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An overview on the present status and future prospects of pelagic finfish resources of India

P P PILLAI[1]

Central Marine Fisheries Research Institute, Cochin, Kerala 682 014

ABSTRACT

The results of the studies on stock assessment made on 11 commercially important pelagic fish groups such as oil sardine, lesser sardines, whitebaits, mackerel, tunas and billfishes, seerfishes, pomfrets, carangids, ribbonfishes, Bombay duck and Hilsa shad based on the data of 1984-88 are presented. Detailed analysis of the production and estimated catchable potential of major pelagic fish groups from the initial stages of mechanization to recent years and in the traditional fishing areas of both the coasts of India are indicated. The species which have reached the optimal level of exploitation and those which hold potential for further exploitation have been described. The results indicated that the stocks of oil sardine, mackerel, tunas, seerfishes, pomfrets and Bombay duck in the traditional fishing grounds are exploited to or beyond their maximum sustainable yield, whereas lesser sardines, whitebaits and allied species, oceanic tunas frequenting the shelf waters, carangids and ribbonfishes have potential for marginal increase. Options open to obtain increase in production to the level of potential estimates are briefly discussed, and the necessity of better post-harvest utilization of these finfishes pointed out.

India, with a coastline of 7 517 km, continental shelf area of 191 972 km^2 between 0–50 m depth, and with an area of 452 060 km^2 between 0–200 m depth zone and possessing 2.02 million km^2 of exclusive economic zone, evince the distribution pattern of pelagic marine fisheries typical of tropical waters. The marine fish production in India, since it began to be estimated by the Central Marine Fisheries Research Institute in 1950, evinced fluctuations and oscillations concomitant with the introduction of improved varieties of gears and craft in the inshore fishery sector. This is evident from the landing data of major pelagic fishes which registered a 1.7-fold increase during 1988–92 compared to the average figures of 1983–85.

Trend of major exploited pelagic fishery resources of India and future prospects

Srinath (1989) and James and Alagarswami (1991) analysed the pattern of development of pelagic fishery based on the data of 1961–85 and 1979–85, respectively. Analysis of the production of major pelagic fish groups from the initial stage of mechanization and during 1988–92 period indicated the trend given in Table 1.

A comparison of the groupwise landings of the important species based on average annual production during 1979–81 and 1982–85 indicated that the groups which increased in production during these years were anchovies and lesser sardines and those decreased were mackerel, Bombay duck and ribbonfishes. However, it was also indicated that anchovies and ribbonfishes have further scope for exploitation (James and Alagarswami 1991).

Purse seines were introduced on a commercial scale in 1977 in Karnataka and Goa, and later in Kerala. Motorization of the traditional craft had commenced during the seventies with plank built boats in northwest coast and southeast coast followed by dug out ca-

Present address: [1]Principal Scientist.

Table 1. Trend in landings of major pelagic fishes

Major Pelagic fish groups	Average landing (tonnes) (1961-65)	(1981-85)	(1988-92)
Oil sardine	173 457	18 2920	19 0378
Other sardines	29 326	6 3069	8 3379
Anchovies and allied species	22 783	5 7073	14 5197
Bombay duck	84 375	11 0064	11 6287
Ribbonfish	24 153	5 0056	8 2910
Mackerel	38 622	4 0595	16 5504
Seerfishes	10 156	3 0206	3 7521
Tunas	4 222	1 7789	4 1236

noes and catamarans in Kerala during eighties. The effort by purse seiners showed about a two-fold increase from 37 880 units of operation in 1981 to 71 050 units in 1982–83. Thereafter, the effort declined to 53 270 units in 1983–84, but picked up to 62 430 units in 1984–85. The catch rate which was 2 987 kg per trip in 1981 declined to 1 616 kg in 1984–85, and further reduction was observed in subsequent years. Similarly, the craft using motorized propulsion showed an increasing trend in effort from 830×10^3 units of operation in 1981 to $1\ 621 \times 10^3$ units in 1984–85, but the landings did not show concomitant increase. The catch rate showed a declining trend in this sector from 410 kg in 1981 to 302 kg in 1984–85. However, in the subsequent years, these two developments have helped to sustain the growth of marine pelagic fish landings to certain extent, although they brought in their wake conflicts between the traditional and mechanized sectors. The traditional and mechanized/motorized craft which employed drift gill nets from the inshore and offshore areas have contributed substantially to the production of pelagic fishes from the exploited 0–70 m depth zone.

