V. POPULATION

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5. 1 STRUCTURE

5. 1. 1 Sex ratio

Pradhan (1956) examining the mackerel landings at Karwar from 1948-49 to 1952-53 concluded that the sex composition of the commercial catches during the fishing season was roughly as 45% male and 55% female. Similar qualitative statements regarding sex distribution of commercial landings at various specific centres are available in the annual reports of the Central Marine Fisheries Research Institute. In 1965-66, the sex ratio studies at Cannanore indicated that the proportion of males was slightly higher than females (53.18:46.32) in the adult population. The predominance of males was also seen in Juveniles (modal size 135 mm). In the medium sized fish (modal size 205 mm) which contributed to the bulk of the catch, the sex-ratio was in the reverse order (40.7M;59.3F). In the same year, at Cochin females dominated the catches except for April and September (Central Marine Fisheries Research Institute Annual Report 1966). In 1966-67 season, the sex ratio during the fishing season was found to vary though in some centres was almost equal (Cenrtal Marine Fisheries Research Institute Annual Report 1967). In the first half of 1967-68 season, the sex-ratio of a sample analysed at Karwar showed that females were more numerous. At Mangalore, males were more numerous in the aggregate. Sexes were almost equally represented at Cochin and Cannanore. At Vizhinjam males were predominant in March. In the second half of the year, at Cannanore the females increased to more than twice that of males (Central Marine Fisheries Research Institute, Annual Report 1968). The above excerpts will show that there is no uniformity in the sex distribution in the commercial catches either among various centres or between various fishing seasons. In the absence of a statistical analysis of data collected at different centres in different seasons, it is difficult to arrive at any firm conclusions. It is necessary that a composite statistical analysis to study the variation in sex-ratio based on data collected at various centres over several seasons should be carried out with particular reference to the size of the fish, the state of maturity of the fish as also the month of capture.

The sex-ratio distribution of samples collected at Cochin over 24 months during 1968 and 1969 was subjected to statistical analysis. The percentages of males as derived from the monthly samples varied from 42.10 to 70.00. But statistical analysis did not show significant departure from the 50:50 ratio among males and females. Similarly, the sex distribution among different sizes ranging from 115 mm to 235 mm was also studied. The sample ratio of males varied from 28.57 to 75.00, but the overall percentage of males of overall sizes was 51.50. Statistical test of sex-ratio among different size groups did not show any significant departure from homogeneity. Thr observed sex-ration is different size groups were not found to be significantly different from the hypothesis of equality of sex-ratio.

5. 1. 2 Size and age composition

The commercial fishery begins to exploit mackerel from about a size of 18 cm. Fish below this size are also caught in good numbers in some places. The following table summarises the percentage of fish of different sizes caught at various places.

Percentage of fishes caught in various size groups

Place	Up to 18 cm (upto 6 months)	18-22 cm (6-12 m)	22-24 cm (12-24 m)	24-26 cm (24 m & above)
1. Karwar (Average of 1948-49 to 1965-66)	4.19	74.12	19.53	2.16
2. Mangalore (1958-59 to 1965-66)	31.01	52.34	14.99	1.66
3. Cannanore (1960-61 to 1965-66)	47.08	49.39	3.45	0.08
4. Calicut (1957-58 to 1965-66)	24.89	66.39	8.60	0.12
5. Cochin (1962-63 to 1966-67)	79.90	18.76	1.32	0.02

It will be seen from the table that about 80-90 per cent of fish in the commercial catch comes from size below 22 cm. The size groups above 22 cm contribute a small portion in the commercial catch. Several interesting facts emerge if the data are carefully examined. The contribution of fish below 18 cm in the commercial catch in Cochin was the highest and that in Karwar was the lowest. In general the percentage of fish below 18 cm in the commercial catch was higher in Kerala than in Mysore. The very high percentage of below 18 cm fish in Cochin catch may be due to the use of small meshed "Thangu vala". The preponderance of below 18 cm fish in Kerala State as a whole may be due to the early appearance of juveniles in these waters. The season in Karwar starts 2-3 months later than in the south and this may explain the low percentage of 10-18 cm group in the catch. The percentage of above 22 cm fish in Mysore catch is higher than in Kerala. On the assumption of only one stock contributing to the fishery both in Kerala and Mysore, it is difficult to explain this divergence. If, however, Mysore stock is different, the above fact can be explained in terms of differential mortality arising out of the fact that fishing starts at a higher size in the State. It is necessary to study if there are more than one stock contributing to the mackerel fishery in the west coast of India.

