CMFRI Special Publication

ANALYSIS OF MARINE FISH LANDINGS IN INDIA

A NEW APPROACH

Central Marine Fisheries Research Institute
P. B. 1912, COCHIN-682018, INDIA

Indian Council of Agricultural Research

Number 10

ANALYSIS OF MARINE FISH LANDINGS IN INDIA

A NEW APPROACH

Alagaraja, Kurup, Srinath & Balakrishnan

ANALYSIS OF MARINE FISH LANDINGS IN INDIA

A NEW APPROACH

Alagaraja, Kurup, Srinath & Balakrishnan

CMFRI SPECIAL PUBLICATION

Number 10

Central Marine Fisheries Research Institute

P. B. No. 1912, COCHIN-682 018, INDIA

Indian Council of Agricultural Research

November 1982

Published by : E. G. SILAS
Director
Central Marine Fisheries
Research Institute
Cochin 682 018

Edited by : K. N. KRISHNA KARTHA
Head
Library & Documentation Division
Central Marine Fisheries
Research Institute
Cochin 682 018

Preface

Fishery resources are such renewable living resources that demand judicious exploitation for obtaining substainable yields. These resources, unlike others, are beyond the visual horizon, for on-the-spot direct observations. Hence, stock-assessment studies on these resources should be different from those employed on any other living resources, and they are in no way easier than others. Till recently, stock assessment studies were mainly based on single species, exploited by a single gear, or different types of gears when the effort expended by these gears are amenable for standardisation, to arrive at standardised unit efforts. These 'unit stock' models, though, based on sound mathematical concepts and knowledge on fisheries, lack the inbuilt mechanism to adjust to the situations obtaining in multi-species fisheries involving multi-gears. Standardisation of effort becomes all the more difficult in these cases where specieswise and gearwise apportioning of effort is not easy and straight forward, even in the case of a single gear.

To meet this challenge, attempts are under way to develop new techniques for stock assessment. The material presented in this publication is one such attempt. In the absence of effort data, the statistical analysis applied here has given broadly an indication on the limitations of the presently exploited fishing grounds in each of the maritime

states along the coast of the mainland. I congratulate my colleagues Dr. K. Alagaraja, S/Shri K. Narayana Kurup, M. Srinath and G. Balakrishnan for their efforts in bringing out this material. I sincerely hope that such attempts to study the fishery as a whole would be made so as to strengthen timely monitoring of the exploited fish stocks to help develop suitable management measures and make the artisanal fisheries and the fishing industry more viable.

E. G. SILAS
Director

ANALYSIS OF MARINE FISH LANDINGS IN INDIA

A NEW APPROACH

K. Alagaraja, K. Narayana Kurup,
M. Srinath and G. Balakrishnan

Central Marine Fisheries Research Institute, Cochin-18

ABSTRACT

Fish landings in India are of multispecies, exploited by multigears. Species-wise stock abundance studies, in this context, pose problems not normally encountered in the case of single-species fishery for which evaluation of standard effort is not difficult and models are available to study such fishery in detail. Hence a new approach, considering multispecies fishery as a whole, is taken up for study in this paper where the relative contributions of mechanised crafts, prawn fisheries and pelagic fisheries are considered for detailed statistical analysis. This approach is found to be useful when there are considerable fluctuations in the landings which is the characteristic feature of marine fish landings in India. In this analysis three assumptions are made on the status of stock abundance and fishery independent and dependent factors. These assumptions are not contradicted by the analysis of variance. Three important points emerge out of this study. In majority of the States as well as on all India level, the trend of total landings was similar to that of pelagic fish landings. Increase in the

intensity of mechanised effort has not relatively increased prawn landings. Landings from mechanised units showed an increase even when there was no increase in the total landings thus indicating the impact of mechanised crafts on the traditional fishing. In addition, this analysis gives a broad indication on the limitations of the present exploited fishing grounds in each of the maritime states along the coast of the main land.

INTRODUCTION

Fisheries in India, particulary marine fisheries have shown a tremendous progress in the recent times. From a modest marine fish landings of about 0.6 million tonnes in early fifties, the contribution from capture sector has touched 1.42 million tonnes in 1975. This two-and-a-half times growth is due mainly to mechanisation of the small-scale fishing industry along with intensive exploitation of exportable varieties, particularly prawns.

Fluctuations have been noticed in the marine fish landings from year to year and these are due to fishery independent factors such as salinty, and also temperature and current, and fishery dependent factors such as rate of exploitation, season of exploitation and size exploited. During the period 1969-'77 wide fluctuations in marine fish landings are noticed (Table-1). During 1976 and 1977 the estimated marine fish landings are 1.35 and 1.26 million tonnes respectively. This decline in the estimates during 1976 and 1977, noticed in the all-India landings as well as in the landings of many maritime states in India, may not be due to the fishery independent factors only.

In 1977 the cyclone that hit the east coast during the third week of November had affected marine fish landings in almost all the states in this coast. In west coast also the impact was felt in Kerala and Lakshadweep islands. However mechanisation of fishing craft, intensive exploitation over a narrow region of near-shore areas up to 5 KM from the coast, and that too of selected varieties, particularly prawns, may

have their impact on the fisheries as a whole. The effect of such exploitation may be obtained from the trends of contribution from pelagic groups, prawns and catches by mechanised crafts to the total landings, since these three groups cover the major range of marine fish catches in India.

For detailed study of exploited fish stocks, micro-analytical models are preferred. However, for such a study, data on large number of parameters are to be collected regularly, processed systematically and analysed quantitatively. In tropical regions, required estimates for such studies may not be readily available. For instance, in temperate zone, age of fish is easily determined (Cushing 1968). It is not so in tropical waters. Added to that, multispecies stocks are exploited by multigears in these waters, making species specific effort evaluation a difficult task. Hence, as a macro-analytic approach percentage contributions of the three groups over years were taken for detailed study. For this, the following assumptions are made.

i) Equilibrium is maintained over years in the fish stocks exploited in Indian coastal waters.

ii) Fishery independent factors will have more or less uniform effect on the availability of exploited species.

iii) Change in the pattern and intensity of fishing, such as introduction of mechanised crafts etc, will also have uniform effect on the exploited fisheries.

Under these assumptions it is clear that though absolute estimates may vary over the period, the respective percentage contributions are expected to remain more or less the same. In other words, distribution of percentage contributions of different categories will be the same over the period.

MATERIALS AND METHODS

The figures used here are the estimates for the period 1969-77 obtained by the Central Marine Fisheries Research

Institute which, collects data on marine fish landings regularly and systematically on the basis of a well-designed, stratified, multistage random sampling scheme. As per the classification of Jones and Banerji (1973) the entire fish landings are classified under pelagic and demersal groups. For the present study of the mechanised sector, landings of mechanised boats other than big trawlers owned by private companies and the trawlers of Government of India are considered, as the data from these big trawlers are not available and the catches by the trawlers of Government of India are not significant. Since prawns are heavily exploited both by mechanised and traditional units over the years, this fishery is also considered as one of the groups. Under the assumptions made earlier, difference in the percentage distribution of the three sectors over years in the maritime States may indicate the effect of fishery dependent and independent factors. To study the overall pattern of distribution, analysis of variance on percentage values transformed to arc sine values, is considered. Owing to wide fluctuations inherent with capture fisheries, Analysis of variance may not be able to indicate the presence of trend over years. To find out the presence of any such trends, rank correlation analysis is also taken up. Moreover the variations over years for different states may not be brought out clearly by the above analysis. Control charts, hence, are drawn for the data to find out the fluctuations. The following are the observations obtained on the basis of such analyses.

GENERAL ANALYSIS

Percentage contribution

Contribution to all India catches from prawn fishery ranged from 11% (1970) to 17% (1972) during 1969-'77, thus exhibiting no wider fluctuation. In the case of mechanised sector, the range was from 20% (1969) to 50% (1977). An increasing trend was noticed almost throughout this period in the share of this sector to the total landings. Regarding the contribution of pelagic sector, the trend was almost decreasing throughout this period indicating an inverse relationship

existing between these two sectors. This demonstrated the fact that mechanised sector contributed comparatively more to the demersal groups (Fig.1)

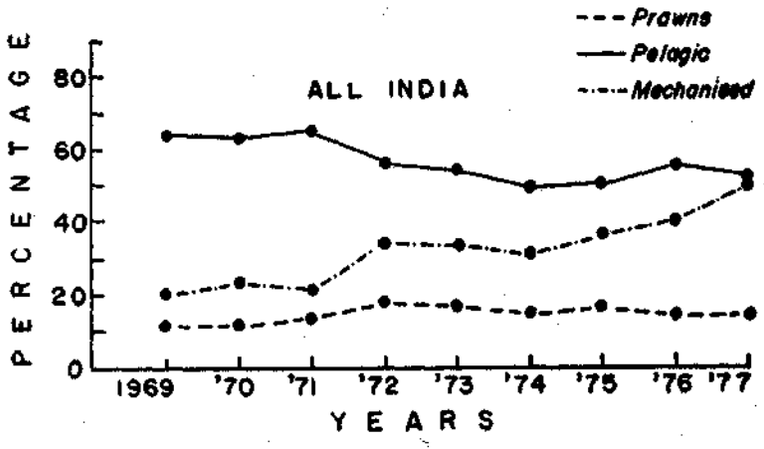

Fig. 1. Percentage Contribution of prawns, pelagic and mechanised sectors to the total catch during 1969-77 in India.

In West Bengal, contribution from prawn fishery has shown an improvement over years ranging from 6% (1969) to 23% (1973). The trend almost agreed with that of the contribution from the pelagic sector ranging from 23% (1969) to 66% (1976). Regarding mechanised sector, its contribution from the region under consideration (Midnapore District) was very nominal ranging from almost nil (1969-72) to 8% (1974). No definite trend could be discerned from the data available here. This indicated no significant effect of mechanised sector in exploiting demersal groups as found in the all India level. (Fig.2)

In Orissa, contribution from prawn fishery varied within a range of 4% (1972-'76) and 10% (1970), virtually showing not much variation. Regarding mechanised sector, the contribution showed wider range over the years, however, maintaining an almost increasing trend throughout the period barring 1977, the range being 3% (1970) to 60% (1976). In this state pelagic sector started from the maximum of 75% (1969) and reached a low level of 38% (1976).

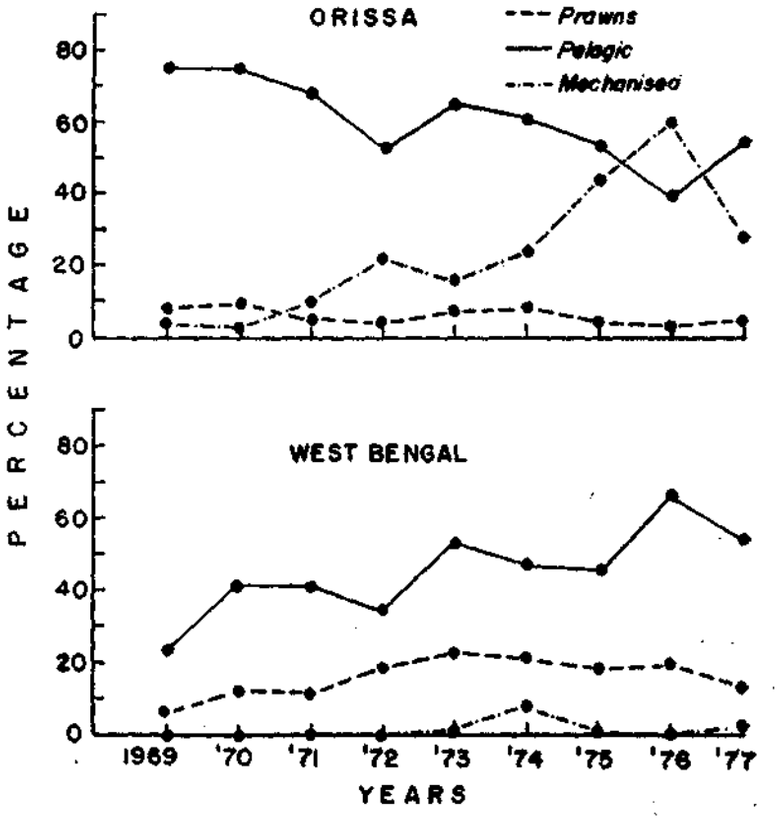

Fig. 2. Percentage contribution of prawns; pelagic and mechanised sector to the total catch during 1969-77 in west Bengal and Orissa.

