MAXIMUM EQUILIBRIUM YIELDS OF DEMERSAL FISHERIES BASED ON EXPLORATORY TRAWLING

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ABSTRACT

In most of the groups of fishes exploited in the 17° 40′ zone along the Andhra-Orissa coast the maximum equilibrium yields are not far different from the average yields. Hence the stock in this zone can but stand in future only a limited increase in fishing pressure.

INTRODUCTION

Over the years commencing with 1959, exploratory trawling operations have been going on off the Andhra and Orissa coasts in the regions between the latitude zones 16°40′N and 20°40′N and in depths extending up to the 200 m contour with the twin objectives of collecting data for assessing the extent of the resources and charting the potentially rich fishing grounds. Consequently a large amount of data now exist at the Waltair Research Centre of Institute, which are being utilised to obtain a knowledge of the maximum equilibrium yields necessary for formulating management policies.

MATERIAL AND METHODS

Although exploratory trawling commenced along this coast in 1959, the early two years were spent in reconnoitring and surveying the area and perfecting a suitable gear for the boats. The data, therefore, of the years 1961-70 alone have been considered in the present exercise. The data obtained from the operations of the vessels M.T. *Ashok* and M.V. *Champa* alone have been presented, since they were the only vessels which were not withdrawn from the investigations until 1970-1971 when they were decommissioned. Similarly, data obtained in the latitude zone 70°40′ alone have been considered since most fishing was conducted in this zone.

Throughout the period of the investigation a 15 m Russian otter trawl and a 14 m Russian otter trawl were respectively operated by M.T. *Ashok* and M.V. *Champa*. The chief source of the data utilised here is the log reports maintained by the skippers and made available by the Offshore Fishing Station (present Exploratory Fisheries Project), Visakhapatnam, for analysis and interpret-

ation. Tese were supplemented by observations made on board the trawelers by the scientists of the Sub-Station.

Since the two trawlers M.T. *Ashok* and M.V. *Champa* were different in size, horse-power, tonnage etc., it became necessary to standardise the fishing effort. For the purpose of standardisation, the vessel M.T. *Ashok*, because of her steadier performance, was considered as a standard. The catch and the effort data (Table 1) obtained from the two statistical squares 17-83/B4 and 17-83/C5 in the latitude zone 70°40′ were considered since they were the only two squares where both the vessels fished on the same day as by definition fishing power is "the ratio of the catch per unit fishing time of the vessel to that of another vessel taken as a standard and fishing on the same density of fish on the same type of ground" (Baverton and Holt 1957). An analysis of variance revealed that the variations in the power factors between years and between areas were not significant (<1%). Hence all the data were pooled and a power factor of 0.72 was used for standardisation of the effort.

TABLE 1. *Catch and effort data of Ashok and Champa.*

Years	*M.T. Ashok*			*M.V. Champa*			*Power Factor*
	Catch (Y)	*Effort* (g)	*Y/g* (A)	*Catch* (Y)	*Effort* (g)	*Y/g* (B)	*(B/A)*
Area 17-83/B4							
1966	1283	23.01	55.8	433	10.50	41.2	0.74
1967	4782.5	28.00	170.8	1777	19.50	91.1	0.53
1968	7196	60.84	118.3	7002	60.58	115.6	0.98
1969	2492.5	23.92	104.2	2530.5	28.00	90.4	0.87
1970	1858.5	28.00	66.4	1048	31.08	33.7	0.51
Total	17612.5	163.77	107.5	12790.5	149.66	85.5	0.80
Area 17-83/C5							
1966	18894.5	172.57	109.5	15229.	150.08	101.5	0.93
1967	18776.	135.68	138.4	9636.5	103.50	93.1	0.67
1968	7586.5	47.83	158.6	3409.5	41.42	82.3	0.52
1969	5574.	40.33	138.2	1992.	33.50	59.5	0.43
1970	2759.	27.50	100.3	2770.	43.13	64.2	0.64
Total	53590.	423.91	126.4	33037.	371.63	88.9	0.70
Areas 17-83/B4 + 17-83/C5							
1966-70	71202.5	587.68	121.2	45827.5	521.29	87.9	0.72

TABLE 2. *Details of data on Area, Effort, Fishing Intensity and Catch per unit of Effort (Y/f) in respect of the various categories of fishes during the years from* 1961 *to* 1970.