Regarding age and size relation, there are divergent opinions. If it is assumed that the fish attains a size of about 22 cm in the first years of its life, it will be seen that the major contribution to the commercial catch comes form the 0-year class. The 1-year and 2-year classes contribute progressively less. Hence the prospect of a fishery in any year will mainly depend on the strength of availability of the 0-yeear class. It will not be out of place here to note that the assumption of very fast growth in the early part of the life of the fish so that it attains a length of 22 cm at 1-year will be in accordance with the fact that less number of below-18 cm fish are caught in Karwar where the fishing starts 2-3 months later-this interval allowing the fish to grow beyond 18 cm size.

5.2 SIZE AND DENSITY

5. 2. 1 Average size

If F is the fishing mortality in any year, and Y_w is the yield (by weight), then $\frac{Y_w}{F}$ will estimate the average stock in weights or average biomass of the fish stock during the year. Similarly, if Y_n is the yield in numbers $\frac{Y_n}{F}$ will represent the average size of the stock in numbers. The fishing morality F is assumed to be proportional to fishing intensity i.e. F=qf where f is the fishing intensity and q is a coefficient of proportionality called catchability coefficient. Thus catch per unit of fishing intensity is proportional to the average abundance of stock (either in number or in weight). Thus if an estimate of the catchability coefficient q is obtained, estimates of F for different years can be obtained, based on which the average stock size or average biomass of the stock in different years can be obtained. There are no published materials regarding such studies. The main reason for paucity studies may be due to the employment of several types of gear, leading to difficulty in arriving at estimates of effort in terms of some standard unit. The fact that rampani net forms the major gear in the exploitation of mackerel in the Mysore waters while various types of boat seines and gill nets are used in the Kerala waters without much overlapping makes the problem of standardization of effort a formidable one.

Even if it is possible to get estimates of effort in standard units, it is doubtful whether for a pelagic fish like mackerel which is exploited only when it is available in the inshore waters, it will be correct to determine the size of the stock from the catch and fishing mortality data. The availability of the fish in the inshore waters may change due to several factors and such availability change will introduce serious biases in mortality rates if they are estimated from the catch per unit effort data.

Sekharan (1958) has stated that “The fact that the fishery is supported mainly by a single age-group cannot be explained in terms of selective action of the gear, at least as far as the rampanis are concerned. These nets touch the bottom of the area fished, and their catches include young forms of other species measuring 3-4 cm and even less; similarly, larger specimens having a length of 100 cm or even more have also been recorded from their catches. As there is little intermingling of the age-groups within the range of waters fished during the months October-March, the average catch-per-unit-of effort of a season would perhaps form an index of the relative numerical strength of the year-class concerned. But the availability of the fish in the normal fishing grounds, especially in those situated very near the shore, might be limited by a number of factors. Hence, estimates of the relative numerical abundance of year-classes based on the statistics of the coastal fishery, are, as likely as not, to be correct. On the other hand, the more offshore fishery off Malabar which samples the population more evenly might yield useful data on this point.

5. 2. 2 Change in density

It has been stated in the preceding sub-section that the catch per unit effort is proportional to the true density of the stock. Hence changes in density can be studied by examining the fluctuations in the catch per unit effort figures. But apart from density of stock, many factors like changes in availability may affect the estimates of catch per unit effort. Even in case of some gear like drift net, as the meshes of the net fill up with fish, the chances of capture decrease and so the catch per unit of effort decrease as an index of stock as the density of fish increases. This effect has been named”gear saturation”. Weather conditions and behaviour of fish are also among factors influencing the catch per unit effort. For example, Sekharan (1965) studying the mackerel fishery in Madapam area has shown that the night hauls gave a much higher catch-per-unit-effort than day hauls, though the average length of mackerel in night catches was slightly smaller.

The table below gives the catch per unit effort in various fishing seasons at some of the centres: for reasons stated above, the unit of effort at different centres was different and as such though the data are not comparable between places, they are comparable between different years. The name of the effort unit for each place is also given in the table.