The Working Group on 'Revalidation of Potential Marine Fisheries of the Indian Exclusive Economic Zone' has indicated the potential of pelagic fishes as 188 000 tonnes from the northwest coast, 245 000 tonnes from the southwest coast, 61 000 tonnes from the southeast coast, 46 000 tonnes from the northeast coast and 139 000 tonnes and 63 000 tonnes respectively from the Andaman and Nicobar, and Lakshadweep islands in the area of 50–200 m depth zone. The major resources holding potential for future development are anchovies, carangids, ribbonfishes, tunas and pelagic sharks. However, the estimated catchable potential of important pelagic fishes in the 0–50 m depth zone, based on 1980–89 data has been at 976 387 tonnes whereas the average catch of these groups in this depth zone in recent years (average: 1988–92) amounted to 829 036 tonnes. This indicates that the 0–50 m depth zone has reached the optimal level of exploitation confirming that further intensification of effort in this narrow inshore belt would not realize further increase in production. The options left is to exploit the potential resources from the 0–200 m depth zone to augment pelagic fish production by extending the operational range of craft, introduction of combination vessels (drift gill netting and longlining) for multiday fishing, widespread employment of light-luring purse seiners, conversion of trawlers for offshore drift gill net fishery, providing chilling and cold storage facility, and by implementing suitable post-harvest technology for utilizing the products for internal as well as export market.

In the ensuing section, the brief resume of the results of stock assessment of eleven commercially important pelagic fish groups is presented, and the status quo of their rate of exploitation and the future possibilities of the fishery for these species from the traditional fishing areas are discussed.

Oil sardine: The oil sardine, *Sardinella longiceps* Val. is a major pelagic resource in the Indian seas, especially along the south-

west coast. Of late, its emergence as a new fishery along the east coast has been of great significance. The species contributes 15–20% of the total marine fish production of the country and is known for its highly erratic nature of the landings, exhibiting both long-term and short-term fluctuations. During last ten years (1979–88) oil sardine landings ranged from 78 700 tonnes (1986) to 221 000 tonnes (1981) with an annual average catch of 145 000 tonnes. Along the west coast of India, Goa, Karnataka and Kerala recorded the maximum catch (96.5%). Tamil Nadu and Andhra Pradesh along the east coast contributed the rest.

The success of the oil sardine fishery along the southwest coast is mainly depended on the recruitment strength of early juveniles (5–10 cm) during post-monsoon months. Juveniles start appearing in the fishery from late August, and from then onwards they form the mainstay of the fishery in the southern regions. In the northern regions juveniles appear in the fishery from late September.

Oil sardine attains a modal size of 125 mm, 170 mm and 195 mm by the end of 1, 2 and 3 years respectively. The long-term forecast by Thompson and Bell model gave an estimate of MSY as 150 000 tonnes, against a mean biomass of 107 000 tonnes. This indicates that there is scope for increasing the production by 26% by expending a four-fold increase in terms of fishing effort, without affecting the sustainability of the stock. However, this reduces the catch per unit operation by 49%, possibly making the fishery uneconomical. But if the effort input is doubled, then the increase expected in the landings is 21% against a reduction in C/E by 27%. Further, it was evident that the increase in the yield after a 50% increase in effort is insignificant. Hence, increasing the fishing effort to obtain the MSY level is not desirable in the present fishery.