Almost a steady decline was noticed in the trend, thus showing an inverse relationship with the contribution of mechanised sector. This trend agreed well with the all India trend. (Fig.2)

In Andhra Pradesh, contribution from prawn fishery remained in the narrow range of 7% (1972) to 11% (1971–'77), whereas for mechanised sector the range was 2% (1970) to 27% (1977) maintaining almost an increasing trend throughout the period of reference. Regarding pelagic

sector the contribution was in the reverse showing a declining trend having the range of 48% (1977) to 62% (1969). Thus here also the all India trend has been reflected. (Fig.3)

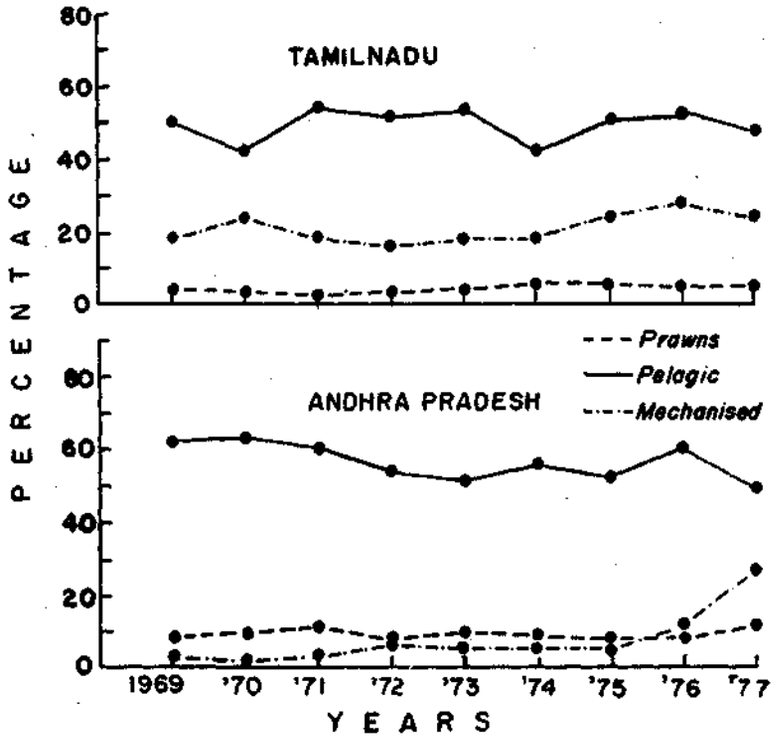

Fig. 3. Percentage Contribution of prawns, pelagic and mechanised sectors to the total catch during 1969-77 in Andhra Pradesh and Tamil Nadu.

In Tamil Nadu, the trends in the contribution from these three sectors appeared to be more or less the same contrary to the trends in other states in east coast and in India as a whole. This might be due to the gill nets operated by mechanised sector, sufficiently contributing to pelagic sector. The ranges in the contribution of prawns, mechanised and pelagic sectors were 2% (1971)-5% (1974,'75 & 76); 16% (1972)-28% (1976) and 42% (1970 & '74)-54% (1971 & '73) respectively (Fig 3).

In Pondicherry excluding Mahe and Yenam, prawn fishery contributed in the range 2% (1973 to '76)-7% (1969),

In the mechanised sector an increasing trend in the contribution was noted, inspite of some fluctuations, the range being 2% (1969)-26% (1977). In case of pelagic fishery the trend was reverse thus maintaining the all India trend (Fig 4).

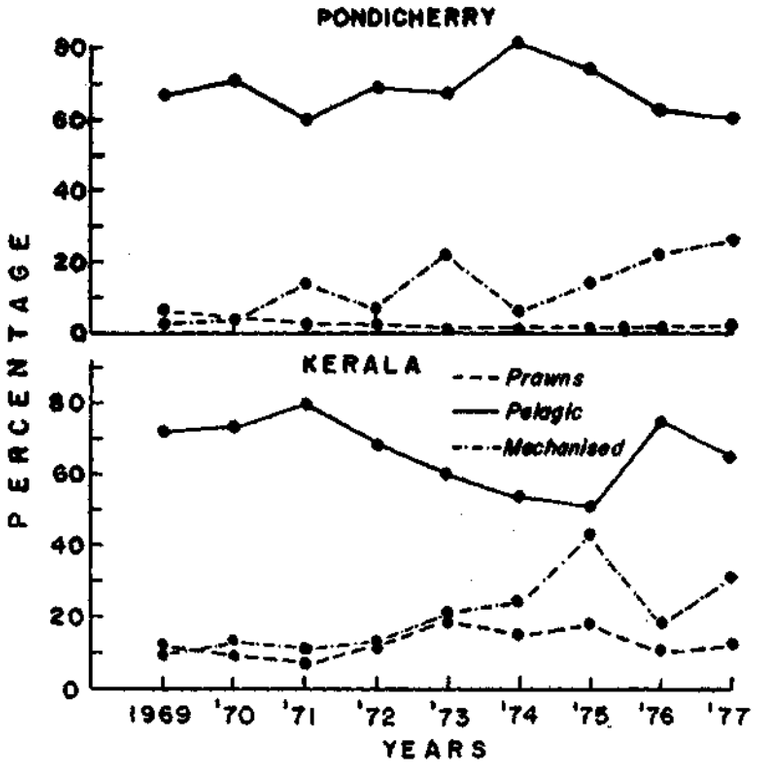

Fig. 4. Percentage contribution of prawns, pelagic and mechanised sectors to the total catch during 1969-77 in Pondicherry and Kerala.

In Kerala, prawn fishery contributed in the range 7%(1971)-19% (1973). However, the contribution from mechanised sector maintained a steady increase up to 1975, attaining the maximum of 43%. Though there was a decline in 1976, increased landings were found in 1977. The range of its contribution was 9% (1969)-43% (1975). Regarding pelagic fishery, the trend was almost reverse to that of

mechanised sector indicating more exploitation of demersal groups, the range being 51% (1975)-80% (1971). (Fig 4) Here also, all India trend has been maintained in case of mechanised and pelagic sectors. One interesting point to note in this State is that, in spite of increasing trend in mechanised sector, there is no parallel increase in prawn fishery. This may be due to the fact that prawn grounds exploited remained the same and the intensity of exploitation has reached from such maximum level that further increase in the effort may not result in increase in the catches so long as the area of exploitation remains the same.

In contrast, in Karnataka, there was no definite trend in the case of prawn and mechanised sectors. However, wide flucuations in the case of mechanised sector were noted with the range 11% (1975)-57% (1977). The trend in pelagic sector was almost reverse to that of mechanised sector till 1975. Then onwards no definite trend was seen in the case of pelagic sector, where as an increasing trend was noticed in the case of mechanised sector, indicating a reduction from the indigenous sector and a possible contribution from the mechanised sector from 1975 onwards. Presence of purse-seine catches could not increase its contribution relatively in pelagic sector to show an increasing trend, indicating an adverse effect of purse seiners on indigenous crafts (Fig. 5).

In Goa, prawn fishery showed almost an increasing trend in the range 2% (1969 to 71)-13% (1976). The contribution from the pelagic sector had a reverse trend throughout. Data for mechanised sector were not available till 1973 as catch statistics with these details were collected by the Central Marine Fisheries Research Institute, only from 1974 onwards. From this year onwards, contribution from the mechanised sector increased with a wide range 23% (1974)-72% (1977). The decreasing trend noticed in pelagic sector indicated that this fishery was not supported by mechanised sector. However, there were purse seiners operating during this period. Hence the absence of

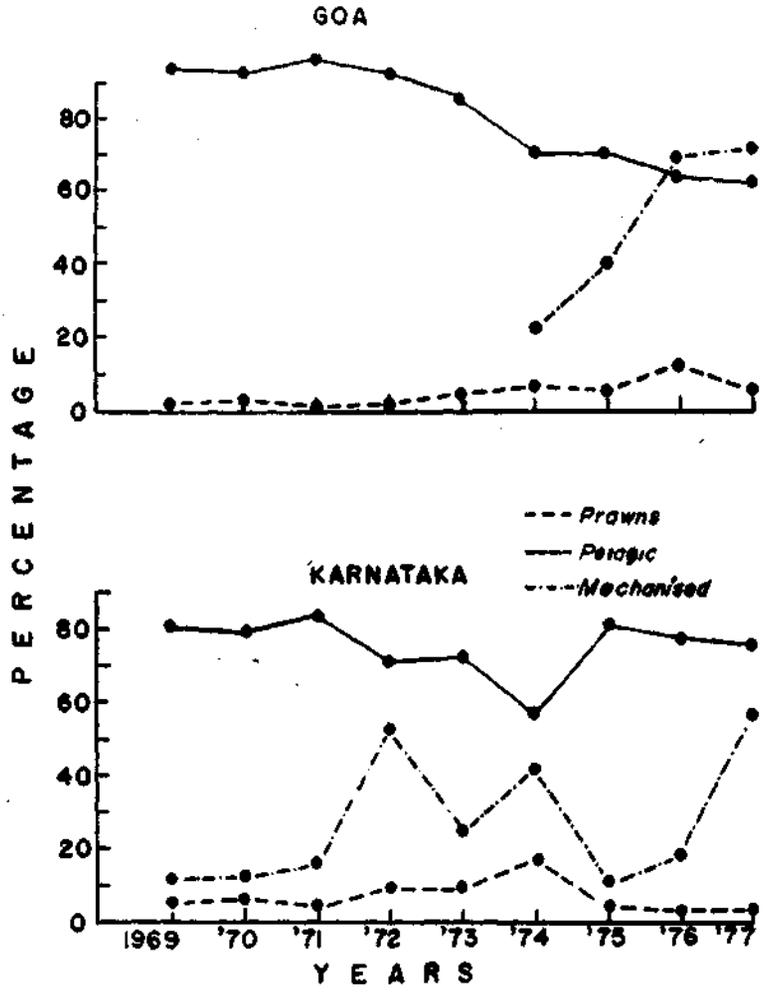

Fig. 5. Percentage contribution of prawns, pelagic and mechanised sectors to the total catch during 1969-77 in Karnataka and Goa.

the effect of purse-seine operation in the pelagic sector may be due to incomplete coverage of purse-seine catches, as the same might not have been landed in the Goa coast (Fig. 5).

In Maharashtra, unlika in other states, prawn fishery was constituted both by penaeid and non-penaeid groups.

Starting at the lowest level of 27%(1969) it went up to 47% (1972) and then declined. From 1973 onwards the contribution was more or less steady. However, in the case of pelagic fisheries it went down to 30% (1972) from 45% (1969). Afterwards it was steady, almost at 39% till 1975.

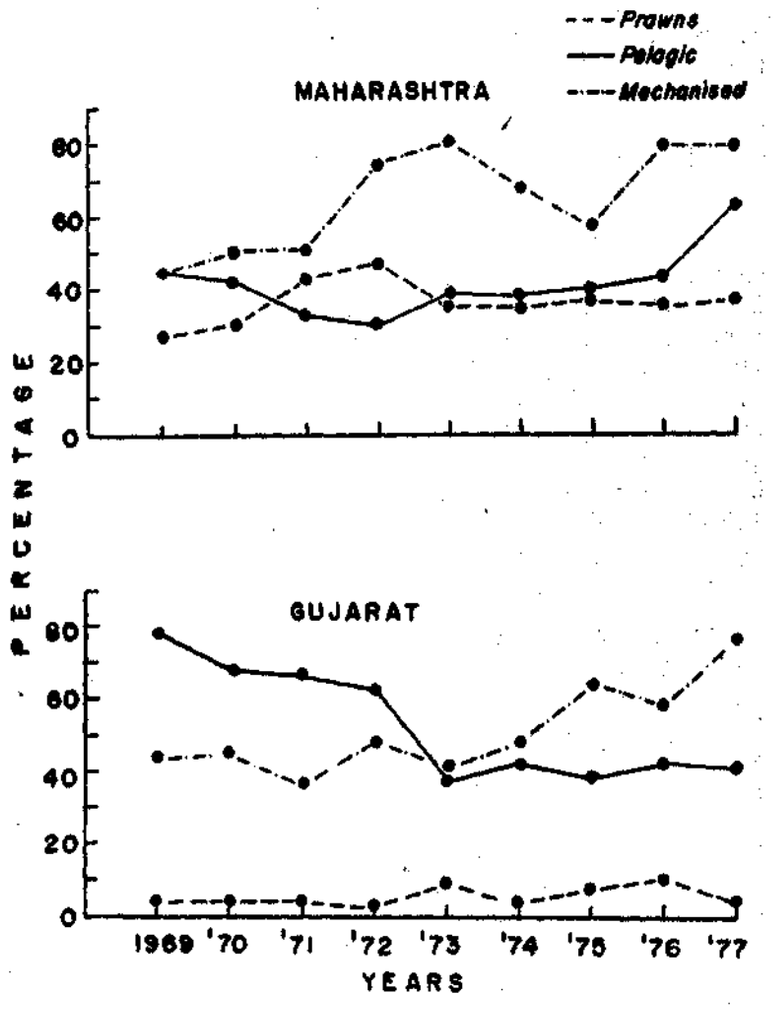

Fig. 6. Percentage contribution of prawns, pelagic and mechanised sectors to the total catch during 1969-77 in Maharashtra and Gujarat.