Tables showing catch per unit effort of mackerel

Years (July-June	Catch (kg) per unit effort				
	Karwar (piece of Rampan)	Calicut (Ayilachala vala)	Cannanore (Ayilachala vala)	Mangalore (Pattavala)	Cochin (Thanguvala)
1950-51	46.62	-	-	-	-
1951-52	34.15	-	-	-	-
1952-53	28.13	-	-	-	-
1953-54	31.46	-	-	-	-
1954-55	19.56	41.55	-	-	-
1955-56	10.11	33.87	-	-	-
1956-57	10.67	41.24	-	-	-
1957-58	47.42	48.65	-	-	-
1958-59	31.35	54.37	-	180.69	-
1959-60	-	35.90	-	58.63	-
1960-61	28.90	72.59	101.39	93.08	-
1961-62	2.76	38.49	110.27	100.22	-
1962-63	10.84	103.53	112.59	143.34	21.55
1963-64	11.05	75.70	119.78	108.80	1.30
1964-65	11.94	74.62	153.26	100.54	3.02
1965-66	2.76	75.68	132.90	22.91	5.60

It will be seen from the above table that the catch per unit effort in Karwar was more or less of the same order during the 4-year period from 1950-51 to 1953-54, then it declined during the next three year period from 1954-55 to 1956-57, it again went up in 1957-58 to 1960-61 and then had a precipitous fall in the subsequent years. The trend of fluctuations in the catch per unit effort more or less follows the fluctuations in annual catches given in the following table. However, in other places there is no such correspondence between the catch per-unit-effort and the relevant regional catch. It is necessary to investigate whether the introduction of nylon nets displacing all other types of indigenous gear of cotton fibre on the Kerala and South Mysore coasts has been instrumental in increasing the efficiency of the nets thereby inflating the catch-per-unit-effort. It is needless to emphasize that in studying changes in stock density, it is necessary to take into account any changes in the efficiencies of the gear due to improvement in design or fabricating material so that catch-per-unit-effort can effectively be considered as indices of stock density.

Table showing State-wise landings of mackerel (m.tons)

Season: July-June	West coast Kerala	Mysore	Maha-rashtra	Total	East coast total	Grand total
1950-51	51,998	15,035	3,099	70,132	1,987	72,119
1951-52	71,852	36,147	9,523	117,522	3,664	121,186
1952-53	15,337	36,737	11,685	63,759	554	64,303
1953-54	5,541	36,421	11,938	53,900	472	54,372
1954-55	8,938	13,699	4,258	26,895	1,302	28,197
1955-56	4,252	12,466	4,044	20,762	2,498	23,260
1956-57	12,784	5,552	4,724	23,060	2,608	25,668
1957-58	38,350	63,320	1,597	103,267	1,238	104,505
1958-59	59,256	73,792	7,729	140,777	1,105	141,882
1959-60	9,744	15,038	316	25,098	3,877	28,975
1960-61	42,479	77,723	12,443	132,645	2,374	135,019
1961-62	8,321	7,129	22	15,472	8,629	24,101
1962-63	14,424	12,441	1,974	28,839	1,820	30,659
1963-64	47,493	19,115	4,612	71,220	6,397	77,617
1964-65	16,873	19,480	2,807	39,160	2,179	41,339
1965-66	9,191	3,971	9	13,171	3,139	16,310
1966-67	10,470	6,510	180	17,160	6,784	23,944
Avarage	25,135	26,740	4,762	56,637	2,978	59,615
Percent	42.16	44.85	7.99	95.00	5.00	100.00