Lesser sardines: The lesser sardine resources comprising of *Sardinella gibbosa, S. fimbriata, S. sirm, S. albella, S. dayi, S. sindensis, S. clupeiodes, S. melanura* and *S. jonesi*, in the order of their abundance, contributed 3.9–5.7% annually to the total marine fish landing in India during 1984–88. Lesser sardine fishery in India during 1979–88 averaged to 69 550 tonnes per annum. Gears such as small meshed gill nets, boat seines, trawls, shore seines and hooks and line landed these species but the gill nets and boat seines contributed maximum. The stock assessment studies carried out on *S. gibbosa* indicate that the yield along the west coast is considerably lower than the MSY, especially in the Kerala region where considerable increase in the present (1984–88) effort is required to achieve the MSY. Along the southeast coast, the present yield is more or less steady.

Whitebaits: The fishery of whitebaits for 1979–88 indicated that the southern maritime states accounted for about 97% of the total whitebait landings in India. *Encrassicolina devisi* and *Stolephorus waitei* are the dominant species in this fishery. The pattern of fishing season indicated that along the southwest coast whitebaits occurred in abundance during July to March and along the southeast coast during October–March and April–December. This resource is chiefly exploited by boat seines (mesh size: 10 mm), gill nets (*Netholi valai* - mesh size: 15 mm), shrimp trawls (mesh size: 15 mm), purse seines (mesh size: 14–18 mm) and ring seines (mesh size: 8 mm) by craft fitted with OBM engine.

Based on Thompson and Bell long-term forecasting model and relative Y/R analyses, it is concluded that scope for increase in the whitebait production from the present level will be marginal. *E. devisi* is poorly exploited

in both the coasts. Studies reveal that a three-fold increase in effort along the east coast and a six-fold increase in effort along the west coast are required to realize the corresponding MSYs with a concomitant increase in the landings by 7.4% and 31.9% respectively. However, in the multispecies/multigear context, this conclusion is impracticable as there is no target fishery for whitebaits alone, and the results reveal only a relative picture of the MSY and the effort to obtain the same.

Mackerel: Indian mackerel is an important pelagic fish resource of Indian coasts. Its catch showed wide fluctuations. The average annual catch was estimated at 73 571 tonnes of which 67.7% was obtained from the west coast and 32.3% from the east coast. At Cochin, Calicut and Mangalore peak catches were obtained during September and at Karwar and at Goa in October. At Vizhinjam, Mandapam and Visakhapatnam peak season was observed in April.

The study on the state of stock of mackerel in its fishery in India revealed that it is almost at the MSY level with an average annual catch of 73 571 tonnes against the MSY of 73 521 tonnes. Further increase in effort would not be effective for it would only reduce the catch. A reduction in effort by 21% would yield almost the same quantity, but this also will not improve economics of the fishery. It is recommended further that large-scale exploitation of young mackerel found along Andhra coast be avoided.

Tunas and billfishes: The tuna catch in India in the small-scale sector fluctuated between 23 170 tonnes and 35 610 tonnes during 1984–88 (average: 29 146 tonnes). There is no organized fishery for tunas in India except the pole and line fishing in the Lakshadweep. Along the coastal waters of the mainland they are caught in the drift gill nets, purse seines, hooks and line and shore seines. The pattern of fishery indicates that pre-monsoon and post-monsoon are productive periods along the southwest coast and post-monsoon along the northwest region, thereby indicating a seasonal shift in their concentration. In Lakshadweep, December–April brings in the maximum catch. The fishing pattern during the monsoon season has changed the scenario of tuna fishery in the Indian seas.

The little tuna *Euthynnus affinis* constitutes the major component, followed by frigate tuna *Auxis thazard,* skipjack tuna *Katusuwonus pelamis* and the longtail tuna *Thunnus tonggol. Auxis rochei* and young yellowfin tuna (*T. albacares*) evince an increasing trend in catch rate concomitant with the expansion of the area of inshore fishery. During the period (1984–88) the catch rates obtained were: gill nets, 9.52–76 kg; purse seines, 85–87 kg; and hooks and line, up to 28 kg. In the pole and line the C/E was 262 kg and 451 kg at Minicoy and Agatti respectively.

