Exploratory Fisheries Project in the region between 15° 40′ N (off Nizampatnam) and 10° 40′ N (off Velanganni) in depths ranging from 8 to 130 m for a 10 year period from 1973 to 1982. Throughout the period of investigation, two 17.5 m trawlers M. V. *Meenagaveshak* and M. V. *Meenasitara* were operated and the source of data utilised here is the log reports maintained by the Exploratory Fisheries Project, which were made available to the Madras Research Centre of CMFRI for analysis and interpretation.

In order to obtain a probable catch trend, the following quadratic equation was fitted to the data (Chakraborty, 1973; Krishnamoorthy, 1978):

$$Y = ax^2 + bx + c$$

where Y is the catch per unit of fishing intensity and x is the year (the base year 1978 being taken as 0).

For estimating maximum sustainable yield (*MSY*), the 'surplus yield' model of Schaefer (1954) and its variants were used. When fishing is carried out in a particular area over a number of years, there exists a relationship between the yield per unit of effort (C/f) and fishing intensity (f) such as

$$C/f = a - bf$$

where a and b are constants of least square estimates (Graham, 1935; Schaefer, 1953, 1954; Ricker, 1975; Pauly, 1980). From differentiation, it follows that the maximum sustainable yield is $a^2/4b$ for a corresponding fishing intensity of $f = a/2b$. It also follows that

$$C = af - bf^2$$

The fishing intensity (f) is defined as the fishing effort per unit area, *i.e.* g/A (Cushing, 1970), where g is the total effort and A the area. Though the usual application of Schaefer's model is on a single species stock, it has been applied frequently to multispecies stock also (Lord, 1971; Krishnamoorthi, 1977).

TABLE 1. *Data on area, effort, fishing intensity and yield* (C) (*in tonnes*) *for different groups of fishes during* 1973-1982

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Area (sq. km) (A)	10,778	9,798	9,798	7,512	6,532	5,552	2,286	5,226	9,145	13,391
Effort (hr) (g)	1068.8	1485.5	1357.7	1095.8	905.5	655.4	854.8	1109.6	798.6	414.5
Fishing intensity (f = g/A)	0.099	0.152	0.139	0.146	0.139	0.118	0.374	0.212	0.087	0.031
Elasmobranchs (C)	10.00	5.95	7.80	9.87	8.89	4.91	2.44	7.27	3.90	3.13
Carangids (C)	—	4.51	7.66	5.22	2.63	1.92	7.19	2.14	2.08	2.53
Silverbellies (C)	23.01	42.49	52.33	47.60	96.35	10.91	15.47	30.24	15.49	24.06
Sciaenids (C)	12.32	—	—	10.29	1.16	—	3.71	14.31	—	3.18
Threadfin-breams (C)	4.17	2.59	3.02	2.76	—	0.62	5.23	3.30	2.82	3.50
Lizardfish (C)	5.07	2.97	5.60	1.04	0.01	2.45	1.78	2.28	8.26	2.88
All fish	155.21	179.60	198.06	150.06	123.95	60.14	49.21	77.20	48.66	60.50

RESULTS

The yields (C) of selected groups of demersal fishes obtained from the pooled data are presented in Table 1. The fishing intensity ranged from 0.031 hr/sq. km (1982) to 0.374 hr/sq. km (1979). For 'all fish' (which includes prawns and cephalopods), the C was high during the first 5 years of observation; this is true for elasmobranchs, carangids and silverbellies also. From the data for the years from 1973 to 1982 utilised to delineate a probable catch trend, the following equations were obtained:

All fish : $Y = 68.04x^2 - 26.83x + 440.08$

Elasmobranchs $Y = 2.37x^2 + 3.15x + 29.20$

Carangids : $Y = 2.52x^2 + 1.05x + 15.49$

Silverbellies : $Y = 14.51x^2 + 6.15x + 226.27$

Sciaenids : $Y = 7.13x^2 + 7.78x + 23.26$

Threadfin breams $Y = 4.06x^2 + 5.27x + 4.16$

Lizardfish : $Y = 3.74x^2 + 7.83x + 7.49$

From these equations, it appears that an increasing trend in catch per fishing intensity could be expected for all the selected groups of demersal fishes. The yield per fishing intensity (Y) for 'all fish' increased from 440 t in 1978 to 1421 t in 1982.

