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TRENDS IN MARINE FISH LANDINGS IN INDIA

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ABSTRACT

From the available specieswise data for the last twenty years, statistical models for the prediction of marine fish landings have been attempted here using the orthogonal polynomial technique. Only the species or groups of fishes having an average production of more than 20 thousand tonnes have been considered. These averages were based on ten years period, i.e., from 1964-1973. The polynomial of fifth degree was taken into account for each of the 15 groups studied. On the basis of the results of the analysis of variance tables, fifth degree curves were fitted to 7 groups, viz., mackerel, other sardines, elasmobranchs, *Leiognathus*, ribbon fish, other clupeids and *Anchoviella*. Since higher degree curves were insignificant even at 10% level, fourth degree curves were fitted in the case of penaeid prawns, sciaenids and cat fishes, second degree for oil sardine and non penaeid prawns and only linear curves for *Harpodon nehereus*, *Caranx* and pomfrets. Higher values of explained variations (*Leiognathus*, maximum 91%) indicate the closeness of fit. Majority of the species groups studied generally show an increasing trend especially after 1966, with the exception of oil sardine and *Harpodon nehereus*, the former showing an increasing trend up to 1964-68 and then decreasing and the latter constantly decreasing.

INTRODUCTION

As a result of the constant efforts in conducting pilot sample surveys since 1950, the Central Marine Fisheries Research Institute, Cochin, has developed the currently employed sample survey which gives the production estimates of different marine species groups. A detailed account of the development of the system through pilot surveys at the initial stage to the presently employed survey is given by Banerji and Chakraborty (1973) and Krishnan Kutty, Nair and Qasim (1973). On the basis of the data collected over a period of years, a considerable amount of work on the trends in catches of different species groups has been done by various authors like Antony Raja (1969, 1970), Mohamed (1973), Sekharan (1973), Banerji (1973) and others. Rao (1973) reported on the distribution pattern of exploited fishery resources. Silas, Dharmaraj and Rangarajan (1976) has vividly given the synoptic survey of the exploited marine fishery resources with number of groups showing the trends. Estimates for the trends in the landings of various fishes of India has been given by Banerji (1969), Chakraborty (1973) and others based on second degree curves which have certain limitations. Reliable estimates can be obtained by fitting the highest degree curves which have statistical justification. If lower degree curves are fitted in cases where there is statistical justification for fitting higher degree curves, the explained variation will be much less resulting in higher standard errors of the estimate. In other words the estimates will show larger deviations from

the observed values. Hence, an attempt was made to higher order polynomials to various important species.

MATERIAL AND METHODS

Data for fish landing over a period of twenty years, *i.e.*, from 1954-1973 were taken from the figures given by the Marine Products Export Development Authority, Cochin. These figures are based on the estimates given by the Central Marine Fisheries Research Institute, Cochin. For a comparative study of the composition of various groups of fishes, the average marine catch figures of the world (F.A.O., 1973) and India (MPEDA, 1974) were used. The statistical classification used by F.A.O. is based on the International Standard Statistical Classification of Aquatic Animals and Plants (ISSCAAP). It consists of nine 'Divisions' of fifty-one groups of fishes. For the present study, only two 'Divisions', *viz.*, marine fishes consisting of 9 groups of fishes and crustaceans were taken into