An increasing trend was noticed then on. Thus inverse trends were noticed between prawn and pelagic sectors indirectly indicating that demersal fisheries are more exploited during this period. In the case of mechaised sector one factor has to be taken note of in this state. This sector includes powered country boats which are used to transportmen and material to the fishing area and back. The contribution from mechanised sector initially showed a reverse trend to that of pelagic sector till 1973. Then on, both had an increasing trend indicating mechanised sector's contribution to pelagic sector also. The range of contribution varied from 45% (1969) to 80% (1973, '76 & '77) (Fig. 6).

Contribution from prawn sector in Gujarat was almost steady with fluctuations confined to the range 3% (1972)-9% (1973) thus indicating vast potentialities to exploit this source further. Pelagic sector showed a steady decline till 1972 with a sharp fall in 1973. Then a steady state was maintained. The range was 38% (1975)-78% (1969. However, from the mechanised sector the contribution showed an increasing trend almost throughout the period. Increase in this sector and a steady state for pelagic fishery during 1973-'77 indicated contribution of mechanised sector to pelagic fisheries also. (Fig.6)

On the basis of the above observations, maritime states can be divided into three classes. In the first one, mechanised and pelagic sectors had same trends, the increase or decrease in one had parallel effect on the other. This may be due either to mechanised sector operating gill nets and others contributing substantially to pelagic sector or indigenous crafts relatively increasing their contribution to pelagic sector. In this class come Tamil Nadu and Maharashtra where enlarging the exploitation of both demersal and pelagic groups may be possible, since only increasing trend was noticed in these two states. The second one is where the trend of contributions from mechanised and pelagic sectors did not seem to have any relationship. This may indicate the possibility of contribution to the pelagic from mechanised sector. In this class come Karnataka, Goa and Gujarat. In the third group, the trends in these sectors have

reverse relationship indicating that mechanised sector contributed mainly to the demersal group. In these states it may be possible to enlarge the exploitation of pelagic fisheries. In this class come the rest of states, *viz.* West Bengal, Orissa, Andhra Pradesh, Pondicherry and Kerala.

It is well known that analysis based on percentage may not give a complete picture of fishery trends. Hence it is worth studying the trends in terms of absolute estimates of contributions from the three sectors to the total catch.

Absolute contributions

The total all-India estimated marine fish landings ranged from 0.91 million tonnes (1969) to 1.42 million tonnes (1975) during the period under review. Except in 1972 the trend in total catch was increasing till 1975. However, in 1976 and 1977 a declining trend was discerned Pelagic fisheries followed more or less similar trend during this period. In the case of mechanised sector there was a steady increase in its contribution throughout the period. Landings of prawns, though maintained a steady increase, the rate of increase was less when compared to that of mechanised sector .During 1973–77 the contribution from prawn fishery was almost steady indicating that at the present rate and area of exploitation not more than 0.30 million tonnes may be expected from this sector. Though there was a steady and steep increase in the contribution of mechanised sector, the total catches followed the trend of the landings of pelagic species. This clearly indicated that in spite of increase in the contribution from mechanised sector which mainly exploited demersal groups, the contribution from the pelagic sector is the deciding factor for total landings. One more point that emerges from the above observations is that increase in the mechanised sector has no considerable impact on total landings. In other words exploitation by mechanised sector may not be totally independent from that of indigenous crafts and overlapping in their areas of exploitation is not ruled out. Clashes between mechanised sector and indigenous sector support this observation. Decline in the total catches and increase in the catches of mechanised sector are a clear indication that presence of mehanised sector may have adverse effects on the age old

traditional sector. The findings under percentage distribution do agree well with the above observations also, thus strengthening the conclusions arrived at. (Fig.7).

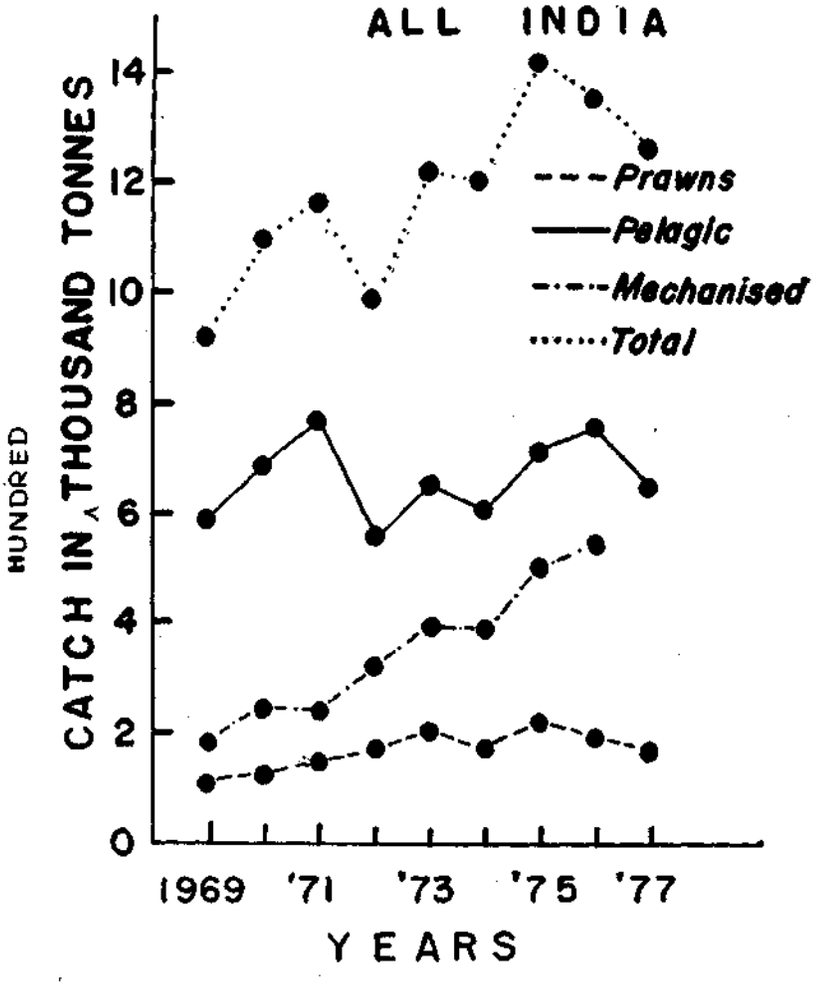

Fig. 7. Total annual landings and the contributions from prawns, pelagic and mechanised sectors (in thousand tonnes) during 1969-77 in India.

The total estimated marine fish landings in West Bengal were in the range 6117 tonnes (1972)-27705 tonnes (1975)

Barring 1972, there was a steady increase in the total landings from 1969 to 1974. In 1975 there was a steep increase followed by a slight fall in 1976 and a steep one in 1977. Similar trend was found in the case of pelagic sector. Contribution from prawn sector also maintained a similar trend with lesser magnitude. Mechanised sector contributed very little in this state. Here it may be noted that these estimates pertain to one costal district, namely Midnapore. Hence any statement made here for this state refers only to Midnapore coast and not the entire West Bengal. In this state also, pelagic contribution remains to be the deciding

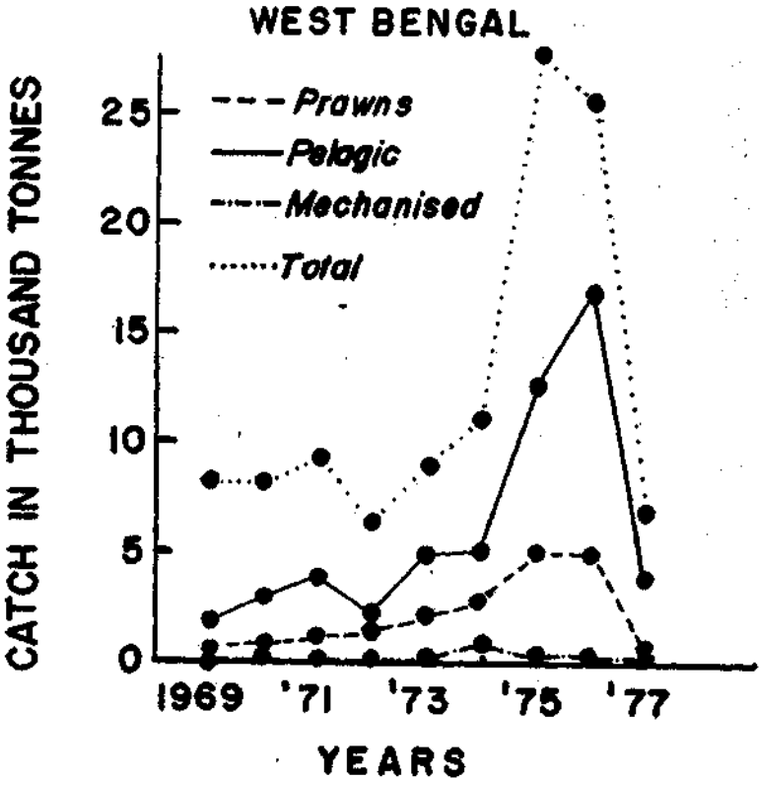

Fig. 8. Total annual landings and the contributions from prawns, pelagic and mechanised sectors (in thousand tonnes) during 1969-77 in west Bengal

factor for the total landings are pointing out the scope for more exploitation of demersal groups. (Fig.8.).

In Orissa the total estimated marine fish landings varied from 8,891 tonnes (1971) to 29,823 tonnes (1976) during 1969-'77. After a steep increase in 1970 there was a sharp decline in 1971. From 1972 a gradual increase was noticed till 1976 and then a sharp decline in 1977. Regarding pelagic sector its contribution followed a similar pattern with a decreased tempo. Contribution from prawn sector was not much. In the case of menchanised sector its contribution from 1969 onwards showed a gradual increase till 1974 then steep

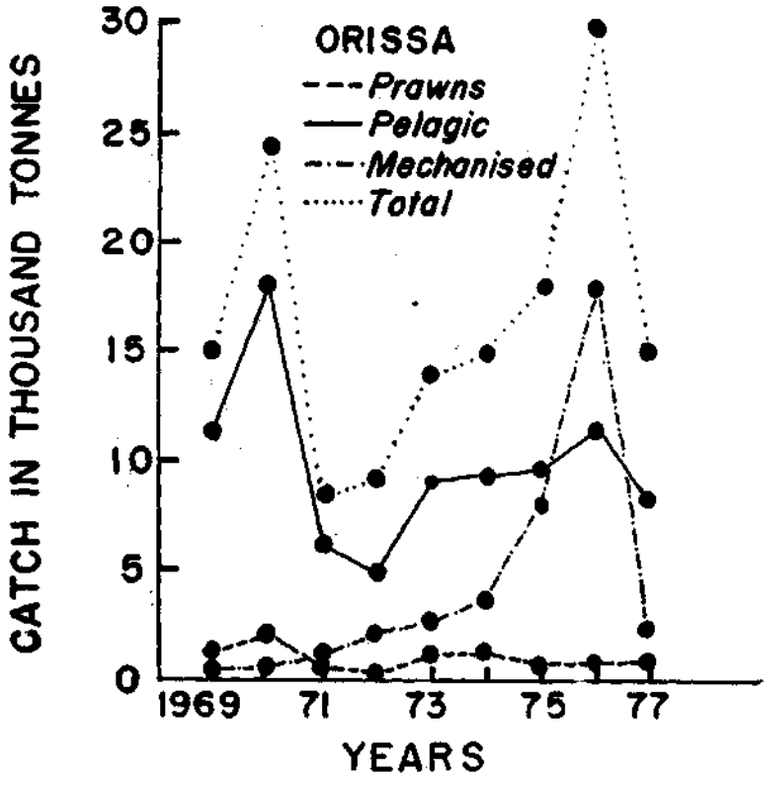

Fig. 9. Total annual landings and the contributions from prawns, Pelagic and mechanised sectors (in thousand tonnes) during 1969-77 in Orissa.

increase till 1976, followed by a sharp decline in 1977. Its trend from 1971 onwards was more or less similar to that of total landings thus indicating the impact of mechanisation in the total landings. The decline in 1977 may not be due to less catches from mechanised sector. Boats landing normally at other observation centres might have landed at Paradip which was not covered during this period. Hence there is scope for increasing the landings from both pelagic and demersal sectors(Fig.9).

