Management of Scombroid Fisheries

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The resources of the Indian mackerel – characteristics, exploitation and future prospects

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ABSTRACT

The Indian mackerel contributed to an annual average (1993-'99) catch of 2.17 lakh tonnes (t). The west coast landed about 80% of its total catch and remaining by the east coast. The resource is rich in upwelling areas of the west coast with a catch contribution of 38.68% from Kerala followed by Karnataka and Maharashtra. The fishery is characterized by annual fluctuations in the catch ranging from 0.14 lakh t in 1968 to 2.9 lakh t in 1989. The annual fluctuations do not show any pattern; whereas the decadel trends show a cyclic pattern of ups and downs. The fluctuations are more pronounced along the upwelling areas of the west coast. In 1990s, there was a quantum leap in the annual catch chiefly due to the introduction of large seine nets and motorization of country crafts. The increase was maximum in Kerala, moderate in Maharashtra and poor in Karnataka. Along the east coast also fishery showed considerable improvement. Of late, the role of trawl net in the mackerel fishery is gaining importance. The surface fishery using large seines along the upwelling areas seems to depend very much on the intensity and duration of upwelling which is perhaps causing the fluctuations in catch rather than the variations in the abundance of the resource. The behaviour of the fish to ascend with upwelling and spreading to deeper waters with sinking of thermocline seem to control exploitation and protect the resilience of the stocks. Perhaps the richness of the resource is much stronger than hitherto believed. With proper management the production can reach further heights.

INTRODUCTION

The Indian mackerel, *Rastrelliger kanagurta* is the most important fishery resource of India especially in the context of national food security. This species supplies the maximum quantity of protein rich food from the sea. It is highly nutritious and affordable even to the poor. During the period from 1993 - '99 the annual average catch has reached 2.17 lakh t forming 8.9% of the total marine fish catch. Though recently small quantities were exported to the Middle East, the Indian population is consuming bulk of the catch of this fish in fresh condition. Mackerel fishery is characterised by its annual fluctuations. This paper is an attempt to study the status of the present exploitation of this resource.

FISHERY AND BIOLOGY

Catch trends

The annual total catch varied from 0.14 lakh t in 1968 to 2.9 lakh t in 1989. There were peaks in 1951, '58,'60,'63,'65,'71,'78, '89, '93,'96

and '99 and troughs in 1956, '59, '62, '64, '68, '74, '82, '91, '95, and '98 (Fig.1). On an average the west coast contributed 84.7% of the catch and the east coast 15.3%. As the catch along the east and west coast was highly unequal, to make the fluctuations comparable the percentage annual contribution to the total catch of the west coast for the period is shown against the similar data from east coast in Fig.2. In many years the peaks and troughs in the annual catch along the west coast is matched by a reverse situation along the east coast. In spite of these fluctuations the general trend in catches was that of increase. On an average the annual catch was increasing at the rate of 3,485 t per year, 2,566 t of which was contributed by west coast and 919 t by east coast. Considering the average annual catch from both the coasts the rate of increase along the east coast has to be considered as the little faster.

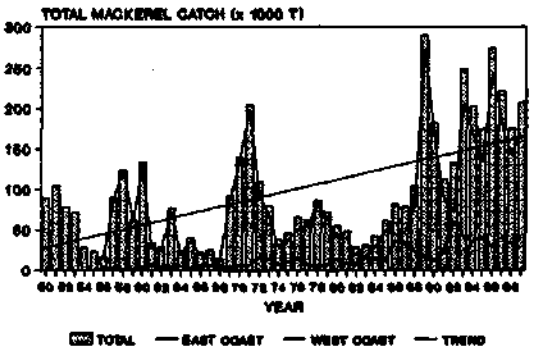

Fig 1. Annual variations in mackerel catch during 1950-'99 period.