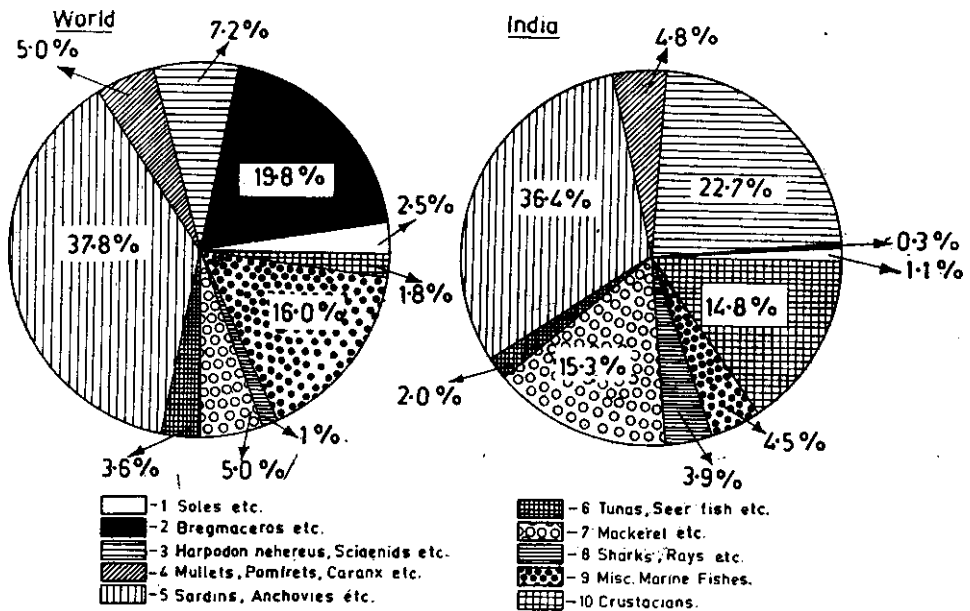


Fig 1. Composition of average marine catches as per ISSCAAP species groups.

account. A comparison of the landings pertaining to these groups under study are given in Fig. 1. The percentage composition of the different species found in Indian waters in the ISSCAAP groups studied are given in Fig. 2.

The selection of species-groups for the present study was based on the percentage composition of average landings during the ten years period (1964-73). In the descending order of the average catches the first fifteen species-groups contributed about 83% to the total marine catch. The average landings of each of these was more than 20 thousand tonnes. The yearly data of these species groups were taken into account for studying the trend. Orthogonal polynomial technique was used for fitting the curves of suitable degree.

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ISSCAAP Species group:

1: 100% Soles

8: 100% Elasmobranchs

2: 100% Bregnaceros

9: Misc

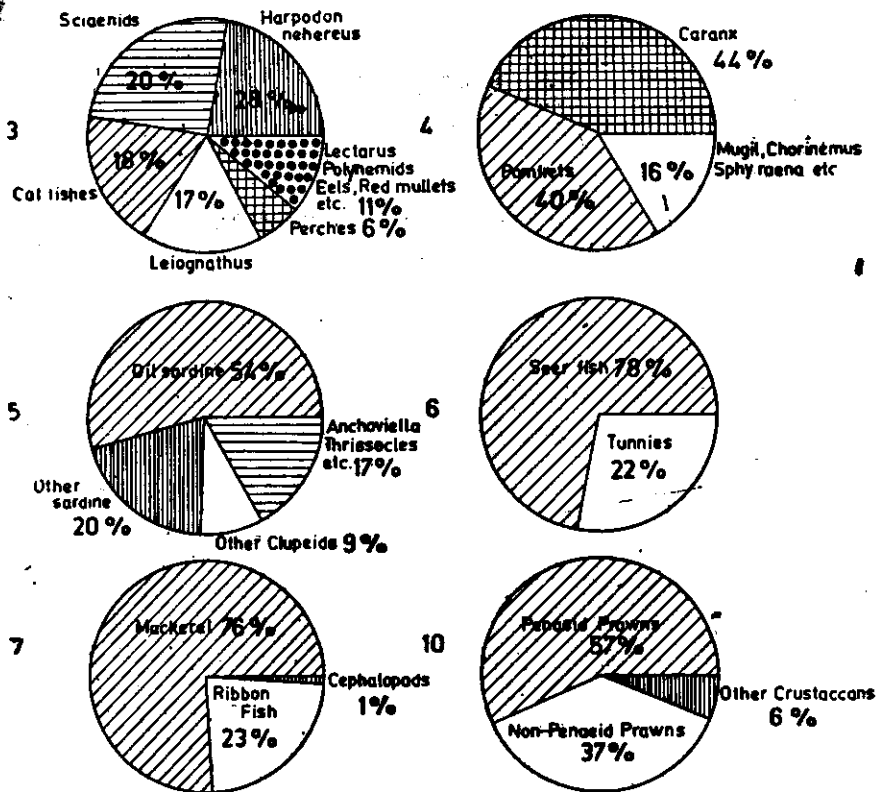


Fig. 2. Percentage composition of species found in sea around India in each ISSCAAP species groups.

Initially it was decided to consider the polynomials of fifth degree for each of these species groups. Separate analysis of variance tables for each species groups and for each degree of curve (from linear to fifth degree) were prepared. The significant results of the usual F-test has been considered as the indicator for the selection of proper degree of curve to be fitted. The curve fitted for the individual species-groups was the highest degree for which the significant result of F-test were obtained.

RESULTS AND DISCUSSION

It is evident from Fig. 1 that the species-group consisting of sardines, anchovies, etc., contributed to the maximum average total catch of the world (37.8%) and also of India (36.4%). The percentage composition of different species constituting this group (Fig. 2) are oil sardine 54%, other sardine 20%, other clupeids 9%, and *Anchoviella*,

thrissocles etc. 17%. When the Indian catches were compared with those of the world, the respective ranks in contribution to the total average catches in the cases of rest of the ISSCAAP species groups were different as follows :

ISSCAAP species-groups	World	India
1. Soles etc.	VIII	IX
2. Bregmaceros etc.	II	X
3. <i>Harpodon nehereus</i> , Sciaenids, etc.	IV	II
4. Pomfrets, <i>Caranx</i> , Mulletts, etc.	VI	V
5. Sardines, Anchovies etc.	I	I
6. Tunas, Seer fish, etc.	VII	VIII
7. Mackerel etc.	V	III
8. Sharks, Rays, etc.	X	VII
9. Misc. marine fishes	III	VI
10. Crustaceans	IX	IV

The species-groups found in the seas around India were divided into 5 groups according to average landings. The species which gave more than 20 thousand tonnes, were included in the first group. The respective ranges of the average landings of species covered in remaining groups were 10-20, 5-10, 1-5 and below 1 thousand tonnes. The total average landings and the percentages of each group are shown in Table I. The first group contributed about 83% of the total average catch. The percentage contribution of each of the 15 species groups, included under this group to the total average catch are given in Table I(a).

The results of the analysis of variance in relation to the number of years for which data are used, are given in Table II. Since fifth degree curves were found out to be significant in the case of 7 species-groups, viz., mackerel, other sardines, elasmobranchs, *Leiognathus*, ribbon fishes, other clupeids and *Anchoviella*, the polynomials of fifth degree, were fitted to the yearly catch data of these species-groups. In the case of 3 species groups, viz., penaeid prawns, sciaenids and cat fishes, the corresponding results of F-test were

Table I. Percentage composition of different groups as per average landings to the total average catch.

Group	Range of the average catch ('000' tonnes)	Total of average landings of species included (in tonnes)	%
1.	Above 20	8,91,696	83.3
2.	10 — 20	76,343	7.2
3.	5 — 10	23,742	2.2
4.	1 — 5	35,781	3.3
5.	Less than 1	1,169	0.1
	Misc.	41,760	3.9
Total		10,70,491	100.0

found to be significant for fourth degree while insignificant for fifth degree even at 10% level. Hence, only fourth degree curves were fitted to these species groups. On the same lines the quadratic curves were fitted to oil sardine and non-penaeid prawns. But for the remaining 3 species, viz., *Harpodon nehereus*, *Caranx* and pomfrets only the first degree curves could be fitted.

Table I(a). Classification of percentage composition of different species included in first group to the total average landings.