5. 3 NATALITY AND RECRUITMENT

The data on the relative strength of the various size groups in the commercial catch are available for two centres in Mysore State and three centres in Kerala. But data on relative strength of various size groups for the entire range of fishery are not available, obviously because of the difficulty of obtaining estimate of effort for the whole region in terms of standard unit. On the basis of current opinion of age-size relation, the data on relative abundance of size groups available for the five centres could be expressed as relative abundance of various age groups. As fluctuations in the commercial fishery are mainly caused by changes in the abundance of the 0-year class, correlation between the abundance of the newly recruit class and catch would not be much helpful towards predicting fishing success. It is, therefore, necessary to undertake detailed studies on the abundance of pre-recruit phase which will ultimately influence the natality and the recruitment in the exploited phase. Another avenue of studying the recruitment problem lies in finding out the relationship between parent stock and subsequent recruitment –one of the hardest problems in fisheries biology to solve. Two sorts of data required are lacking viz., (1) long-term series of estimates of stock and recruitment, and (2) a range of measures of larval and juvenile mortality at sea. Both sets of data are required to understand the nature of compensatory mechanism. It is likely that the essence of the mechanism is a form of density-dependent mortality. A proper understanding of this mechanism can only explain the fluctuations in the recruitment in the exploited phase.

5. 4 MORTALITY, MORBIDITY ETC.

Banerji (1967) has shown that in spite of variations in the levels of abundance of mackerel from year to year at Karwar, the instantaneous rate of decrease remains constant. Since the mackerel fishery depends mainly on one age group, this furnishes an estimate of instantaneous total mortality, the best estimate of which was found to be 0.64 on a monthly basis. Since the fishing season is for a period of 6 months only, the estimate for instantaneous annual mortality rate will be about 2.64. Based on the relative abundance of various age groups in the commercial catch at Karwar for the period from 1948-49 to 1965-66, Banerji and Krishnan (MS) has estimated that the annual instantaneous mortality rate varied from 0.86 to 4.55 with an average of 2.06 which is not far from the estimate obtained by Banerji *(op. cit)* earlier by a different method. By plotting the annual estimates of annual mortality rates against annual effort, Banerji and Krishnan *(op. cit)* obtained the estimates of natural mortality rate as 0.65. These estimates are only tentative and have to be compared with similar estimates to be obtained from the data of other centres.

Instances of mass mortality of mackerel are not recorded though one such doubtful reference relates to the reports of enormous quantity of mass mortality in the Arabian Sea between 55-70^{0}E and 10-25^{0}N in 1957 and 1958. It was estimated that the quantity involved was over 20 million tons of fish. Jones (1964) has listed the various reports from commercial ships regarding this phenomenal mass mortality of fish in the Arabian Sea and considering the size and the area of occurrence of the reported mass mortality, he is of the opinion the fish involved might have been juvenile tunas, though according to Kesteven quoted by Prof. S. Rass of the Institute of Oceanology, Academy of Sciences U.S.S.R. in personal communication to Jones, the fish involved might have been *Rastrelliger* or *Scomberomorus*

5. 5 DYNAMICS OF POPULATION

5. 5. 1 Population parameters

One of the fundamental problems is to determine the effect of fishing on the fish stock and to determine level of fishing intensity that will fetch the maximum yield on a sustainable basis. This leads to deriving mathematical model linking yield to various population parameters of growth, recruitment, natural and fishing mortality rates. Having obtained estimates of parameters of growth and natural mortality either from data on catch and effort or from capture-recapture data, the curve for yields-per-recruit in relation to variation in fishing mortality is drawn from which estimates of maximum yield per recruit corresponding to associated level of fishing mortality is obtained.

Work on estimation of the various population parameters has just been initiated with regards to mackerel. By considering the monthly length frequency distributions of fish samples at different places from data collected over several years, and plotting the modal values of different broods in a sequential order, it has been possible to obtain the average size attained by the fish at the end of sucessice months of the life of the fish. Fitting Bertalanffy's growth equation to these data, Banerji and Krishnan (MS) obtained estimates of the three parameters, 1_{oo},k and t_o for the five centres as follows:

Place	Estimates of growth parameters		
	l_{00} (mm)	k	t_0 (months)
Cochin	222	0.40	+0.85
Calicut	233	0.26	-0.06
Cannanore	226	0.36	+0.64
Mangalore	228	0.42	+1.85
Karwar	229	0.41	+2.03
West coast	235	0.26	+0.35

The analysis of covariance showed that there was no significant difference among the growth equations obtained from the data of five centres and a pooled growth equation for the west coast was obtained. The estimates of the parameters in the pooled growth equation are also given above.

