Sustain Fish

Proceedings of the International symposium on "Improved sustainability of fish production systems and appropriate technologies for utilization" held during 16-18 March, 2005
Cochin, India

Editors

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Status, prospects and management of pelagic fisheries in India

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Abstract

The annual pelagic fish production in India increased from 0.3 million t (mt) during 1950 to 1.4 mt in 2003 registering more than four fold increase. The potential yield from the pelagic resources of the EEZ is estimated to be 1.92 mt. During the last decade pelagic finfish resources contributed 46-56 % (average 51 %) of the total production. Almost 70 % of the production was obtained from within 50m depth zone. The southwest region comprising the maritime states of Goa, Karnataka and Kerala continued to be the highly productive area (41 %) followed by the northwest covering Gujarat and Maharashtra (25 %), southeast covering Tamil Nadu, Pondicherry and Andhra Pradesh (23 %) and northeast covering West Bengal and Orissa (11 %). Mechanized sector contributed 47 % to the total pelagic followed by motorized (37 %) and non-motorized (16 %) units. Out of the 240 spp. that contributed to the pelagic fisheries only about 60 species belonging to 7 groups viz., the oil sardine, lesser sardines, anchovies, Bombay duck, ribbon fishes, carangids and Indian mackerel formed the major fisheries. The oil sardine and ribbonfishes were the most dominant contributing 14 % and 6.8 % respectively to the overall marine fish landings during 2003. Bombay duck, lesser sardine, mackerel, anchovies and Hilsa *shad contributed 4.9 %, 4.3 %, 4.2 %, 4.1 % and 1.6 % respectively to the total marine fish landings. As there is no further scope for increasing the production from the inshore waters, there is urgent need to bring the pelagic/mesopelagic realm of oceanic waters to increase and diversify exploitation. The fluctuation in the landings and the stock assessment of major pelagic species are discussed in the paper. For sustaining the pelagic fisheries, suitable management measures have been suggested.*

Keywords: *Pelagic fisheries, Oil sardine, Lesser sardines, Anchovies, Bombay duck, Ribbon fishes, Carangids, Indian mackerel*

1. Introduction

India has been one among the top ten fish producing countries of the world since 1960 with its position oscillating between the 6th and the 8th ranks. Currently India occupies the 4th position contributing about 4.81 % (6.2 million tonnes (mt), including inland and marine production) to the world fish production of about 128.8 mt. The marine fish production in India reached 2.72 mt in 1997 due to mechanisation of the crafts, motorisation of the country crafts, commencement of stay over fishing, improvements in gears and related infrastructure facilities which were introduced at different

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periods since the late 1950s. Almost 90 % of the productions were obtained from within 70 m depth covering an estimated area of about 100,000 km^2.

Among the countries bordering the Indian Ocean, India, endowed with 2.02 million km^2 of EEZ along a coastline of 8,129 km and 0.5 million km^2 of continental shelf with a catchable annual marine fishery potential of 3.93 mt occupies a unique position (Anon. 2000). The development of Indian marine fisheries from a traditional subsistence-oriented one to industrial fisheries through Five-Year Plans has been phenomenal. However, the present scenario is characterized by declining yields from the inshore waters and increasing conflicts among different stakeholders, whereas the increasing demand for fish in domestic and export markets indicates good prospects for large scale exploitation of oceanic and deep sea resources. The production from capture fisheries is stagnating around 2.5 mt per annum, threatening to decline, and warranting effective management of the exploited stocks. Srinath (1989) and James and Alagarswami (1991) analysed the pattern of development of the pelagic fishery based on historical data relating to 1961-85 and 1979-85 respectively. Pillai (1992) has given a comprehensive account on the results of the stock assessment of the major pelagics. Devaraj *et al.*, (1997) has given an exhaustive account on status, prospects and management of the small pelagic fishes of India. Nair *et al.*, (1998) summarised the status of pelagic fish production during the period 1985-94. Pillai and Pillai (2000) analysed the growth in the annual overall and pelagic fish production through the five decades from 1950 to 1996. An attempt is made here in this paper to bring out the historic and current status of the pelagic fisheries and to focus attention on their sustained development through appropriate management plans.

2. Materials and Methods

The present study is based on the database made available by NMLRDC of CMFRI and observations by the Scientists. The fish landings data by different sectors for the period 1985-2003 was analysed to study the trend of production and the species composition of major pelagic groups. The information on biological characteristics of dominant species were mostly gathered from published works.