During 1969-'77 in Andhra Pradesh, barring 1970, there was a gradual increase in the total landings from 1969 to 1973 with a steep increase in 1974. After a slight fall in 1975 there was a sharp decline in 1976 and 1977. More or less a similar trend was noticed in the case of pelagic species. In the case of mechanised sector there was a gradual increase throughout 1969-'77 indicating that in this state also contribution from pelagic group had been the deciding factor for total landings. Contribution from prawn sector did not show a regular trend(Fig.10). Here one point deserves consideration. Private trawlers numbering between 30 and 70 were operated off Visakapatnam during this period. As contribution from this sector was not available the same could not be considered for the present analysis. It may be noticed that taking a modest estimate of about 300 Kg of prawns per trawler per day and considering 200 days of operation by each trawler per year the expected annual catch of prawns will not be less than 2000 tonnes, valued at about 100 million rupees. Most of the fish caught incidentally during the operations were thrown overboard. Only the fish caught in the last haul of the operation were brought and landed. The total quantity of fish caught can roughly be put at 20,000 to 30,000 tonnes. Had this been landed, there would not have been a decline in the overall catches. (Project Reports of A.P. Govt)

But for slight decrease in 1972, 1974 & 1977 in Tamil Nadu there was an overall increasing trend in the total marine fish landings during 1969-'77, the range being 154,876 (1969)-226078 tonnes (1976). Similar trend was noticed in pelagic sector except in 1970. In the case of mechanised landings the trend was reverse during 1969-'72

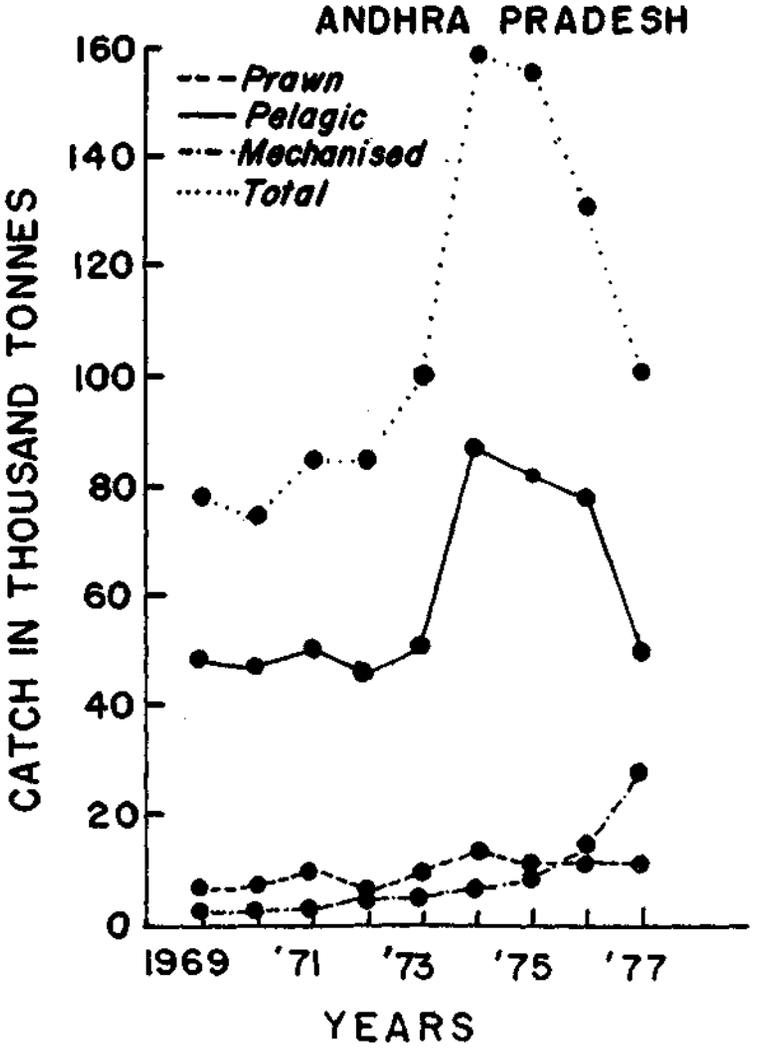

Fig. 10. Total annual landings and the contributions from prawns, pelagic and mechanised sectorss (in thousand tonnes) during 1961-77 Andhra Pradesh.

and from 1973 onwards it was similar to both pelagic and total catches indicating that demersal species were exploited during 1969 -'72 by mechanised boats and later on, the

possibility for contribution to pelagic from mechanised sector may not be ruled out. Contribution from both demersal and pelagic groups hence may be increased. Prawn landings did not show much variation (Fig. 11)

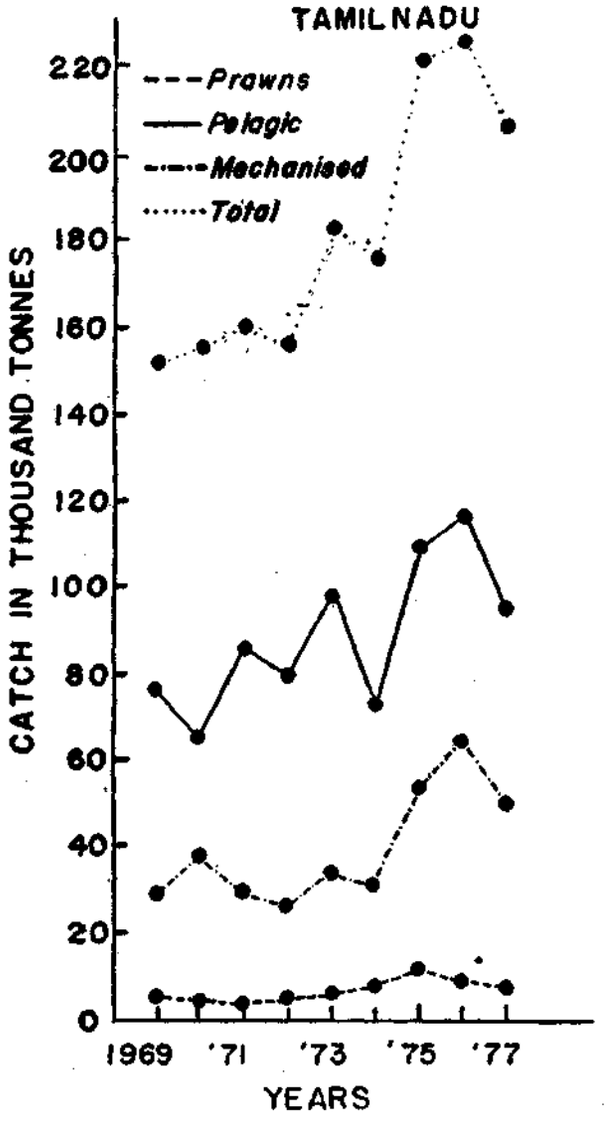

Fig. 11. Total annual landings and the contributions from prawn, pelagic and mechanised sectors (in thousand tonnes) during 1969-77 in Tamil Nadu.

In Pondicherry excludiug Mahe and Yenam the catches were of the same magnitude during 1969–72 but declined from 1972 onwards till 1974. Then there was an increasing trend till 1976 with a steep decline in 1977. In the csse of pelagic fisheries except for a slight increase in 1970, the estimates were more or less steady during 1971–'76 with a sharp decline in 1977. There were heavy fluctuations in the estimates of mechanised fish landings during 1969-'74. Thereafter there was an increasing trend till 1976 with a fall in 1977. However, in the case of prawns the estimates showed a decreasing trend till 1974 and then remained more or less stable till 1977. Similarity between the trends of total landings and pelagic fish landings indicate that in this region also the trend in the total catches depended mainly on the contribution of pelagic groups. Moreover, in spite of increase in the landings from mechanised sector, stability in the case of prawn landings indicated that prawn landings did not depend much on this sector. It might also be that contribution from mechanised to pelagic sector was there during this period to maintain the lead in the contribution of pelagic sector(Fig.12).

In Kerala during the period of reference total landings showed heavy fluctuations with steep increase during 1969–'71 and a step decline in 1972. Again a steep increase was noticed in 1973 touching an all - time high during 1969–'77 and there was a decline till 1976 with a slight increase in 1977. The contribution from the pelagic sector reflected similar trend till 1975. During 1976 and 1977 the trend was just the reverse. In the case of mechanised sector, except during 1971 and 1972 when there was a slight decline, increasing trend was maintained during 1969–'75 with a steep decline in 1976 and an increase in 1977. In this state also pelagic contribution happened to be the deciding factor on total landings. Moreover, no relationship could be attributed to trends of pelagic and mechanised sectors. This may be due to non-dependability of these sectors. This is quite in contrast to the observations made in other states. In Kerala, major contribution under mechanised

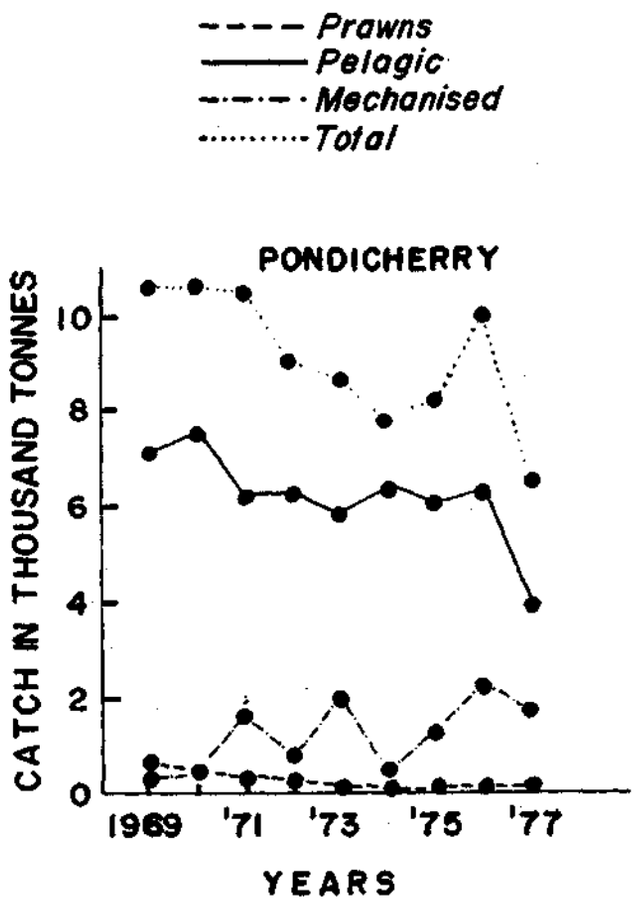

Fig. 12. Total annual landings and mechanised sectors (in thousand tonnes) during 1969-77 in Pondicherry.

sector comes from one landing centre Neendakara where both trawls and gill nets were operated. Regarding prawn landings the contribution remained more or less steady from 1969 to 1972. Then, an increasing trend was noticed till 1975 with a fall in 1976 and then a rise in 1977. But for 1974, when there was a decline in prawn landings, the overall trend was similar to that of mechanised sector indicating that major contribution to prawn sector was from

mechanised sector and mechanised sector's contribution to pelagic sector would not be considerable. (Fig. 13)