It has already been stated that the natural mortality M has been estimated at 0.65. Taking the minimum age of capture at 0.25 years, Banerji anf Krishna (MS) has found that maximum yield per recruit will be obtained at effort corresponding to the fishing mortality rate of F=1.55 as compared to the currently employed average intensity corresponding to F=1.40. This shows that we are almost exerting the maximum effort and are nearer to the optimum yield and further increase in fishing intensity in the inshore fishing area exploited at present may fetch only marginal increase in catch.

In this connection reference may be made to Banerji and Chakraborty (1965) who defined the ratio of unweighted index of abundance to the weighted index of abundance to be a measure of fishing efficiency and have shown that the regression coefficient of unweighted index to the weighted index provides the best estimate of fishing efficiency. By using catch per unit of effort data from Karwar from 1948-49 to 1958-59, they have shown that the fishing efficiency was not significantly better than what would have been in the case of random fishing. Discussing if this inefficiency is due to the inability of the fishermen to detect the periods of high abundance and exploit them at the time or due to some other reasons, the authors attributed this inefficiency to inadequacy of transport,marketing facilities and other economic factors. This would indicate the bias introduced in taking catch per unit effort as index of stock abundance and in using it in estimating mortality rates, This aspect needs further investigation.

5. 5. 2 Length-weight relationship

The total instantaneous mortality rates are estimated by comparing relative abundance of consecutive age-groups in adjoining years. The relative abundance of various age group is generally obtained from the

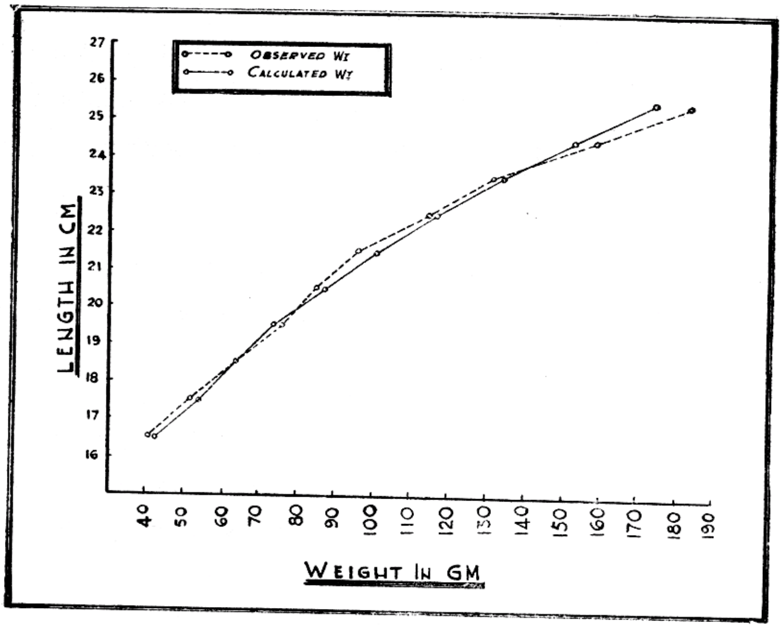

Fig. 7. Length-weight relationship of ***Rastrelliger kanagurta*** (Reproduced from Pradhan, 1956).