	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Area (A) in sq. km.	5879	5552	5552	5225	5552	4572	3266	2613	2612	2612
Effort (g) in hrs.	737	753	755	518	654	1334	911	849	751	806
Fishing Intensity (F = g/A)	0.13	0.14	0.14	0.10	0.12	0.29	0.28	0.32	0.29	0.31
Sharks & Skates										
Catch in kg (Y)	7828	7072	7024	5063	4692	8091	6861	8585	7188	6192
Y/f	60197	50494	50151	50630	39084	27914	24494	26828	24799	19969
Rays										
Catch in kg (Y)	4796	7455	5730	2773	4679	10394	6996	8164	7989	4084
Y/f	36881	53229	40912	27730	38976	35859	24976	25513	27562	13171
Cat-fish										
Catch in kg (Y)	29198	25996	20887	18380	16775	37963	33846	37860	26453	21750
Y/f	224533	185611	149133	183800	139736	130972	120830	118312	91263	70144
Prawns										
Catch in kg (Y)	1373	6334	1633	2320	1829	6367	4923	4438	4725	3426
Y/f	10558	45225	11660	23200	15236	21966	17575	13869	16301	11049
Misc.-small										
Catch in kg (Y)	92679	86627	55908	34508	25417	55122	59551	55323	62109	30735
Y/f	712702	618517	399183	345080	211724	190171	212597	172884	214276	99120
Misc.-big										
Catch in kg (Y)	13392	8794	2747	2580	2537	11163	9613	8721	5350	2421
Y/f	102984	62789	19614	25800	21133	38512	34318	27253	18457	7808
All Fish										
Catch in kg (Y)	149266	142278	93929	65624	55929	129100	121790	123091	113814	68608
Y/f	1147855	1015865	670653	656240	465889	445394	434790	384659	392658	221261

RESULTS AND DISCUSSION

It has been shown (Ricker 1975) that when fishing is carried out over a large number of years, there exists a relationship between the yield per unit of effort (Y/f) and fishing intensity (f) such as:

$$Y/F = a - bf$$

where a and b are constants which are least-square estimates. This is somewhat similar to Graham's (1935) method and Schaefer's (1953, 1954) approach. From differentiation it follows that the maximum equilibrium yield is $a^2/4b$ for a corresponding fishing intensity of $f=a/2b$. Also it follows that:

$$Y = af - bf^2$$

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 production model has been on a single species stock, its application to multispecies has been recently attempted (Lord 1971).

In Table 2 are presented the respective data obtained from the operations of M.T. *Ashok* and M.V. *Champa*. The estimated values of Y_{max} and f for each group of fisheries are presented in Table 3. Also presented in the table are the annual average value of yields; the corresponding fishing intensity; and the correlation coefficient (r) between the yield per unit of effort and the fishing intensity observed over the various years from 1961 to 1970. In Fig. 1 are depicted the yield curves i.e., the predictable yield at various levels of fishing intensities for the different groups of fishes.

TABLE 3. *Values of a, b, Y_{max} and f in respect of the various categories of fishes.*

Categories	*a*	*b*	Y_{max}	*f*	*Ave.f* Y_{max}	*Ave.f*	*.Coef. Corr.*(r)
Sharks & skates	67,265	1,41,947	7,969	0.24	6,860	0.21	- 0.82
Rays	48,472	76,149	7,714	0.32	6,306	0.21	- 0.55
Cat-fish	2,26,169	4,03,503	31,693	0.28	26,911	0.21	- 0.70
Prawns	24,729	28,880	5,294	0.43	3,737	0.21	- 0.21
Misc.-small	6,35,787	15,15,058	66,701	0.21	55,798	0.21	- 0.63
Misc.-big	1,14,491	59,910	7,837	0.26	6,732	0.21	- 0.34
All fish	10,62,332	22,80,029	1,23,743	0.23	1,06,343	0.21	- 0.64

The values of r were fairly high in all groups except in the case of prawns and the miscellaneous-big group of fishes. The reason(s) for the low values obtained for the above mentioned two groups is (are) presently not known. Nevertheless, both the Y_{max} and f values were high as in the case of the rest of the groups of fishes. While there is room for stepping up of the