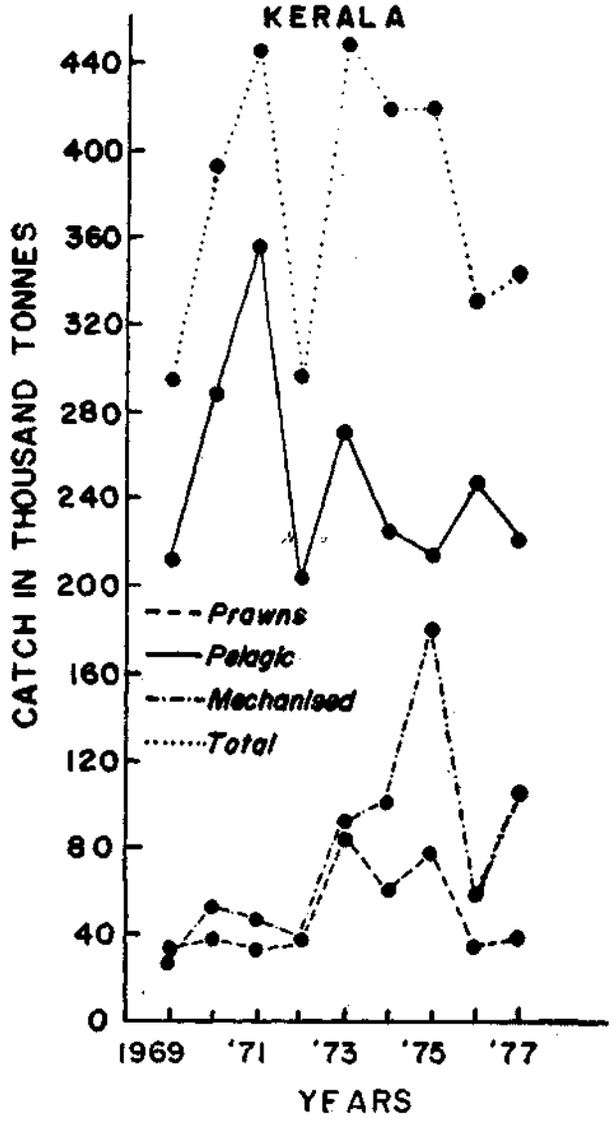

Fig. 13. Total annual landings and the contributions from prawn, pelagic and mechanised sectors (in thousand tonnes) during 1969-77 in Kerala.

In Karnataka also heavy fluctuations were noticed with an all-time-high landings in 1970 and low landings in 1969 and 1974. From 1970 onwards there was a decline till 1974 and then an increasing trend was observed till the end of the period under review. Pelagic sector reflected the same trend as observed in the total landings, thus indicating clearly that this state also depends heavily on pelagic sector. Contribution from mechanised sector did not follow the above trend. From 1969 to 1971 there was a gradual increase in the landings. In 1972 there was a steep rise in the landings followed by a decline in 1973, a slight increase in 1974, a decline in 1975, a slight increase in 1976 and a steep rise in 1977. The rise in 1976 and 1977 was mainly due to the presence of purse seiners in this state. However, this steep rise in 1977 was not reflected either in the total landings or in the pelagic fishery. This Indicated the possibility that contribution from indigenous sector was considerably reduced, and that purse seiners were operated on the same stocks available for indigenous crafts. This is not a healthy trend as it weakens the indigenous sector. Wide fluctuations as noticed in the mechanised sector were not found in the prawn sector indicating that prawn fishery was not very much affected by the mechanised sector. However, the decreasing trend in 1974 and less-stabilised landings during 1975-'77 may indicate that either exploitation in this sector may be stepped up to maintain 1974 level or further increase in the explotiation may indicate future action to be taken. If increase in the effort results in the higher landings, effort may be increased fruther till stabilisation take places. If the yield does not commensurate with the effort, then further effort need not be expended. (Fig. 14).

In Goa also total landings experienced wide fluctuations. Decrease in 1970, increase in 1971, decrease in 1972 and 1973, gradual increase during 1974-'76 and decrease in 1977 was the picture of its trend. Close to its heels followed the trend in the pelagic sector. The estimates available from 1974 onwards for mechanised sector showed an increasing trend till 1976 with a decline in 1977. Its trend

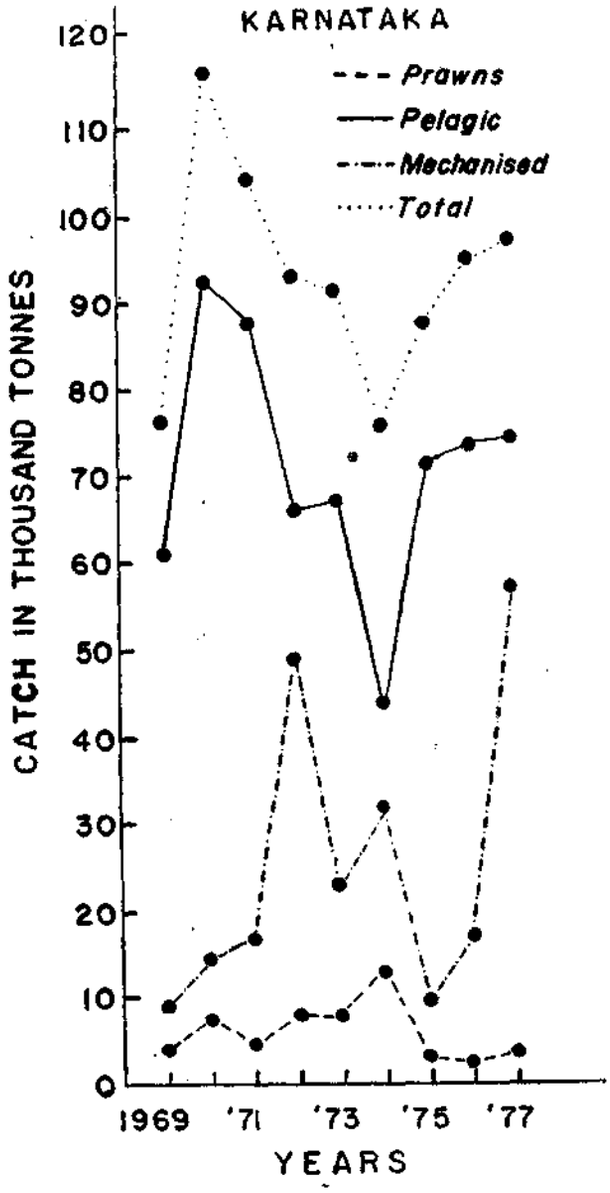

Fig. 14. Total annual landings and the contributions from prawn, pelagic and mechanised sectors (in thousand tonnes) during 1969-77 in Karnataka.

closely agreed with the trends of total landings during 1974–1977. In the case of prawn landings a stablised state was noticed during 1969–1972, then an increasing treand till 1976 with a decline in 1977. Thus in all these sectors and total as well, trends remained the same during, 1974–1977, indicating that machanised sector also contributed to the pelagic during this period. Presence of purse seines justifies this (Fig 15).

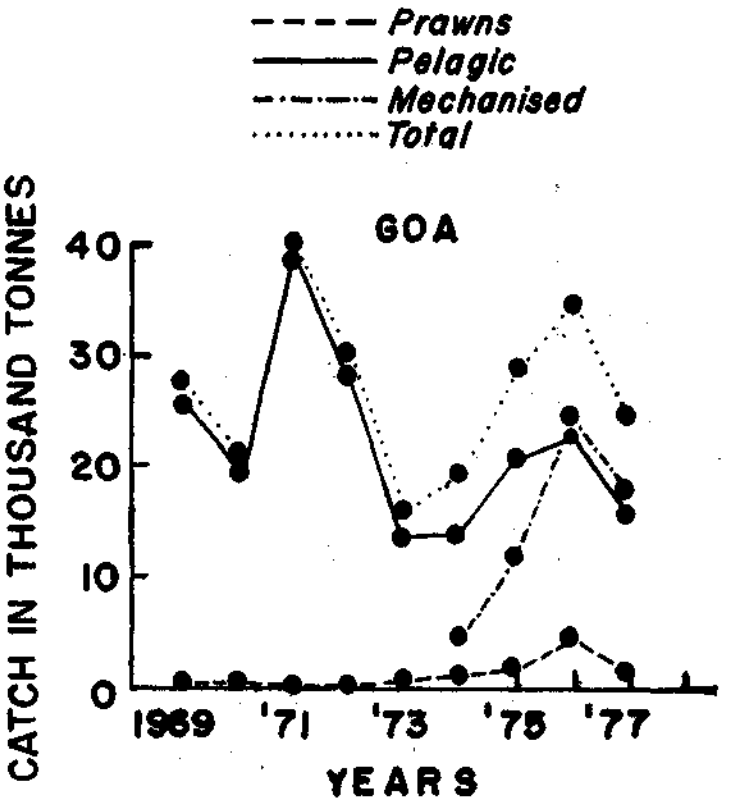

Fig. 15. Total annual landings and the contributions from prawn, pelagic and mechanised sectors (in thousand tonnes) during 1969-77 in Goa.

But for a drop in 1974, the trend in the total landings in Maharashtra was always increasing during 1969 to 1976,

with a drop in 1977. Similar trend was noticed in the case of mechanised sector also. With less fluctuations during 1969-1974 an increasing trend was noticed during 1975–1977 in the case of pelagic sector. The trend in the prawn sector was similar to that in the total and mechanised sector. As mentioned earlier it is worth noting that in this state, indigenous crafts are powered and the gears are operated exploiting both demersal and pelagic groups (Fig. 16).

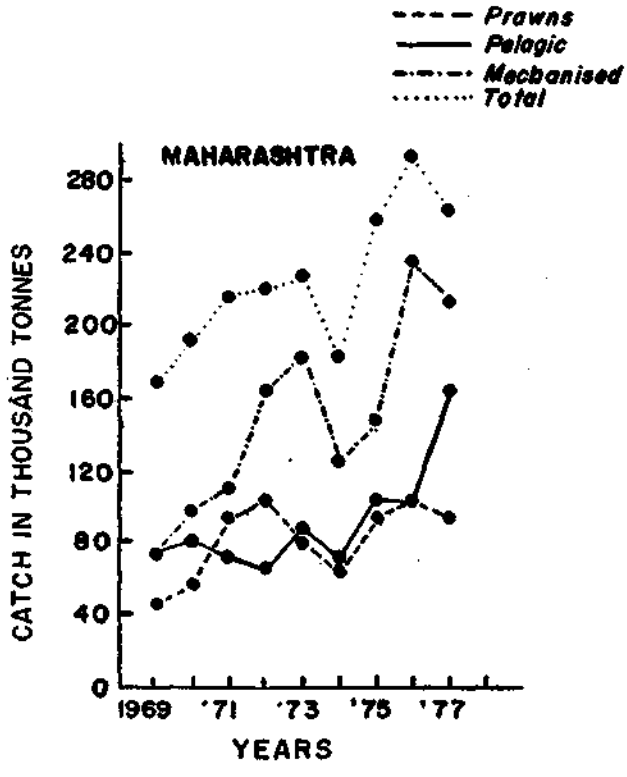

Fig. 16 Total annual landings and the contributions from prawns, pelagic and mechanised sectors (in thousand tonnes) during 1969-77 in Maharashtra.

In Gujarat also total landings and mechanised – boat landings had more or less similar trends during 1969–1977. But for a slight drop in 1971 and 1972 there was a steady increase in the total landings till 1975. Then there was a

drop in 1976 and a rise in 1977. In mechanised sector, but for a drop in 1971, there was a steady and steep increase during 1969–1975. In 1976 there was a drop with a rise in

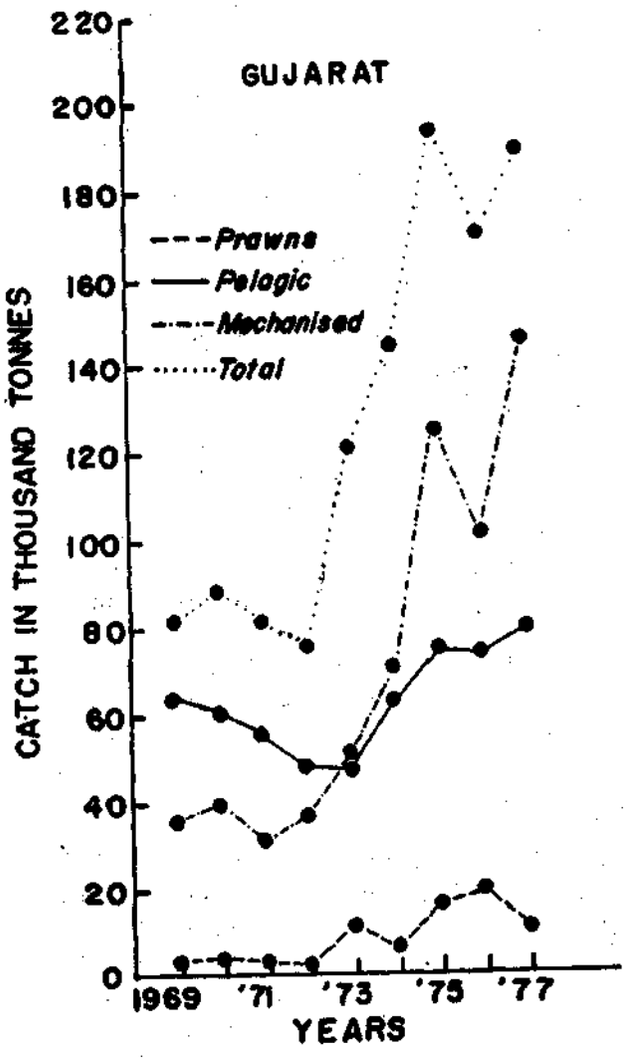

Fig. 17. Total annual landings and the contributions from prawn, pelagic and mechanised sectors (in thousand tonnes) during 1970-77 in Gujarat.