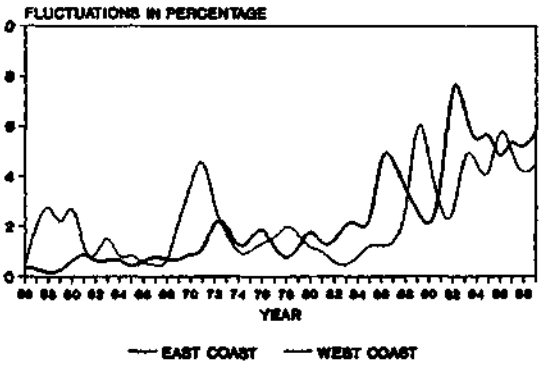

Fig. 2. Percentage of mackerel catch on the east and west coast of India during 1956-'99.

The annual average catch during different decades gives a clear cyclic pattern of peaks and troughs with a general trend of increase. The increase in catch during 90s was phenomenal. The pattern of decadel total catch fluctuations is seen in the catch along the west coast also. The cyclic pattern of fluctuations is observed only along the west coast. Along the east coast the increase in catch was steady.

Table 1 gives the minimum and maximum annual catch during different decades and the percentage of minimum catch in the maximum catch. The highest percentage is observed in 90s indicating that the intensity of fluctuations has reduced.

Table 1. Maximum and minimum annual catch (t) during different decades and the percentage of minimum catch in the maximum catch.

Decades	Minimum	Maximum
50s	16214	123271
(%)	(13.15)	(100.00)
(year)	(1956)	(1958)
60s	14,483	133,647
(%)	(10.84)	(100.00)
(year)	(1968)	(1960)
70s	37,424	204,553
(%)	(18.30)	(100.00)
(year)	(1974)	(1971)
80s	27,652	290,159
(%)	(9.53)	(100.00)
(year)	(1982)	(1989)
90s	112,868	274,135
(%)	(41.17)	(100.00)
(year)	(1991)	(1996)

State-wise trends

The condition of the fishery in different fishing areas during 1956-'99 was studied. Of the average annual catch of 1.01 lakh t, 38% was contributed by Karnataka and Goa, 37% by Kerala, 9% by Maharashtra and Gujarat, 9% by Tamilnadu and Pondicherry and 1% by West Bengal and Orissa. In all the areas the trend of catches showed an increase. The annual average increase in catch in different areas are given below:

States	Increase (in tonnes)
Kerala	1,305
Karnataka & Goa	658
Maharashtra & Gujarat	604
Tamilnadu & Pondicherry	478
Andhra Pradesh	416
West Bengal & Orissa	25
Total	3,486

It is noteworthy that though Karnataka and Goa contributed maximum to the total catch, the annual rate of increase was much higher in Kerala. The general increase in the catch of mackerel observed along the west coast during 90s was not very marked in the Karnataka-Goa region.

There was a general increase in the catch of mackerel from 1989 onwards. The annual average catch of different regions during the eleven year period from 1978-'88 is compared to that of 1989-'99 and the increase in catch from the first period to the second is given below:

Regions	Increase (in tonnes)	%
Kerala	59,240	42.2
Karnataka & Goa	37,097	26.4
Maharashtra & Gujarat	26,039	18.6
Tamilnadu & Pondicherry	11,446	8.2
Andhra Pradesh	6,436	4.6
West Bengal & Orissa	2	-
Total	140,260	

Present exploitation

The annual total catch of mackerel along the Indian coast during the years from 1991-'99 fluctuated from 113,675 t in 1991 to 275,694 t in 1996 with an average catch of 196,460 t. Though the catch fluctuations are still there the intensity is much reduced. West coast accounted for 79.9 % of the catch while the contribution by east coast was only 20.1 %. Notwithstanding the fluctuations the general trend is that of increase. It is estimated that on an average the annual increase was 8,817 t during the period. This increase is contributed by the fishery along the west coast where the estimated annual average increase was 9,157 t, 405 t of which was offset by a decline along the east coast.