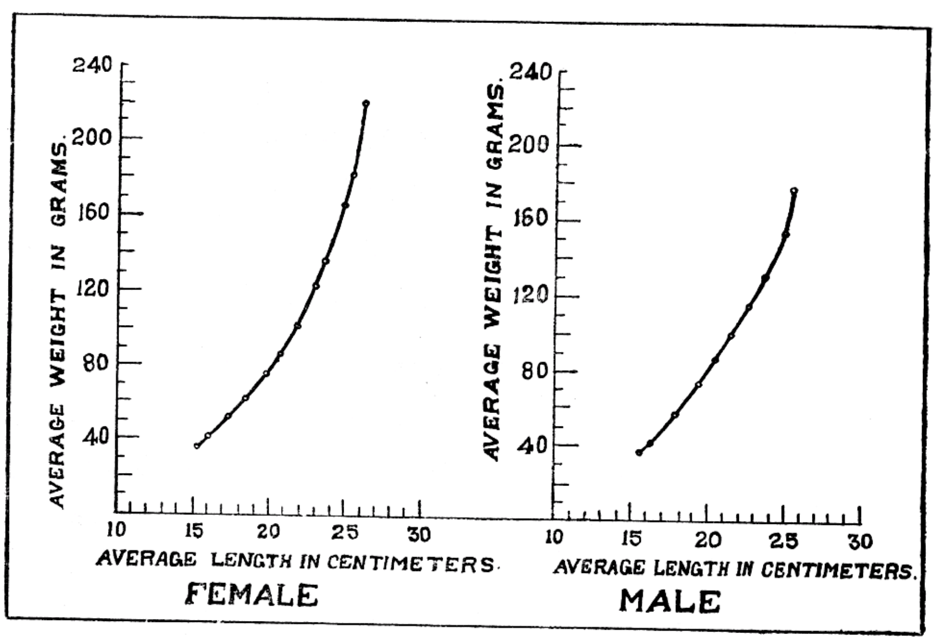

Fig. 8. Average observed length and weight of ***Rastrelliger kanagurta*** for male and female (Reproduced from Pradhan, 1956).

relative abundance of various size groups. As the commercial catch is generally given by weight, it is necessary to convert them into numbers for the purpose of estimating the relative abundance of various size groups. A general relation between length and weight is useful for the purpose. Often statistical studies are necessary to find out if there are significant difference between the relations obtained in different areas or in different years.

Sometimes the length-weight relationship studies have been profitably used to discriminate between different independent stocks.

Pradhan *(op. cit)* on the basis of a sample collected at Karwar between 1948-49 and 1952-53 of 1250 specimens of mackerel ranging in size between 12 and 26 cm total length obtained the length-weight relation as $W= 0.005978\ L^{3.1737}$. He did not furnish the standard error of the estimates of two parameters in the length weight relation (Fig. 7 & 8).

Sekharan *(op. cit)* studying the mackerel in Mandapam area gave the following relations in respect of day and night landings.

Day: $\text{Log } W= \bar{6}.2161 + 3.3390\ \text{Log}^{L}$

Night: $\text{Log } W= \bar{6}.5662+3.1571\ \text{Log}^{L}$

He also showed that there is no significant difference between the two relationships. Jones and Silas (1964b) obtained for Andaman mackerel *R. kanagurta* the relation as $\log W=\bar{6}.4610 + 3.3087\ \log^{L}$.

5.6. IDENTITY OF SUBPOPULATION

A species can comprise a single stock or a number of stocks. Each stock has often a fixed spawning ground with a specific spawning season and probably a consistent migratory circuit. Spawner of one stock does not leave the stock or join others from other spawning grounds to any great extend from year to year. From the point of fisheries management, identification and delimitation of constituent stocks of a species is very important in as much as different fishing intensities may be employed to different stocks, resulting in varied management policies for the individual stocks. Practically no attempts have been made so far to find out if the mackerel fishery on the west coast of India is based on a single homogeneous stock or on a number of independent stocks. A programme of takning exhaustive measurements on a number of morphometric characters and counts on meristic characters on samples of fish from different localities was undertaken in the Institute several years back. No publications on the statistical analysis of these measurements are, however, available. If the voluminous data collected are subjected to statistical analysis by employing discriminatory or distance functions, the results will be interesting. The small amount of recoveries made from the large scale tagging and liberation of mackerel during 1967-68 show that all the recoveries were made around the centres of liberation and not a single instance of interzonal recovery was made a phenomenon that would tend to indicate the existence of a number of independent and discrete stocks, though categorical assertion on this would not be justified based on the very small number of recoveries (Prabhu and Venkataraman, 1970). Apart from capture recapture data and statistical analysis of morphometric and meristic characters, biochemical methods can also be profitably employed in differentiating stocks.

5. 7 RELATION OF POPULATION TO OTHER FISHERIES

It is well-known that the geographical range as well the fishing season of the mackerel and oil sardine fishery o the west coast of India broadly coincide and the two fisheries form the mainstay of the pelagic fisheries of the west coast. In the beginning of this century, Hornell (1910b) observed that the fishing success of the one species is inversely correlated with that of the other in the sense that scarcely ever both the species were abundant in the same year and a good year for one generally coinciding with an unsuccessful fishery for the other. Nair and Chidambaram (1951) on the basis of landings data of 24 years from 1925-26 to 1948-49 complied from fish-curing yard records agreed with Hornell regarding the existence of an inverse relationship between the fishing success of these two fisheries.