1977 touching an all-time high during 1969-1977. Regarding pelagic sector, the trend showed a gradual decrease from 1969 to 1973. Then on an increasing trend was noticed throughout. Though stability was maintained in the case of prawns during 1969 to 1972 slightly increasing trend was maintained in the rest of the period (Fig. 17).

The variations so far encountered in the percentage contribution of different sectors and their absolute contributions over the years and states may or may not be due to chance fluctuations. To ascertain whether these variations are due to chance fluctuations or not, statistical analysis on the lines mentioned earlier is attempted.

STATISTICAL ANALYSIS

Contributions to the total marine fish landings from different states as well from different groups of fishes in each state over years are not of the same magnitude. However, under the assumptions made earlier on the exploited fish stocks in the Indian costal waters, percentage composition of the contributions from different sectors may not be different over the years and the states, as well as in the overall total estimates. Under this null hypothesis Analysis of Variance (Table-2) for percentage contributions of states over years for totals, prawn, pelagic and mechanised sectors was taken up after introducing arc sine transformation. Salient features of the findings are as follows.

For the total landings ,Anova has indicated highly significant differences between States. However, between year's do not show significant diffenences. The absence of significant differences over years supports the asumptions made earlier. Regarding the contributions from the prawn sector also, Anova brought out the same results as for the totals. In other words, inspite of increase in the number of mechanised crafts over the years, the percentage contributions from the prawn sector did not show wide variations

over the years. This point has already been brought out in this account. In the case of pelagic sector also same results were available from the Anova. However, Anova for mechanised sector indicated highly significant differences. Among the states the concentration of mechanised units was not uniform and also over the years the growth of mechanised sector was so spectacular as to result in highly significant differences. In spite of highly significant differernces in the case of mechanised sector over the years, the absence of the same for pelagic and prawn sectors may be due to relative contributions from the landings of indigenous gears.

To see whether there existed a trend in the contributions over the years within each state, rank correlations (r_s) were calculated along with correlation (r) and regression coefficients (b) (Table-3). In the case of total landings, 'r_s' for all the states in east coast except Pondicherry were found to be posititive. In the west cost, for Maharashtra and Gujarat only the values were positive and for Kerala, Karnataka and Goa the values were negative.

Regarding prawns positive 'r_s' for Goa was highly significant indicating a possible strong trend over the period and r and b were also significant at 5% level. In Pondicherry though negative r_s was not found to be singnificant, r and b were significant. Thus in this state also possibility for negative trend cannot be ruled out. In all other states no significant coefficients were found. However, negative trend was noticed in Orissa and Karnataka. At all-India level, none of the coefficients were found to be significant.

In the case of pelagic sector in Goa, all the coefficients found to be negative were highly significant. In West Bengal, Orissa and Gujarat r_s were significant, whereas r and b were highly significant. Similar results were obtained in the all-India totals also. In Andhra Pradesh though r_s was not found to be significant, r and b were significant, thus indicating a passible trend in the pelagic sector's contribution over the years. In other states the

coefficients were not significant. Barring West Bengal and Maharashtra, in all the states, the trend was negative which was reflected in the all-India totals also. This is mainly due to increased landings of demersal group from mechanised sector in these states which brought down the percentage contribution from the pelagic sector. In Maharashtra, particularly, mechanised boats included powered country crafts also, which were used for exploiting pelagic groups as well. Hence there is positive regression for this state. So far as West Bengal is concerned, mechanised sector's contribution was not at all significant and so also its contribution to demersal fishery. In other states more exploitation of demersal groups might be the reason for the negative trend in pelagic sector. In these states it is worth trying to extend and intensify exploitation of pelagic resources.

In the case of mechanised sector, coefficients for West Bengal and Goa were not calculated for want of sufficient data. In Orissa all the coefficients were highly significant with positive trend indicating that there is considerable scope for increasing effort in this sector in this state. So also in the all-India level. In Andhra Pradesh and Gujarat r_s were significant whereas r and b were highly significant. In Pondicherry and Kerala all the coeficients were significant. In all the other states all the coefficants were positive. Hence it is a clear indication that contribution from mechanised sector in all the states is on the increasing side. In other words, contribution from the traditional sector was affected in India. Only in Tamil Nadu, Karnataka and Maharashtra, though positive trend is noted none of the coefficients were significant.

Considering all the three sectors, viz. prawn, pelagic and mechanised, in Orissa, pelagic and mechanised sectors were not complementary indicating that mechanised sector mainly exploited demersal groups. Similar indication was found in the case of Andhra Pradesh and Gujarat. Hence in these states there is a scope to extend and inten-

sify the exploitation of pelagic fishery resources. The same remark holds good, in general, in the case of all-India landings also.

To have a more clear idea about the trends in the contribution from these sectors over years in each state and in each year for all the states, control charts were drawn with mean and standard error of all-India estimates for each sector. Control lines for 95% and 99% levels were drawn to locate the outliers. In the case of total landings Andhra, Karnataka and Gujarat were within 95% confidence band, West Bengal, Orissa, Pondicherry and Goa were lower outliers for 77% line whereas Tamil Nadu, Kerala and Maharashtra were outliers for 99% line.

From the charts for each state over years it was clear that for West Bengal till 1972 the contributions from prawn sector were with in 95% band and for 1973 it was an upper outlier for 99%. The figures for 1974 to 1976 were upper outliers for 95% line and for 1977 it was within the 95%

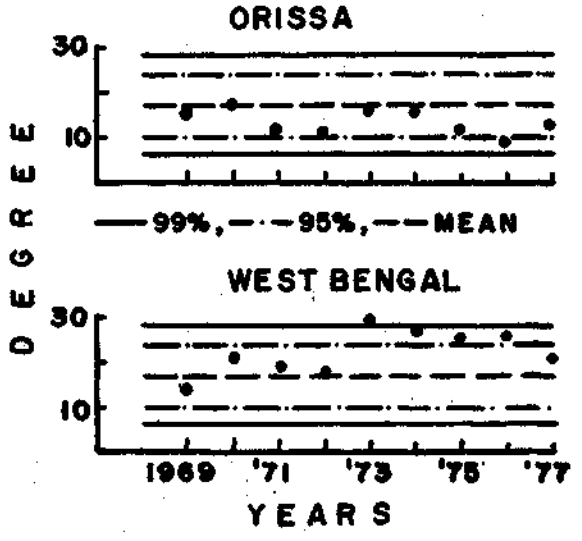

Fig. 18. Control charts for prawn landings in the states of West Bengal and Orissa during 1969-77.

confidence band (Fig 18). So far as Orissa was concerned the figure for 1976 alone was lower outlier for 95% line. The rest were within the 95% confidence band. However all the points were below the average line indicating that percentage contribution of prawn sector to the total landings in Orissa was below the all-India level (Fig. 18). It might be due to the non-inclusion of data from Paradip. In Andhra Pradesh all the estimates were within the acceptable region (95% confidence band. hereafter called A.R) and agreed well with the all-India figure (Fig. 19). In Tamil Nadu though all estimates were within A.R. they were also below the mean level (Fig. 19). In case of Pondicherry a declining

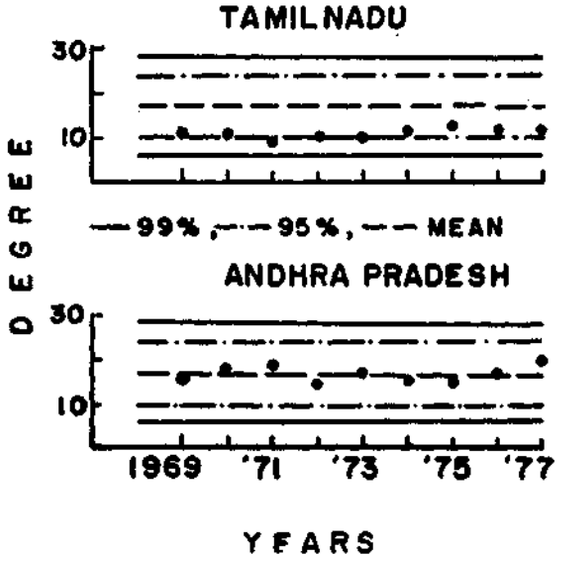

Fig. 20. Control charts for prawn landings in the states of Andhra Pradesh and Tamil Nadu during 1969-77.

trend was noticed from 1971 onwards. The figures for 1972 & 1977 were the lower outliers for 95% line and for 1973 to 1976 lower outliers for 99% line (Fig. 20). In Kerala the estimates for 1973 and 1975 were the only upper outliers for 95% line. The rest were within A.R. However almost

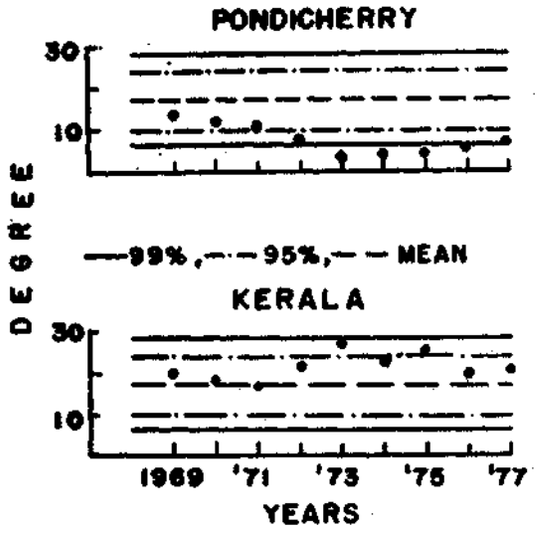

Fig. 20. Control charts for prawn landings in the states of Pondicherry and Kerala during 1969-77.

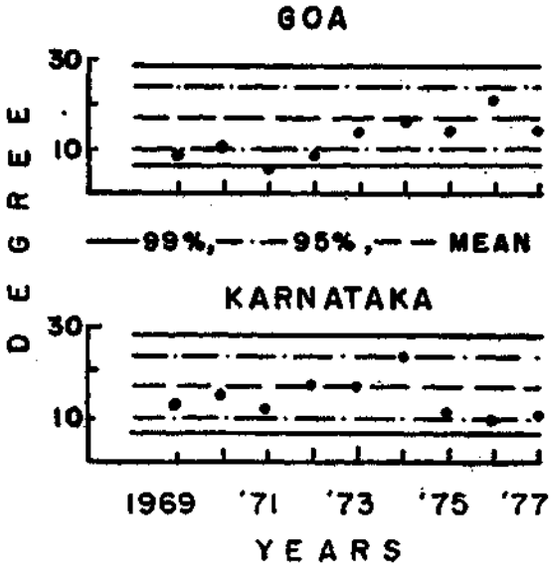

Fig 21. Control charts for prawn landings in the states of Karnataka and Goa during 1969-77.

all the estimates were above the mean line and for 1971 it was below the mean line (Fig. 20). In case of Karnataka 1974 and 1976 were just on the 95% line, the rest being within A.R. (Fig. 21). In the case of Goa 1971 was a lower outlier for 99% line; 1969 and 1972 lower outlier for 95% line and 1970 was just on the lower 95% line. The other years were within A.R. (Fig. 21). Regarding Maharashtra the picture was quite different from other states in that all the estimates were upper outlier for 99% line indicating that in this state contribution from prawn sector was comparatively very high (Fig. 22). This was mainly due to major contribution from nonpenaeid groups in this state. However in Gujart except 1972 which was just on 95% line, the rest were within A.R. (Fig. 22).