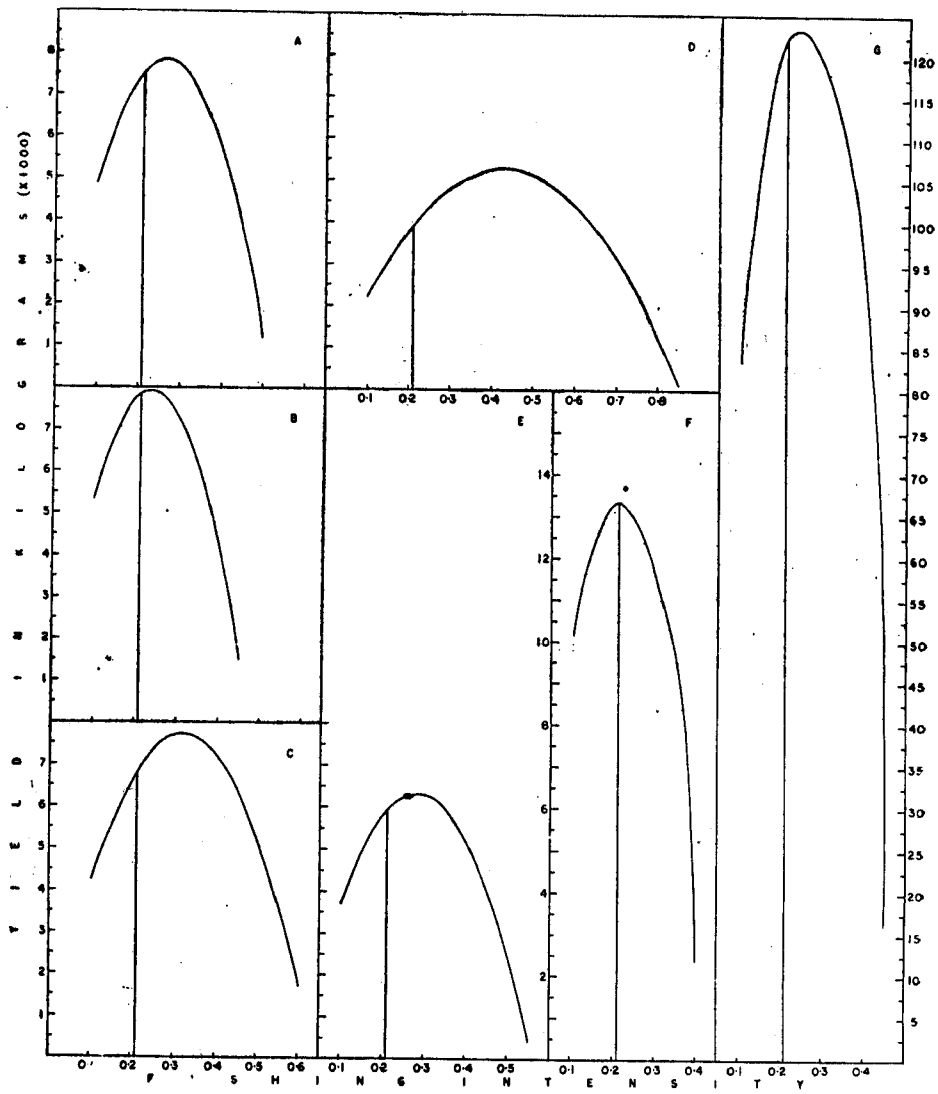

FIG. 1. Yield curves of the different groups of fishes:
A — Miscellaneous - big; B — sharks and skates;
C — rays; D — prawns; E — catfish;
F — miscellaneous - small; G — 'all fish'.

fishing intensity in most groups, the miscellaneous-small group of fishes, having reached the maximum, cannot stand any further increase in fishing intensity. Since in most groups the maximum equilibrium yields are not far different from the average yields, the stocks in the 17°40′ zone can but stand in future only a limited increase in fishing pressure. The single exception are the prawns. Although there is room for substantial increase in fishing intensity in regard to this group, the resultant increase in yields can only be relatively small (30%) for a corresponding f of 0.43.

The values obtained in the present study are only rough estimates and when sophisticated data are available more refined estimates are possible. But in most cases management decisions are required in the early stages of fisheries development and the importance* of even rough estimates in such situations needs no emphasis.

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° Alverson and Pereyra (1969) state: "In fact, at times one wonders whether management decisions at an early stage of fisheries development based on exploratory survey data might not lead to a more stable and commercially viable fishery than a fishery that follows the normal course of boom and bust, followed by a parade of scientific post-mortems".

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