Species	Average landings (in tonnes)	%
1. Oil sardine	1,76,491	16.5
2. Mackerel	1,24,482	11.6
3. Penaeid prawns	89,785	8.4
4. <i>Harpodon nehereus</i>	68,428	6.4
5. Other sardines	64,428	6.0
6. Non-penaeid prawns	58,995	5.5
7. Sciaenids	48,256	4.6
8. Cat fishes	44,117	4.1
9. Elasmobranchs	42,241	3.9
10. <i>Leiognathus</i>	40,672	3.8
11. Ribbon fish	38,545	3.6
12. Other clupeids	28,136	2.6
13. <i>Anchoviella</i>	23,889	2.3
14. <i>Caranx</i>	22,523	2.1
15. Pomfrets	20,708	1.9
Total	8,91,696	83.3

Table II. Results of test of significance of F-test in polynomials of different degrees.

Species	No. of years data used	Results of F-test for polynomials of degrees					Curve fitted of degree
		1	2	3	4	5	
1. Oil sardine	20	***	***	NS	NS	NS	2
2. Mackerel	20	*	NS	NS	+	++	5
3. Penaeid prawns	18	++	++	NS	**	NS	4
4. <i>Harpodon nehereus</i>	18	+	NS	NS	NS	NS	1
5. Other sardines	20	++	**	NS	NS	++	5
6. Non-penaeid prawns	18	NS	+++	NS	NS	NS	2
7. Sciaenids	20	NS	+++	NS	+	NS	4
8. Cat fishes	20	++	+++	NS	**	NS	4
9. Elasmobranchs	20	+++	NS	**	NS	*	5
10. <i>Leiognathus</i>	17	+++	NS	**	NS	***	5
11. Ribbon fish	20	NS	***	NS	NS	**	5
12. Other clupeids	20	NS	+++	NS	NS	***	5
13. <i>Anchoviella</i>	17	NS	NS	NS	NS	***	5
14. <i>Caranx</i>	17	+	NS	NS	NS	NS	1
15. Pomfrets	20	***	NS	NS	NS	NS	1

* Significant at 10% level

** Significant at 5% level

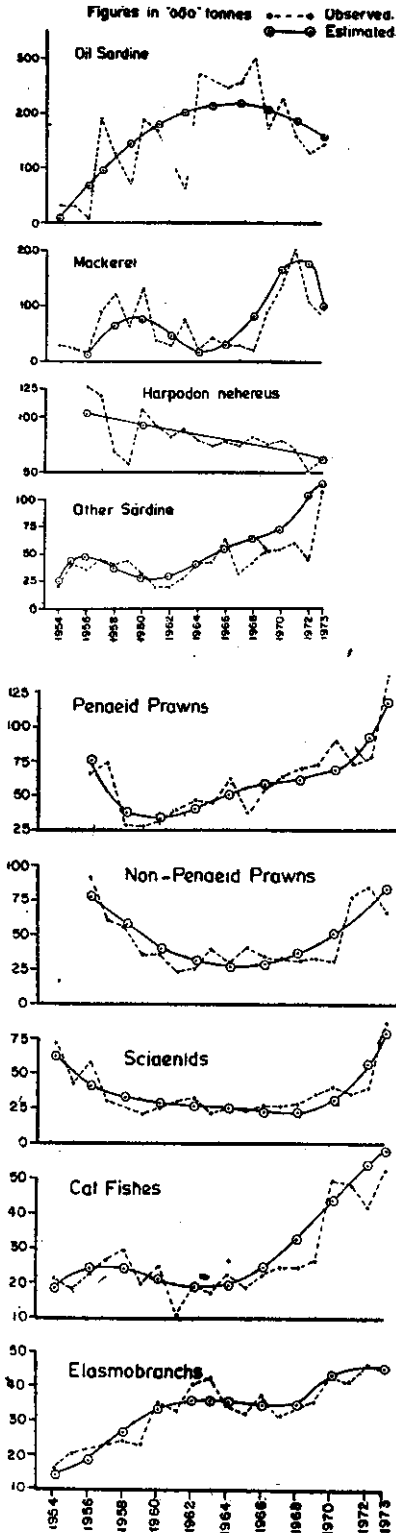
*** Significant at 25% level

NS Not significant even at 10% level.