Hence for the prawn sector, taking 99% line as the line of reference, the states having outliers were West Bengal (upper) in the est and Goa and Maharashtra in the west coast

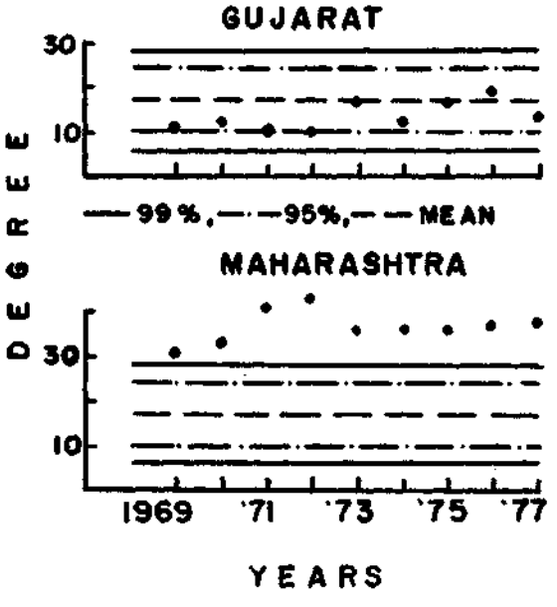

Fig. 22. Control charts for prawn landings in the states of Maharashtra and Gujarat during 1969-77.

The states having outliers for 95% line and within 99% line were West Bengal, Orissa and Pondicherry in the east coast and Kerala, Goa and Gujarat in the west coast. It is worth repeating that the picture for Maharashtra was entirely different from other states where all the estimates were upper outliers for 99% line.

Charts for pelagic sector indicated the following. Except 1969, 1970 and 1972 in West Bengal where 1969 was a lower outlier for 99% line and 1970 and 1972 were lower outliers for 95% line the rest were within A.R. In Orissa no outliers were found (Fig. 23). So also in the states of Andhra Pradesh, Tamil Nadu (Fig. 24) and Pondicherry (Fig. 25) in the east coast and Kerala (Fig. 25) and Gujarat (Fig. 27) in the west coast. In Karntaka, 1969, 1971 and 1975 were upper outliers and 1976 the lower outlier for 95% line (Fig. 26). In the case of Goa,years 1969 to 1972 were upper outliers for 99% line and 1973 an upper outlier for 95% line (Fig. 26). In Maharashtra 1971, 1972 and 1976 were lower outliers for 95% line. The rest were within A.R (Fig.27). The data did not exhibit any trend in the states of Andhra Pradesh, Tamil Nadu, Kerala, Karnataka and Maharashtra. However there was an increasing trend in West Bengal and a decreasing one in Orissa. Goa and Gujarat, indicating that in West Bengal demersal fishery's contribution has gone down and in Orissa, Goa and Gujarat it has gone up.

Charts for mechanised sector indicated the following. For want of data as mentioned earlier, states of West Bengal and Goa were not considered under this sector. In Orissa 1969 was the lower outlier for 95% line, where as 1970 and 1976 were the lower and upper outlier for 99% line respectively. The rest were within the A.R. In Andhra Pradesh 1969, 1970 and 1971 were the lower outliers for 99% and 1972 to 1975 were the lower outliers for 95% line. The rest were within A.R. (Fig. 28). In Tamil Nadu all were within A.R. In Pondicherry, the years 1969, 1970, 1972 and 1974 were the lower outliers for 95% line. The rest were wiihin the A.R. (Fig 29). In Karnataka except 1972 and 1977 which were the upper outliers for 95% line, all the rest were

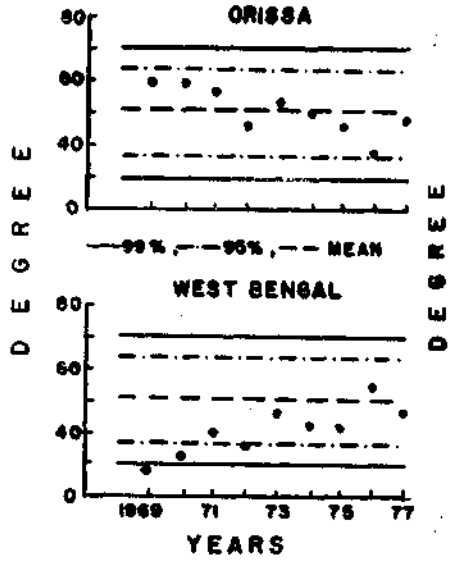

Fig. 23. Control charts for pelagic contribution in the states of West Bengal and Orissa during 1969-77.

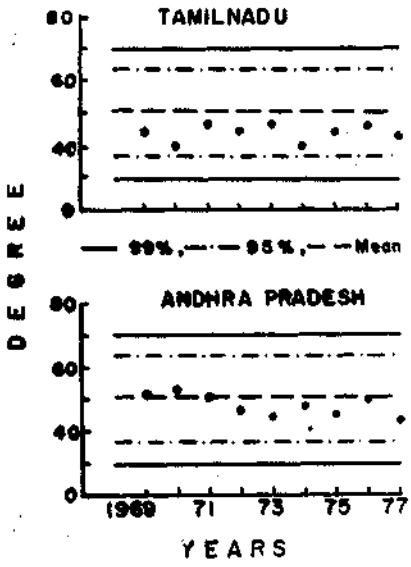

Fig. 24. Control charts for pelagic contribution in the states of Andhra Pradesh and Tamil Nadu during 1969-77.

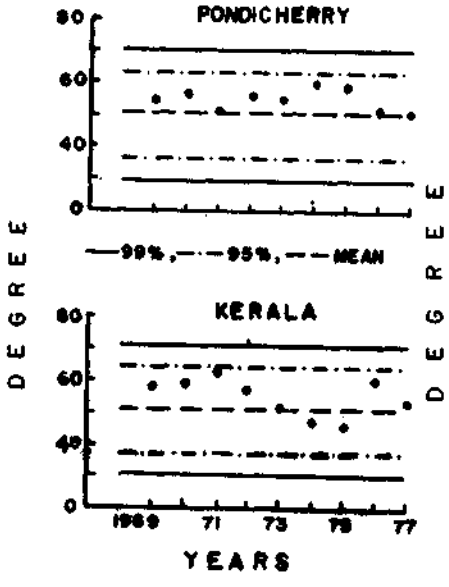

Fig. 25. Control charts for pelagic contribution in the states of Pondicherry and Kerala during 1969-77.

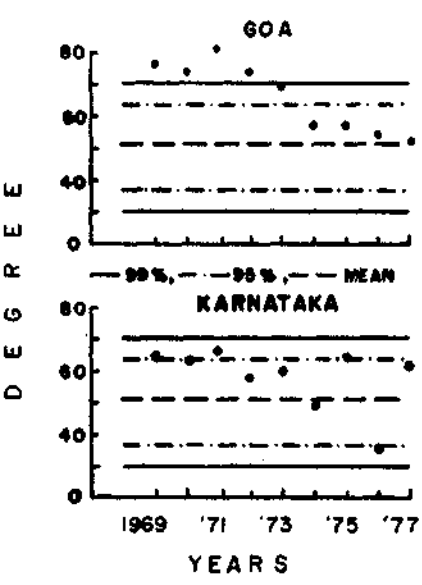

Fig. 26. Control charts for pelagic contribution in the states of Karnataka and Goa during 1969-77

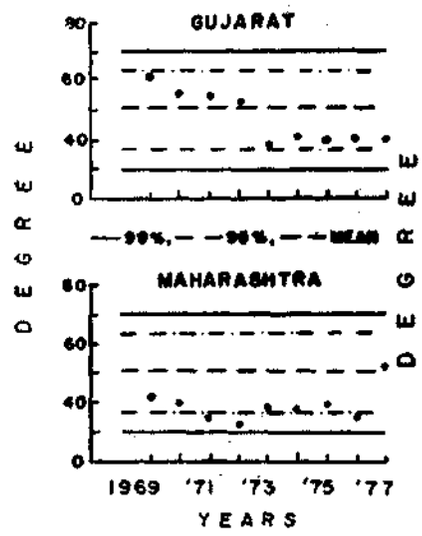

Fig. 27. Control charts for pelagic contribution in the states of Maharashtra and Gujarat during 1969-77.

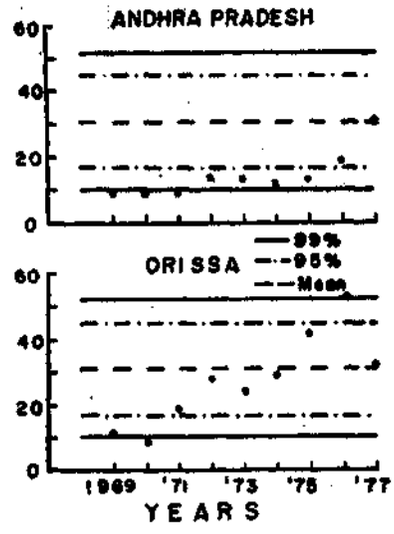

Fig. 28. Control charts for mechanised landings in the states of Orissa and Andhra Pradesh during 1969-77.

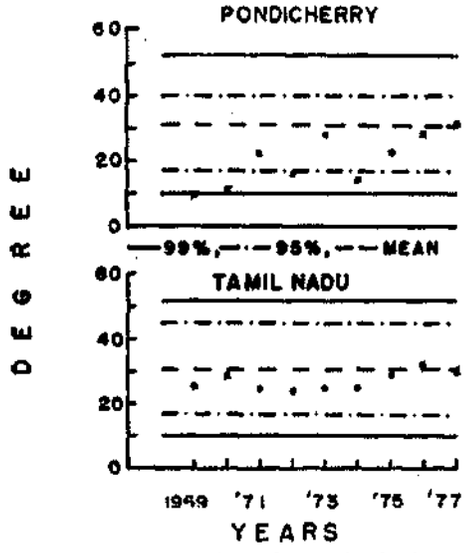

Fig. 29. Control charts for mechanised landings in the states of Tamil Nadu and Pondicherry during 1969–77.

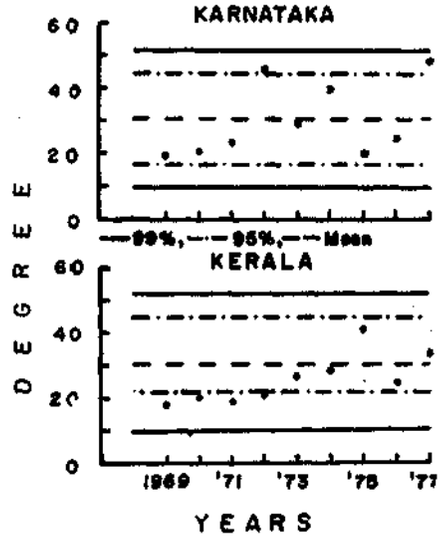

Fig. 30. Control charts for mechanised landings in the states of Kerala and Karnataka during 1969-77.

with in the A.R. (Fig 30). In contrast, in Maharashtra except 1969 and 1975 the rest were all outliers in that 1970 and 1971 were upper outliers for 95% line; 1972 to 1974 and 1976 and 1977 were all upper outliers for 99% line. In Gujarat 1972 was just on the upper 95% line, 1976 an upper outlier for 95% line and 1975 and 1977 were upper outliers for 99% line (Fig. 31).