3. Results and Discussion

3.1. Trends in production

The annual average marine fish production of India for the period 1985 to 2003 was 2.5 mt of which the pelagics contributed 1.4 mt against an annual catchable potential yield of 1.92 mt from the Indian EEZ (Fig.1).

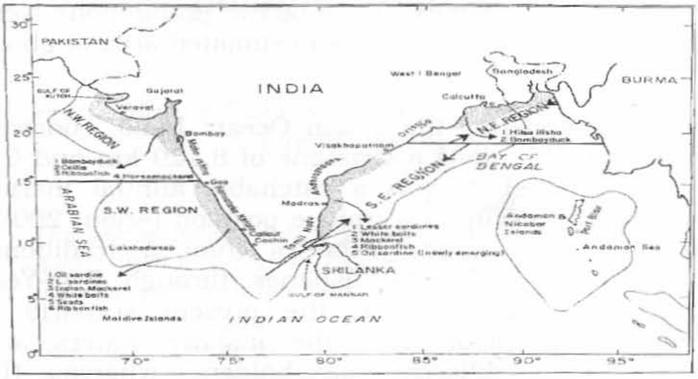


Fig. 1 Exclusive Economic Zone of India indicating the distribution of major pelagic fishery resources

During the last decade pelagic finfish resources contributed 46-56 % (average: 51 %) of the total marine fish production. Almost 70 % of the production was obtained from within the 50m depth zone. As per the revalidation, annual potential yield from the EEZ of India is 3.9 mt, out of which 2.21 mt are from within the 50m depth zone and 1.69 mt from beyond it (Anon, 1991). The current yield from 0-50m depth zone is at the optimum level, and hence does not offer any scope for increasing the yield and this zone requires regulatory management for sustaining the yield.

Until the mid-seventies, the share of the pelagic groups in the overall production remained very high with a consistently increasing trend from 54 % in 1950 to 71 % in 1960, and thereafter, at around 65 % till the early seventies. The pelagic catches increased from 309,000 t in 1950 to the current 1,414,064 t (2002) registering more than a fourfold increase. The growth in the production of the pelagics vis-à-vis the overall production could be gauged from Table 1 and Fig. 2.

Table 1. Growth in the average annual overall and pelagic fish production through the five decades from 1950 to 2003

Period	Production (t)		Relative growth (%)	
	Pelagics	Overall	Pelagics	Overall
1950-59	362,548	618,501	-	-
1960-69	527,211	814,721	+ 45	+ 31
1970-79	643,142	1,243,707	+ 22	+ 27
1980-89	819,093	1,579,836	+ 27	+ 27
1990-99	1,116,792	2,258,874	+ 36	+ 43
2000-2003	1,243,424	2,422,043	+11	+7

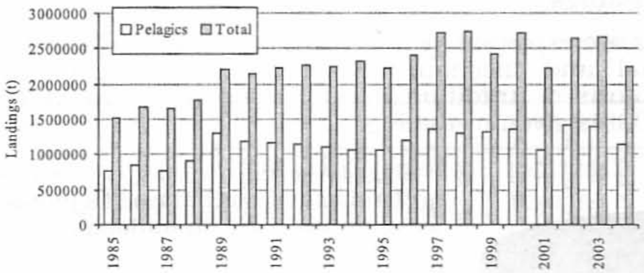


Fig. 2 All India landings of total marine and pelagics during 1985-2003

In the early years of the development of marine fisheries, the growth rate in the production of pelagic fishes had been conspicuously higher than that of the overall production. This trend reversed during 1970-79 because of the rapid expansion of commercial trawling for shrimps for exports by the industrial sector. Commercial trawling resulted in significantly high production of demersal finfishes also, besides shrimps, crabs, lobsters and cephalopods. Although the pelagic fish catches increased by 22 %, the trend in the overall production was set by the demersal finfish and crustacean catches. The next decade (1980-89) witnessed a growth of 27 % in the pelagic catches as well as in the overall production. During this decade there was rapid motorization of traditional fishing craft, particularly in the latter half of the eighties. As a result, the stagnation in marine fish production witnessed in the first half of the eighties gave way for accelerated production in the latter half. Intensive motorisation of the traditional fishing crafts resulted in a remarkable increase in the annual production, especially of the total pelagics, which increased from 769,000 t in 1985 to 1,414,064 t in 2002, registering a 71 % increase (Fig. 2).