Biological studies and estimates of population parameters were carried out for five species. The recruitment pattern indicated two pulses for the little tuna, longtail tuna, frigate tuna and bullet tuna, and only one pulse in the skipjack tuna during the study. The results of analysis indicate that for all the species the exploitation rates (F/Z) range from 0.05 to 0.80. For *E. affinis* a decrease in effort to 66% of the current level would yield 341 tonnes. The present level of exploitation rate for *T. tonggol* is 0.499 with the estimated yield of 623 tonnes. It can be increased by 1.6 time to obtain the MSY of only 642 tonnes. The MSY estimate for *A. thazard* is 4 582 tonnes which can be obtained by increasing the effort by 1.2 times. With respect to *A. rochei,* the MSY of 896 tonnes can be obtained by increasing the effort by 1.6 times. For skipjack the estimated MSY of 4 440 tonnes can be obtained by increasing the effort

by 4.1 times to realize an additional yield of 300 tonnes.

This study indicated that the tuna stocks in the traditional grounds are exploited to the maximum level. Recent reports indicate that after the expansion of the area of operation, the longtail (*T. tonggol*) and yellowfin tunas (*T. albacares*) are the dominant species in the drift net fishery in the northwest sector. With regard to tuna live-baits, the economic utilization and enhanced exploitation of all the species from the northern islands could enhance the tuna production in Lakshadweep.

The options for further enhancing the production include large-scale deployment of fish aggregating devices and effective utilization, management and diversification of fishing operations by introduction of multiday boats with catch storage facilities, expansion of drift gill net operations, introduction of light-luring purse seiners, intensification of trolling operations and harnessing the wind power in this fishery, and economic utilization of live-baits in the pole and line fishery.

Seerfishes: This study is based on the fishery and biology of *Scomberomorus commerson* from the east and west coasts of India. Statewise landings indicated that Kerala contributed 25.6%, Tamil Nadu 18%, Maharashtra 16% and Andhra Pradesh 12% of the total catch of this species during 1984–88. In the southern states such as Karnataka, Kerala, Tamil Nadu and Pondicherry, *S. commerson* constituted the bulk of seerfish catch, whereas in other states *S. guttatus* dominated. The major gear used in the fishery was drift gill net with mesh size varying from 7–17 cm in the same net. However, troll lines, trawl nets and hooks and line also landed a part of the catch.

S. commerson occurred in the size range 30–130 cm with modal value at 60 cm in the gill nets. In the areas where troll lines, shore seines and trawl nets were operated, smaller sized fishes (25–59 cm) dominated. Y/R analysis indicated that the total annual stock of *S. commerson* in India ranged from 24 844 tonnes to 29 079 tonnes and annual average standing stock from 6 635 to 7 715 tonnes. *S. commerson*, a migratory species, was more abundant along the east coast during June and September when they were young (L_c, 45 cm). Along the southwest coast they were abundant in October (L_c, 60 cm). This indicated its movement from the east coast to west coast during this period. Exploitation at high rates before it attains the age at first maturity can affect the spawning stock and recruitment. The fishing of this species by shore seines, trawl nets and small-meshed gill nets which catch the young ones of this species, should be discouraged.

Pomfrets: Pomfrets support a lucrative fishery along both the coasts of India and are exploited by a variety of gears such as drift nets, dol nets, purse seines and trawls. This resource contributes on an average 36 501 tonnes to the annual marine fish landings in India. The pomfret fishery is supported by 3 species viz., *Pampus argenteus* (65.7%), *P. chinensis* (1.0%) and *Formio niger* (33.3%). The spawning seasons of these species are April to August for *P. argenteus* and June to September for *F. niger*. The size at first maturity for the females of *P. argenteus* and *F. niger* are 26 cm and 28 cm respectively.