The following table furnishes the estimated landings of mackerel and oil sardine separately for Kerala and Mysore from the 1950-51 to 1968-69 seasons (based on Central Marine Fisheries Research Institute survey).

Comparative figures of landings (tonnes)
of mackerel and oil sardine in Kerala and Mysore

Season	Kerala		Mysore		Kerala-Mysore	
	Mackerel	Oil sardine	Mackerel	Oil sardine	Mackerel	Oil sardine
1950-51	51,998	12,442	15,035	1,643	67,033	14,085
1951-52	71,852	19,545	36,147	1,855	107,999	21,398
1952-53	15,337	27,664	36,737	10,201	52,074	37,865
1953-54	5,541	19,519	36,421	2,762	41,962	22,281
1954-55	8,938	41,306	13,699	6,648	22,637	47,954
1955-56	4,252	14,196	12,466	837	16,718	15,033
1956-57	12,784	20,175	5,552	2,141	18,336	22,316
1957-58	38,350	243,393	63,320	5,746	101,670	249,139
1958-59	59,256	74,949	73,792	542	133,048	75,491
1959-60	9,744	32,163	15,038	2,970	24,782	35,133
1960-61	42,479	260,508	77,723	2,734	120,202	263,242
1961-62	8,321	91,181	7,129	6,006	15,450	97,187
1962-63	14,424	115,644	12,441	10,091	26,865	125,735
1963-64	47,493	47,241	19,115	8,523	66,608	55,764
1964-65	16,873	281,548	19,480	77,742	36,353	359,290
1965-66	9,191	157,930	3,971	40,261	13,162	198,191
1966-67	10,470	233,614	6,510	53,841	16,980	287,455
1967-68	4,216	204,318	14,944	11,414	19,160	215,732
1968-69	3,877	235,545	5,784	68,682	9,661	304,227
Average	22,916	112,257	25,016	16,560	47,932	128,817

In comparing the failure or success of a fishery, it is necessary to fix some yardstick which will provide the basis for such measurement. One such yardstick is provided by the average annual catch of each species. On the basis of this yardstick, if we compare the annual landings of mackerel and oil sardines in Kerala for the 19 years period, we find that out of 19 years, there were two years when both oil sardine and mackerel landings were above annual average; and 7 years when the landings of the species were below annual average; in the remaining 10 years the mackerel landings alone exceeded the annual average in 4 years and the oil sardine in 6 years. In Mysore, out of 19 years, the landings of both the species in 9 years were below their respective annual average catches, while in 6 years the mackerel landings exceeded the annual average and in 4 years the oil sardine landings exceeded its annual average. Taking both States together, we find that there were 7 years when the landings of both the species were lower and 2 years when the landings of both were greater than their respective annual average and in the remaining 10 years, the mackerel landings were better than average in 5 years and oil sardine landings better than average in another 5 years. Thus measured against the yardstick of annual average, no definite inverse relationship in the fishing success of the two species as averred earlier was discernible. Only in about half the number of years, there are indications of inverse relationship. Since the range of variability of the annual landings of the two species may differ, it may be argued that he variability also should be taken into consideration along with average in providing a yardstick for comparison. This is done by dividing the difference of a year's landing from the average by the standard deviation. Comparing the two sets of transformed data thus obtained, no significant negative correlation was obtained to sustain the hypothesis of inverse inter-relationship between the abundance of the two species.

The annual catch of both the species exhibits wide fluctuations. In case of mackerel, the annual landings varied from 9,661 to 133, 048 tonnes with an average of 47,932 tonnes. The coefficient of variation is about 81%. In case of sardine, the annual landings varied from 14,085 to 359,290 tonnes with an average of 128,817 tonnes and coefficient of variation of about 86%. Thus in both the fisheries the magnitudes of variations are more or less of comparable order at least for the 19 year period from 1950-51 to 1968-69. Since the magnitude of variations are of comparable order, if clear-cut inverse relationship between the annual landings was found, one would have easily explained the phenomenon in terms of competing species in a multiple fishery eco-system. Eventhough this aspect of competition cannot be ruled out altogether, probably many other factors interact to cause such variations in abundance of the two species that could not be explicitly expressed in terms of simple inverse inter-relationship.