The estimated values of *MSY* and optimum fishing intensity for all the groups considered in the present study were higher than the average yield and average fishing intensity respectively (Table 2). For example, there is scope for increasing the fishing intensity from the average fishing intensity of 0.041 hr/sq. km to 0.183 hr/sq. km to obtain 148.9 t of 'all fish' catch instead of 110.3 t, *i.e.* the fishing intensity can be increased by 4.5 times to obtain 33% more yield. Similarly, there is scope for increasing the fishing intensity by 4.3-5.0 times and obtain 22-47% more yield of elasmobranchs, carangids, silver-bellies and sciaenids and for increasing the fishing intensity by 3.5 - 3.9 times and obtain 52 - 59% more sustainable yield of lizard-fish and threadfin-breams.

TABLE 2. *Values of a, b, MSY (tonnes) and f (hr/sq.km) for different groups of fishes.*

Group	a	b	MSY	Average yield	Optimum f	Average f	Coefficient of correlation (r)
Elasmobranchs	87.8	—248.6	7.8	6.4	0.177	0.041	0.730
Carangids	52.1	—127.8	5.3	4.0	0.204	0.041	0.537
Silverbellies	534.3	—1472.1	48.5	35.7	0.181	0.041	0.552
Sciaenids	109.5	—273.6	11.0	7.5	0.200	0.041	0.679
Threadfin-breams	59.8	—189.2	4.7	3.1	0.158	0.041	0.562
Lizardfish	71.2	—247.4	5.1	3.2	0.144	0.041	0.646
All fish	1624.4	—4431.1	148.9	110.3	0.183	0.041	0.702

DISCUSSION

The present study based on exploratory trawling suggests that the fishing intensity off Madras may be stepped-up by 4.5 times to obtain 33% more demersal fish yield. Based on the catch and effort data collected from commercial trawlers in Madras for the years 1980—1984, Dharmaraja *et al.* (1987) concluded that scope for increasing the catch is only marginal (3.9%). There are obvious reasons for the difference between the results obtained from exploratory and commercial trawling operations. Whereas most of the commercial operations were restricted to the area between 13° 40' N and 12° 40' N and to a depth less than 30 m, exploratory trawling was conducted in a vast area (from 15 °40' N) at a depth ranging from 8 to 130 m. The exploratory trawlers expended 41.4% of the total trawling time within 30 m depth and 58.1% between 31 and 60 m depth during the years 1973 - 1982. The difference in area and depth of operation has led to difference in the conclusion drawn between the present study and that of Dharmaraja *et al.* (1987).

In order to overcome this, depthwise analysis of exploratory data pertaining to the area between 13° 40' N and 12° 40' N (where most of the commercial trawlers operate) were made, which resulted in the following equations:

Depth 8-30 m : $Y = 146.2 + 0.888x$
Depth 31-60 m : $Y = 128.3 + 0.029x$

where y = catch rate (kg/hr) and x = effort (hr). These equations reveal that the *MSY* in the area less than 30 m depth is 60 tonnes as against the average yield of 56 tonnes and the *MSY* in the area between 31 and 60 m depth is 140 tonnes as against the average yield of 55 tonnes. This the exploratory data confirm the earlier conclusion of Dharmaraja *et al.* (1987) that the scope for increasing the yield is only marginal in the inshore area. However, in the area between 31 and 60 m depth, there is good scope for increasing the fishing effort and obtain about 2.5 times more catch.

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