With a catch of 77,363 t Kerala stands first followed by Karnataka (32,998 t), Maharashtra (27,323 t), Tamilnadu (18,476 t), Goa (17,784 t), Andhra Pradesh (16,231 t) and Pondicherry (2,403 t) (Fig. 3). Contribution by other states was negligible. The average state-wise annual catch per km of coastline and per 1000 sq.km of shelf area shows that the intensity of exploitation was high in Kerala-Karnataka-Goa area. The coastal waters of Kerala, Karnataka, Goa and Maharashtra to-

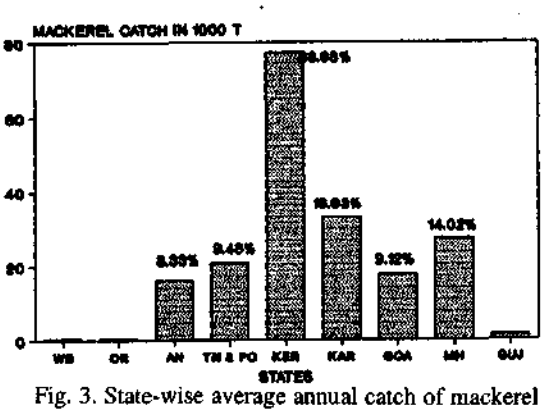

Fig. 3. State-wise average annual catch of mackerel during 1991-'99.

gether accounted for 79 % of the catch indicating that the west coast is more productive than the east coast. Better catches are made from south. Along the east coast also, southern area is more productive than the north.

Along the west coast the maximum annual average increase (4,129 t) is noted in Kerala followed by Maharashtra (3,226 t), Karnataka (2,208 t) and Gujarat (389 t). In Goa, there was a decline of 796 t. Along the east coast the major decline was in Tamilnadu where the annual average decline was 588 t followed by Andhra Pradesh (48 t) and Orissa (20 t). In Pondicherry and West Bengal there was an annual average increase of 137 t and 114 t respectively.

These observations indicate that the upwelling areas of the south-west coast are the rich grounds for the mackerel fishery, Kerala being the richest followed by Karnataka, Goa and Maharashtra. Along the east coast also the catches are better towards south.

Gear-wise catch

Fig. 4 gives the average gear-wise contribution to annual mackerel catch in India during 1991-'99. It can be seen that large seines like purse seine and ring seine contribute 62.27% of the catch. Such seines are operated only along the west coast from Maharashtra to Kerala. In Maharashtra, Goa and Karnataka purse seines dominate the mackerel fishery contributing 79.7%, 96.4% and 79% of the total mackerel catch of these states respectively. In Kerala, purse seines are operated only in Cochin and the dominant gear in the state is the ring seine, which contribute 68.4% of the total mackerel catch.

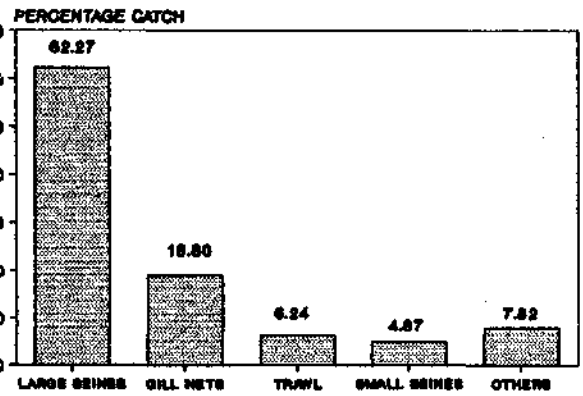

Fig 4. Gear-wise contribution of mackerel catch during 1991-'99.

The contribution by gill nets amounts to 18.8%. Gill nets are operated for mackerel all along the west coast and east coast of India and the gear dominates the fishery along the east coast from Orissa to Tamilnadu. The contribution by the gear is 63.7%, 67.1%, 34.8% and 40.8% in Tamilnadu, Pondicherry, Andhra Pradesh and Orissa respectively. The gear stands second in importance in Gujarat (43.3%), Goa (1.5%), Karnataka (10.9%), Kerala (14.2%) and West Bengal (25.6%).

Trawl net is the next important gear with a contribution of 6.2%. It dominates the fishery in Gujarat and West Bengal with a contribution of 56.4% and 74.4% respectively. In Maharashtra and Tamilnadu it is the second important gear with a contribution of 8.1% and 8.2% respectively. Mackerel is a by-catch in the trawl fishery all along the east and west coast of India. The contribution of this gear to the mackerel fishery has increased considerably in all the states in 1990s.