The stock assessment of *P. argenteus* and *F. niger* was carried out for 1984–88. The results indicate a high fishing pressure on *P. argenteus* to the extent of 40% along Karnataka coast. The MSY estimates are 1 055 tonnes off Kerala and 1 856 tonnes off Karnataka. A reduction of effort by 60% is recommended for *F. niger* along Karnataka coast. *P. argenteus* stock along Maharashtra coast, where dol net is the main gear, is under

pressure due to recruitment overfishing and growth overfishing and hence either mesh size regulation or closing of fishing season or both is recommended for a sustainable yield.

Carangids: There has been a sizeable increase in the production of carangids in recent years, the average annual catch during 1981–88 was 74 080 tonnes. *Megalaspis cordyla, Decapterus russelli, Alepes kalla, Atropus atropus, Alepes djedaba, Atule mate, Caranx carangus* and *Selaroides leptolepis* contribute significantly to the fisheries in different regions. Traditional craft and gears are used in the carangid fishery. It forms good catches in the shrimp trawls also.

The average annual catch of *M. cordyla* was estimated at 6 627 tonnes. The MSY estimated for different regions were 1 056 tonnes for east, 4 727 tonnes for northwest and 8 378 tonnes for southwest coasts. There is scope of increasing the effort by 81% from the present level in the southwest coast.

The estimated average annual catch of scads (*D. russelli*) was 19 055 tonnes with seasonal abundance in catch rate. The MSY estimated were 2 799 tonnes for the east coast, around 3 700 tonnes for the northeast coast and 22 208 tonnes for the southwest coast thus showing that MSY is 5.7% more in the east coast, 17% more in the northeast coast and 2% more in the southwest coast than the present production. *Caranx carangus* forms a fishery along the Tamil Nadu-Pondicherry coast and the average annual production is 2 720 tonnes taken chiefly by trawlers. The present production of 2 314 tonnes is 13.5% lower than the MSY. Reduction in the fishing effort from the present level by trawlers will increase the yield of the species.

Selaroides leptolepis forms a fishery only along the Tamil Nadu coast. The average annual landing is 5 726 tonnes taken by trawl nets. The MSY in trawl nets was found to be 6 583 tonnes and the present production is 9.5% higher than that level. Reduction in effort by about 39% is recommended to increase the yield.

Atropus atropus forms a fishery along the northwest coast of India. The average annual catch is estimated to be 977 tonnes and 67.5% of the annual catch comes from Maharashtra and the rest from Gujarat. The MSY level is estimated to be 953 tonnes. *Alepes kalla* forms a resource along the southwest coast of India with an average annual catch of 14 264 tonnes. Nearly 61% of the catch is from Kerala. The MSY is 1.36% more than the present exploitation rate but to reach this level the increase of effort required than the present is 41%, which may not be economically viable. *Alepes djedaba* is limited to Kerala coast with an average annual catch around 4 297 tonnes. At present the fish is underexploited and to reach the MSY level an effort increase by 221% is required.

Atule mate is also limited to Kerala coast and is landed mainly in hooks and line and drift gill nets. The average annual catch was estimated as 3 364 tonnes. The MSY level was estimated at 4 305 tonnes.

Ribbonfishes: Ribbonfishes occupy an important place among the exploited marine fish resources of India. The annual average production of ribbonfishes is 79 220 tonnes i.e. 4.5% of the total marine fish catch. In recent years the catch has increased due to the increased exploitation by trawl nets which contribute about 50% of the catch. About 75% of the catch is taken from the west coast. *Trichiurus lepturus* contributes over 90% of the total ribbonfish catch.

The MSY level estimated was 65 666 tonnes. The stock assessment studies indicate that there is overfishing on the east coast and the effort should be reduced by 33%. But, along the west coast there is scope to increase

the effort as the present yield is not even 50% of the estimated biomass (223 773 tonnes).