+ Significant at 1% level

++ Significant at 0.5% level

+++ Significant at 0.1% level



The polynomials of different degrees fitted to the yearly catch data of various species are given in Table III and represented in Fig. 3.

Table IV shows the percentage of the variation in Y (*i.e.* catch) explained by the fitted polynomial and also the remaining percentage which is not attributable to the fitted polynomial. The total explained variation is further classified into the percentage of explained variation due to the various degrees. The figure in each cell indicates the role of that particular degree in the totality of the explained variation. It is obvious that the respective cells in Table II and Table IV synchronise with each other. In other words if the results of F-test for a particular degree of polynomial is not significant the respective contribution of that particular degree is less in the totality of the explained variation.

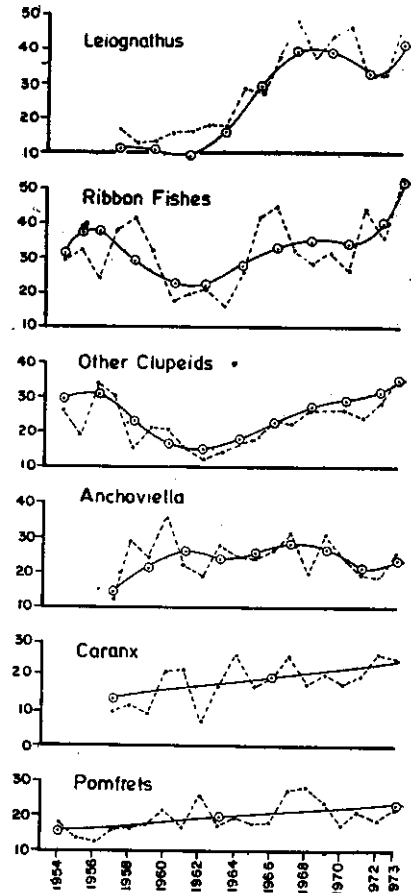


Fig. 3. Trends in marine fish landings in India.

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Table III. Polynomial equations fitted to yearly data of different species.

Species	No. of years (ending 1973) data used	Fitted polynomial (Figures in '000' tonnes)
1. Oil sardine	20	$Y = -27.76 + 36.52X - 1.36X^2$
2. Mackerel	20	$Y = -27.08 - 33.06X + 26.58X^2 - 4.57X^3 + 0.29X^4 - 0.0063X^5$
3. Penaeid prawns	18	$Y = 112.02 - 44.82X + 8.46X^2 - 0.61X^3 + 0.02X^4$
4. <i>Harpodon nehereus</i>	18	$Y = 104.60 - 2.34X$
5. Other sardines	20	$Y = -16.08 + 56.26X - 16.80X^2 + 2.02X^3 - 0.105X^4 + 0.002X^5$
6. Non-penaeid prawns	18	$Y = 91.49 - 13.84X + 0.74X^2$
7. Sciaenids	20	$Y = 83.24 - 23.24X + 3.77X^2 - 0.27X^3 + 0.007X^4$
8. Cat fishes	20	$Y = 10.70 + 9.21X - 1.94X^2 - 0.14X^3 - 0.003X^4$
9. Elasmobranchs	20	$Y = 16.14 - 4.43X + 2.61X^2 - 0.34X^3 + 0.017X^4 - 0.0003X^5$
10. <i>Leiognathus</i>	17	$Y = 2.40 + 14.58X - 6.89X^2 + 1.22X^3 - 0.084X^4 + 0.002X^5$
11. Ribbon fish	20	$Y = 13.44 + 24.85X - 8.18X^2 + 1.01X^3 - 0.053X^4 + 0.001X^5$
12. Other clupeids	20	$Y = 20.92 + 13.11X - 4.74X^2 + 0.57X^3 - 0.028X^4 + 0.0005X^5$
13. <i>Anchoviella</i>	17	$Y = -10.71 + 34.21X - 10.39X^2 + 1.36X^3 - 0.0795X^4 + 0.0017X^5$
14. <i>Caranx</i>	17	$Y = 13.01 + 0.71X$
15. Pomfrets	20	$Y = 15.57 + 0.38X$