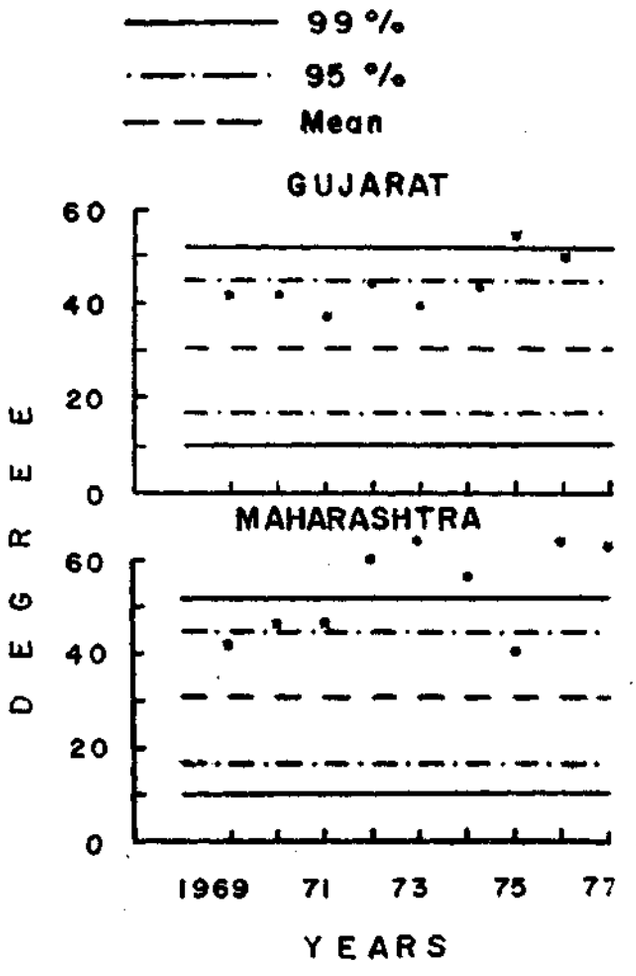

Fig. 31. Control charts for mechanised landings in the states of Maharashtra and Gujarat during 1969–77.

CONCLUSIONS

In West Bengal there is a vast scope to enlarge mechanised sector in order to increase the catches. In Orissa both pelagic and demersal groups may be exploited intensively and extensively. In Andhra Pradesh, in spite of increase in the effort of mechanised sector, total catches did not Increase. Rather there was a downward trend. The data on landings of about 70 large trawlers operating off Visakapatnam are not available for this study. However, it is known that these trawlers throw overboard the fish caught in all but the last haul. This may adversely affect the fish stocks exploited by the other gears. This may be one of the reasons for the downward trend of the total landings in Andhra Pradesh. Hence steps are to be taken to study this problem in order to pinpoint the reasons for the downward trend and suggest remedies required to increase the landings. In Tamil Nadu the three sectors did not show any adverse trend indicating the possibility for increasing the intensity of exploitation of both demersal and pelagic resources. In Kerala in spite of Increase in the efforts in the mechanised sector, prawn landings did not show any considerable increase. This may be due to the area of exploitation remaining the same. Extensive exploitation in the mechanised sector may increase the landings of prawns from this State. Pelagic fishery may also be improved by extending the area of exploitation. In Karnataka mechanised and pelagic sectors showed similar trends from 1975 onwards, indicating the exploitation of pelagic groups by mechanised crafts in good quantities. This clearly shows the presence of purse seiners from 1975 onwards in this state. However, landings from indigenous crafts have been very much affected. Hence it is high time to see that the interests of rural fisherfolk is protected. The same condition exists in Goa also. In Maharashtra and Gujarat there is a wide scope to increase the exploitaion of pelagic groups.

In all, three important points emerge out of this study. In majority of the states as well as on all-India level the trend of total landings was similar to the trend of pelagic

landings. In spite of increase in the intensity of exploitation by mechanised boats there was no comparative increase in the landings of prawns. Finally, even in the case of lesser total landings, mechanised sector's contribution was increasing. From the first two points it may be surmised that demersal sector has not much to offer in the present region of exploitation, hence may increase the landings from pelagic and demersal groups. The last point clearly brings out the fact that in spite of increase in the effort in mechanised sector there is no considerable increase in prawn as well as total landings though contribution from this sector was increasing. In other words, the traditional sector experienced a set back due to the presence of mechanised sector both having the narrow region of nearshore areas for exploitation. Traditional fisheries involve lot of manpower from the rural fisherfolk. Fishing, being a family occupation for generations, the sudden encroachmeht has certainly affected the socio-economic conditions of the local rural fisherfolk further. To safegurad the interests of the indigenous sector is the paramount need of the hour, in the interest of national economy, in this country. There are three different set-ups of fisheries operating in this country, namely,

1) Mechanised sector is competitive with traditional sector; 2) Mechanised sector is complementary to the traditional sector and 3) Mechanisation of indigenous sector.

In most of the sates, the first set-up of fisheries prevails resulting in heavy competition in fishing between mechanised and indigenous sectors in the same region of exploitation. Hence clashes take place between these sectors not only disturbing the local law-and-order condition, but also adversely affecting the landings. Clashes in Goa, Kerala and Tamil Nadu are the result of this situation. However, there are few areas in some states where these sectors have become complementary to each other, increased the income of local rural fisherfolk and improved their living conditions. For instance in Pudiappa-Pudiangadi landing centre near Calicut in Kerala, under a scheme by Agricultural Reference and Development Corporation (ARDC) mechanised boats were distributed through

co-operative societies to the fishermen community so that each and every fishing family is associated with this project in one way or the other. Added to this, most of these families own their traditional units. When the sea becomes rough, indigenous crafts are towed by mechanised ones to calmer areas for fishing and brought back ashore with catches. Country boats are used as carrier boats when mechanised boats bring their catches. Thus mechanised and indigenous sectors have become complementary to each other. Moreover the cooperative societies have created other infrastructure facilities for processing, preserving and better marketing of the catch. This, all put together, has resulted in better living conditions for the fisherfolk of this area. The third kind of setup prevails in Maharashtra where indigenous crafts are powered and profitably used for transportation of crew and material to the fishing grounds and back. The living conditions of fisherfolk with this system of fishing are better than their counter parts elsewhere, where such system is not in vogue. Thus in the last two cases the fruits of mechanised fishing have reached the local fisherfolk whereas under the first case it is not so, in which a separate community has come out remaining hostile to the indigent local fisherfolk.

Hence the need of the hour is to safeguard the interests of rural fisherfolk and at the same time to increase the fish landings. From the foregoing analysis it is quite clear that unless local fisherfolk are involved in the expanding fishery there will arise clash of interests affecting the whole setup. But this may not be easy at present since already the mechanised sector has grown up to too large a size to accommodate the involvement of local fisherfolk. However, the following measures may be considered wherever pyssible for achieving the goal:

i) Fishermen co-operative societies may be made to supply mechanised boats and other required inputs to local fishermen, involving each and every family and create locally other infrastructure facilities such as ice factories, boat and net-repairing yards and better marketing facilities;

ii) Mechanisation of the country crafts may be taken up to increase their mobility and to extend their area of fishing so as to exploit fish stocks intensively and extensively and iii) In general, traditional fishing areas may be allotted to indigenous crafts and areas beyond that to mechanised sector to avoid conflict between these two sectors.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. E.G.Silas, Director, Central Marine Fisheries Research Institute, for the constant encouragement shown throughout the preparation of this paper. They are also thankful to Shri.G.Venkataraman, Shri. T. Jacob, Senior Scientists, and Dr S.V. Bapat Joint Director for their valuable comments.

REFERENCES

Banerji, S.K. 1973. An assessment of the exploited pelagic fisheries of the Indian seas. *Proc. of Symposium on Living Resources of the Seas Around India.*

Beverton, R.J.H. and S.J. Holt, 1957. *On the Dynamics of Exploited Fish Populations,* Her Majesty's Stationery office, London.

Cushing, D.H., 1968. *Fisheries Biology*. The University of Wisconsin Press PP 1-200.

Jones, S and S.K Banerji, 1973. A Review of the Living Resources of the Central Indian Ocean. *Proc. of Symposium on Living Resources of the Seas Around India,* C M F R I, PP 1 - 17

Schaefer, M.B., 1954. Some aspects of populations important to the management of the commercial marine fisheries. *Inter - American Tropical Tuna Commission Bulletin* 1 (6) : PP 27 - 56

Silas, E. G., S. K. Dharamaraja and K. Rangarajan, 1976. Exploited marine fishery resources of India. *CMFRI Bulletin,27.*

TABLE I

STATE-WISE MARINE FISH LANDINGS IN INDIA DURING 1969-1977
(Figures in tonnes)

	1969	1970	1971	1972	1973	1974	1975	1976	1977
West Bengal	7,944	6,989	9,141	6,117	8,854	10,932	27,725	25,411	6,689
Orissa	14,935	24,414	8,891	9,213	13,882	15,160	18,036	29,823	15,072
Andhra Pradesh	77,526	74,459	84,010	84,480	99,544	158,818	155,638	131,321	100,756
Tamil Nadu	151,876	155,516	160,619	155,153	182,419	175,713	221,215	226,078	206,046
Pondicherry	10,637	10,624	10,454	8,980	8,682	7,698	8,150	10,123	6,462
Kerala	294,787	392,880	445,347	295,618	448,269	420,257	420,836	331,047	345,037
Karnataka	75,793	116,936	103,724	92,676	91,484	76,263	87,494	95,283	97,152
Goa	27,559	20,736	39,980	30,104	15,740	19,534	29,170	34,968	24,731
Maharashtra	168,720	192,361	215,305	220,002	226,696	184,961	256,619	293,601	264,452
Gujarat	82,248	80,027	82,159	75,846	121,963	145,309	193,775	171,294	189,638
Andamans	412	500	569	780	854	920	1,104	1,334	1,532
Lakshadweep	1,193	1,165	1,190	1,080	1,853	2,232	2,931	2,572	2,215
Total	913,630	1085,607	1161,389	980,049	1220,240	1217,797	14,22,693	13,52,855	12,59,782

TABLE 2

ANALYSIS OF VARIANCE

		Total landings		Pelagic		Prawns		Mechanised	
Source	D.F.	S. S.	M. S.	S. S	M. S.	S. S.	M. S.	S. S.	M. S.
STATE	9(7)	7832-5265	870.2867**	5420 4698	602.2744**	5546.3632	616.2626**	10588.4528	1512.6361**
YEAR	8(8)	4.5216	N. S. 0.5652	640.7697	N. S. 80.0962	113 0709	N. S. 14.1334	2503.9396	312.9924**
ERROR	72(56)	242.9262	3.3740	3445.8153	47.8585	934 6189	13.1058	2727.662	48.7082

1. Figures in the paranthesis denote degrees of freedom for the mechanised sector
2. **. Highly significant. (P. < .01) N. S. Not significant.

TABLE 3

TABLE OF COEFFICIENTS

Name of the state	Total landings			Prawns			Pelagic			Mechanised		
	rs	r	b	rs	r	b	rs	r	b	rs	r	b
West Bengal	0.0667	0.3186	0.1565	0.6167	0.6153	1.1335	0.90*	0.8687**	2.5608**	—	—	—
Orissa	0.0667	0.0451	0.0222	-0.55	-0.5231	-0.5259	-0.7667*	-0.8172**	-2.12**	0.9167**	0.8599**	4.2367**
Andhra Pradesh	0.4167	0.4474	0.3090	0.15	0.1215	0.0729	-0.65	-0.6843*	-0.7648*	0.8333*	0.8075*	2.0715**
Tamil Nadu	0.3667	0.3567	0.1112	0.5833	0.5238	0 2623	-0.1333	-0.0229	-0.0218	0.50	0.5730	0.5993
Pondichery	-0 8833**	-0.9103**	-0.2270**	-0.6833	-0.7518*	-0.9843*	-0.05	-0.0747	-0.1213	0.80*	0.7749*	2.1963*
Kerala	-0.6667	-0.6667	-0.7011	0.3667	0.3304	0.4050	-0.3083	-0.4496	-0.9735	0.8167*	0.7629	2.0997*
Karnataka	-0.5583	-0.6668	-0.3857	-0.3833	-0.2103	-0.3538	-0.4333	-0.5008	-1.7645	0.6167	0.4432	1.8993
Goa	-0.2833	-0.3758	0.1935	0.9472**	0.7636*	1.3903*	-0.9333**	-0.9186**	-3.6438**	—	—	—
Maharashtra	0.3000	0.2759	0.1670	0.2583	0.2518	0.3378	0.05	0.3397	0.691	0.4667	0.5735	2.1033
Gujarat	0.8333**	0.8775**	0.8468**	0.6833	0.6068	0.7265	0.7833**	-0.8806**	2.9078**	0.7667	0.8203**	2.2927**
All India landings	—	—	—	0.6835	0.5871	0.2165	-0.7417**	-0.8782**	0.9073**	0.9083**	0.9575**	2.1873**

rs = Rank correlation coefficient r = Simple correlation coefficient b = Regression coefficient ** = Significant at 1% level * = Significant at 5% level