With the introduction of large seines, small seines like boat seines and shore seines which dominated the fishery till mid-70s lost its importance and subsequently in 1990s the gear contributed only 4.9 % of the total mackerel catch. Only in Pondicherry the gear contributed substantially (32.6%) to the catches.

Evolution of the Fishery

Till recently the exploitation of the resource was mainly restricted to the upwelling areas of the southwest coast of India during post monsoon period. The exploitation was by small surface gears like shore seine, boat seine and gill nets made of cotton or hemp. Being made of hemp or cotton the mesh size of the gears was large (around 30 mm). Oars using human physical labour propelled the crafts. The effective area of exploitation was restricted up to 20 m-depth zone. Landing facilities were poor and hence fishing was not possible during rough weather.

In late 70s purse seines operated from large mechanised boats were introduced. Early 80s saw a series of changes in the indigenous fishery. The crafts were motorised with outboard engines. This development revolutionized the indigenous fishery for mackerel. The oars were discarded and the newly acquired speed of fishing facilitated longer time for fishing and exploitation from distant waters. Fishers became bolder to go for fishing even in bad weather. Design of the country crafts changed for better use of outboard engines. In the middle of 80s ringseines were introduced in Kerala which soon made the earlier gears obsolete. With the introduction of nylon fibres in net making in the early 90s the gears became lighter and larger and the mesh size smaller. Fisheries harbours and jetties were constructed which gave safe landing facilities even during bad weather. Trawling also spread to deeper areas catching abundant quantity of mackerel from deeper areas. As a result the mackerel catches increased even during summer. Exploitation spread in space and time. The traditional season of mackerel fishery expanded to throughout the year.

Biology

Present knowledge on the biology of the Indian mackerel is summarized below. The most successful spawning of the fish along the west coast takes place around May. By July when they are about 10 cm long they form large shoals at the surface waters near-shore. The fish is a plankton

feeder. They increase in abundance in the surface waters till September/ October, declining subsequently when they start moving down to deeper waters. From November to February they move up to the surface in the night. After February they seldom move up to the surface. As the summer advances they move deeper and deeper and loose the compactness of the shoals and live more or less diffused in the deeper waters beyond 40 m depth area. In the mean time they mature.The fish is a prolific breeder. A single fish spawns continuously many times in a season. Spawning starts by February when they are about 9 months old. It intensifies by May, when they are one year old and measure around 23 cm and continues till July. This spawning produces the most successful broods that will support the fishery in the ensuing season. There is a subsidiary spawning in September/October producing some weak broods.

The effect of environment on the biology of the fish

One major factor that influences the biology of the fish is upwelling and the resultant plankton bloom. Upwelling of the bottom water along the west coast starts by about March. The thermocline reaches almost the surface during June-September. Upwelling of this nutrient rich bottom water produces a bloom of phytoplankton at the surface waters. The products of spawning in May will be able to exploit this plankton bloom and produce a strong year class. Mackerel cannot move below the thermocline and during upwelling period they will be locked in the reduced upper mixed layer where food is also plenty. This situation causes the formation of large shoals in the surface waters. As the food are plenty they grow very fast. After October when the thermocline starts sinking mackerel spreads to deeper waters. As the availability of plankton declines the shoals get diffused. Then the maturation sets in. Reduced availability of plankton and the strains of maturation reduce the growth rate considerably. When the availability of plankton increases by next April the growth rate also increases again. The egg production also increases.