Bombay duck: The Bombay duck *Harpodon nehereus* (Ham.) forms an important pelagic resource along the Saurashtra and Maharashtra coasts. The landings of this species during 1980–88 varied from 28 870 tonnes to 55 877 tonnes with an average of 41 747 tonnes. Saurashtra contributed about 86.2% of the total catch, while south Gujarat 10.2%. The dol net is the primary gear used in the fishery. The season begins by April with high catch rates which dwindle with the progress of the season recording the lowest value in February–March. The whole fishing season can be divided into two parts (1) September-January which is more productive when the occurrence of juveniles are relatively less, and (2) February–March which is less productive with juveniles forming a major part. Studies indicated 6–9% higher yield from 25 and 27 mm cod end net. At Satpati (Maharashtra), dol net with cod end 25–27 mm are in vogue. At Versova (Bombay) cod end mesh is changed depending upon the availability of the species. When Bombay duck is in abundance 40 mm mesh cod end is used.

The MSY has been estimated at 34 668 tonnes. However, by taking M/K ratio as 1, there was not much change in the estimated MSY (37 486 tonnes). Two basic regulatory measures suggested to increase the yield are: (a) change over to 25–27 mm mesh at the cod end of the net, and (b) closing of fishing season during February–May, which would form the basic management strategy in future for the development of this fishery along the Saurashtra coast.

Hilsa shad: The hilsa shad, *Hilsa ilisha,* forms a commercial fishery in the northeast coast of India (coastal regions of West Bengal and Orissa). The decline in the landing of hilsa shad punctuated by fluctuating catch trends in recent years has become a matter of concern.

The data for analysis were collected from four fish landing centres, viz., Diamond Harbour, Fraser Gunj and Digha in West Bengal and Talsari in Orissa, during 1984–88. The annual average catch was 5 710 tonnes which formed 0.4% of the total catch.

The MSY was estimated at 4 168 tonnes and the biomass as 4 707 tonnes. Since the present yield of 4 168 tonnes and the estimated MSY 4 168 tonnes are obtained by expending more or less similar levels of effort, it can be inferred that present level of exploitation is at optimum level, and the exploitation ratio of 0.58 supports the above assumption.

GENERAL REMARKS

The study on the stock assessment of 11 commercially important pelagic finfishes indicate that most of the species are exploited to or beyond the maximal level from the present fishing ground. In view of the dynamic and self renewing nature, the pelagic resources of our country are subject to fluctuations due to fishery dependent and fishery independent parameters. In view of this, it becomes necessary to review periodically the status of exploited resources and make critical assessment of the fishery potential.

The average estimated landings of pelagic fishes comprising of clupeids, anchovies, other clupeids, Bombay duck, half-beaks and full-beaks, flying fishes, ribbonfishes, carangids, mackerel, seerfishes, tunas and billfishes, baracudas, mullets and unicon cod was 1.167 million tonnes in India, during 1988–1992 from the presently exploited grounds. The pelagic marine fishery potential in the 50–100 m depth region has been estimated at 401 000 tonnes and the rest from the 100–200 m depth zone. The important fish

groups constituting the above potential resources are: (i) anchovies (especially in the Gulf on Mannar during July–September and on the southwest coast during October–December; additional yield, 100 000 to 150 000 tonnes); (ii) Carangids, comprising of horse mackerel, scads and travallys with an estimated additional resource of 200 000 tonnes from the inshore and immediately deeper waters of 50–125 m depth off southwest, northwest and northeast coasts; (iii) ribbonfishes from the 50–200 m depth zone along the southwest and northwest coasts; (iv) tunas and related species with a potential of 100 000 tonnes in Andaman waters and an additional 50 000 tonnes along the mainland coast (southwest and northwest areas); and (v) pelagic sharks in the areas northwest (15 000 tonnes) and southwest (29 000 tonnes) coasts in the 50–200 m depth region.

The options open to exploit the additional resources have been indicated earlier. Further development in the aimed fishery for pelagic sharks as pointed out by BOBP and expansion of fishery for larger pelagics such as ribbonfishes, yellowfin and longtail tunas, would assist in enhancing the pelagic finfish production. Effective utilization of anchovies when they are caught in commercial quantities during monsoon has been propogated by BOBP (1992). However, for optimum utilization and streamlined development of the fishing industry, post-harvest utilization and development of domestic and export markets are of prime importance.

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