Table IV. Percentage of variations in Y explained by fitted polynomials.

Species	Explained variation due to curves of..... degree						Un-explained variation
	1st	2nd	3rd	4th	5th	Total	
1. Oil sardine	28.44	21.97	—	—	—	50.41	49.41
2. Mackerel	14.69	3.92	8.77	30.03	20.88	78.29	21.71
3. Penaeid prawns	42.87	28.82	0.75	8.34	—	80.78	19.22
4. <i>Harpodon nehereus</i>	39.27	—	—	—	—	39.27	60.73
5. Other sardine	38.75	15.85	4.97	0.01	19.74	79.02	20.98
6. Non-penaeid prawns	0.29	71.40	—	—	—	71.69	28.31
7. Sciaenids	0.28	70.44	0.05	11.60	—	82.37	17.63
8. Cat fishes	44.95	30.89	3.46	4.84	—	84.14	15.86
9. Elasmobranchs	73.08	3.32	5.31	2.15	3.32	87.18	12.82
10. <i>Leiognathus</i>	72.74	1.09	7.67	2.88	6.41	90.79	9.21
11. Ribbon fish	13.67	26.33	0.56	1.36	17.59	59.51	40.49
12. Other clupeids	6.21	47.49	0.02	5.80	12.56	72.08	27.92
13. <i>Anchoviella</i>	0.07	11.83	4.13	4.13	30.56	50.72	49.28
14. <i>Caranx</i>	37.80	—	—	—	—	37.80	62.20
15. Pomfrets	27.80	—	—	—	—	27.80	72.20

As shown by Chakraborty (1973) oil sardine has shown an increasing trend upto 1964-68, decreasing thereafter (Fig.3) and the trend indicates that higher catches may not be expected at least in near future (*i.e.* upto 1975). The catch data for 1974 and 1975 available now (MPEDA, 1976) supports this conclusion. Mackerel has shown two different phases with the dividing line at 1964. Each phase has shown first an increasing and then decreasing trend. In the second phase, the rate of increase in first part or the rate of decrease in latter part was much more than its counterpart observed in the first phase.

Since at present, we are in latter part of the second phase, catches will definitely be on the decrease. As pointed out by Chakraborty (1973), *Harpodon nehereus* also show constantly decreasing trend. In this case it was not possible to fit higher degree curve and also the fitted curve explains only 40% of the variation. Therefore, any prediction of the future catches of this species will be only misleading. In the case of penaeid prawns, as reported by Banerji (1969) there is a decreasing trend upto 1959, continuously increasing thereafter. This increasing trend may be expected at least for further few years. Sciaenids has shown sharp declining trend till 1957. The same trend was maintained but at lesser magnitudes till 1968 and a sharp increase thereafter, thus enabling prediction of higher catches at least for the next few years. Cat fishes, elasmobranchs, *Leiognathus*, ribbon fish, other clupeids, and *Anchoviella* in spite of their ups and downs have shown an increasing trend in the latter part which may be maintained for the coming few years.

In the present analysis the estimated catches of various species groups for different years were found out to be sufficiently close to the corresponding observed data.

The method used for the present analysis, although useful for interpolation, has unfortunately little value in prediction as it may involve large number of errors due to unknown natural causes. The study of relationship between hydrographical and biological parameters and the catch sizes of year classes, growth and age composition etc., may help the prediction to be more trustworthy.

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