Exploitation pattern in relation to environment

Upwelling areas of the west coast are the rich grounds for the exploitation of the Indian mackerel. Abundant plankton produced as a result of upwelling sustains the resource. The traditional hectic exploitation of the resource using surface gears was during the post monsoon from August/ September to October/November. With the recent developments in the exploitation technology and the availability of fishing ports facilitated fishing operations even during monsoon and intensive exploitation by surface gears often starts much early by June/July. The availability of mackerel shoals in the surface waters of the upwelling area is closely related to upwelling. The traditional season of exploitation of mackerel along the west coast was during the post monsoon months using surface gears. This is strongly related to the environmental conditions. The juveniles of mackerel are highly vulnerable to surface gears during upwelling as they are locked in the shallow

upper mixed layer. By October/November as the thermocline starts sinking the exploitation by surface gears will be restricted to night as the fish moves up to the surface. The fishing will also be shifted to deeper areas. By February, the fish will move down deeper beyond the operational range of the surface gears and the surface fishery comes to an end. Recently with the spreading of trawling to deeper areas using the high opening trawl nets, especially along the Kerala coast, considerable quantity of mackerel is caught during this season. The trawl catch of mackerel often go on increasing till the next monsoon and along the Kerala coast the summer catches of mackerel by trawls are equally abundant as that of surface gears during the post monsoon.

It is indicated that the fish prefers to stay immediately above the thermocline and hence it moves with the thermocline. The earlier fishery could not follow the movements of mackerel due to technical limitations and hence the fishery was highly seasonal as it was limited to the period of their availability in the surface waters. During the upwelling period concentration of the shoals will be high in the surface waters because of the abundance of plankton and shallowness of the upper mixed layer. During sinking they spread to wide areas and lose the compactness of shoals.

Along the east coast the exploitation is high during December to May. Normally the catches reach a peak by March. The period corresponds with the increase in salinity with the entry of high saline equatorial waters into the Bay of Bengal, low temperature due to winter cooling and the increase in temperature interfered by upwelling during April-May.

Many earlier studies on the population dynamics and stocks of mackerel have concluded that maximum pressure was being exerted on the resource and further increase in effort may not produce better yield (Banerji, 1973; George *et al.*, 1977; Devaraj *et al.*, 1994). But the recent spreading of exploitation has increased the catch significantly. Perhaps these studies were biased due to the non-awareness on the behaviour of the fish and also the limitations in its exploitation at the areas of its seasonal distribution.

The mackerel fishery is notorious for its annual fluctuations in catch. These fluctuations were believed to indicate the fluctuations in their stock abundance. Perhaps these fluctuations were mostly caused by the variations in their catchability. Wide annual variations were observed in the intensity and duration of upwelling (Yohannan and Abdurahiman, 1998). These variations can influence the catchability of the fish and catch or catch rates can not be taken as proportional to the stock. It is proposed that all these characteristics of the fishery will have to be considered while studying the dynamics of the population and the condition of the stock.

PROSPECTS

The recent increase in the exploitation of the mackerel resource in space and time has resulted in a considerable increase of catch and no seri-

ous decline is indicated. Perhaps the resource is much stronger than hitherto believed. It indicates further scope of developments, provided the exploitation is managed properly. Overexploitation of early juveniles during the monsoon is the immediate concern. The major gears used in the mackerel fishery are non-selective with a mesh size below 20 mm. With the increased efficiency in exploitation and the availability of landing facilities the fishing has spread even to the monsoon season. This is the period of abundance of early juveniles and spawners/post spawners in the surface waters. Their catchability is also high during this period. Consequently, a high percentage of these early juveniles are now being exploited. This can cause loss to the fishery in two ways. These fishes are being harvested much before they reach an optimum weight. It is not understood how this will affect the prey-predator relationship in the ecosystem. Plankton feeders are a major link in the energy flow in the ocean. The carnivores cannot utilize the energy directly from plankton. Juveniles of mackerel also form an important prey item for carnivores (Yohannan and Balasubramanian, 1989). The effect of large-scale exploitation of early juveniles of mackerel on the ecosystem is not well understood. Controlling the over exploitation of early juveniles will further improve the catch of this resource as well as that of carnivores.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. Mohan Joseph Modayil, Director and Dr.N.G.K. Pillai, Head of Pelagic Fisheries Division of CMFRI for their constant support and encouragement. We are also thankful to Mr.K.N. Kurup, Head, Fishery Resource Assessment Division of CMFRI for providing the data on mackerel landings pertaining to the study period.

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