3.2 Pelagics production in the four geographical regions

The statewise average contributions to the pelagic fish production showed that Kerala ranked first among the maritime states of India contributing about 29 % to the total pelagic fish catch, followed by Tamil Nadu contributing 14 %. The contributions by other states were: Maharashtra 13 %, Gujarat 12 %, Karnataka 7 %, Goa 5 %, Andhra Pradesh 9 %, West Bengal 8 % and Orissa 3 %. This shows that the southwest region comprising the maritime states of Goa, Karnataka and Kerala continued to be the highly productive area (41 %) followed by the northwest covering Gujarat and Maharashtra (25 %), southeast covering Tamil Nadu, Pondicherry and Andhra Pradesh (23 %) and northeast regions covering West Bengal and Orissa (11 %)(Fig.3).

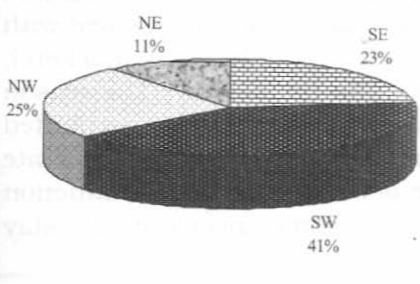


Fig. 3 Regionwise pelagic finfish landings during 2003

3.3. Sector-wise landings

The pelagic stocks are exploited by the non-mechanised (traditional), motorised traditional and mechanised sectors. The sector-wise landings of non-motorised (traditional), motorised and mechanised units (avg. 1999-2003) is given in the Fig. 4.

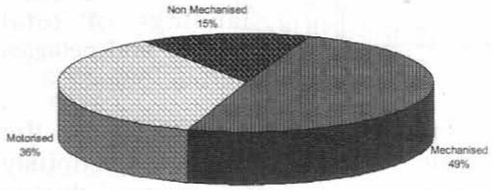


Fig. 4 Average pelagic finfish landings of mechanised, motorised, non-motorised (traditional) during 1999- 2003

Mechanised sector contributed 47 % to the total pelagics followed by motorised (37 %) and non-motorised units (16 %). The sector-wise average effort expended, catch and catch per hour of pelagics landed during 1999 to 2003 is given in Table 2.

Table 2 Sector wise effort, catch and catch/hr of pelagic groups in respect of non-motorized (traditional), motorized and mechanised units in India during (1999-2003)

	Mechanized	**Motorized**	**Non-motorized (traditional)**
catch/hour(in Kg)	44	32	22
Total catch(in t)	763994	550911	227498
Effort(AFH)(in hr)	17435308	17697995	10961736
Effort(Units)(in number)	1076745	4102995	3015025

A comparison of the average annual production of major pelagic finfish groups from the initial stages of mechanisation in 1960s to 1993-94, through early and late 1980s, shows an increasing trend with respect to all the groups (Table 3). Substantial increase was noticed in the case of anchovies, Bombayduck, and tunas & b illfishes till 1992 and that of ribbonfishes and mackerel till 1993-94. Compared to 1960s, in 1980s the production almost doubled or even trebled with respect to many groups, except that of oil sardine and mackerel, which showed only marginal increase during the period. The reason for increased production in the early eighties could be attributed mainly to the introduction of purseseine fishing, while that of the late eighties and nineties to the motorisation of country crafts, introduction of innovative gears like ringseine and commencement of stay overfishing.

Table 3 A comparison of average annual landings of major pelagic finfishes in the initial stages of mechanization to 1998-2003 (catch in tonnes)

Major pelagic groups	1961-65	1981-85	1988-92	1993-97	1998-2003
Oil sardine	173,457	182,920	190,378	106,611	304,690
Other sardines	29,326	63,069	83,379	106,143	97,205
Anchovies	22,783	57,073	145,197	136,449	122,031
Bombayduck	84,375	110,064	116,287	98,190	108,328
Ribbonfishes	24,153	50,056	82,910	116,043	156,811
Mackerel	38,622	40,595	165,504	226,535	136,423
Seerfishes	10,155	30,206	37,521	41,611	48,883
Tunas & Billfishes	4,222	17,789	41,236	41,485	46,210
Carangids	22,027	48,769	152,142	150,509	150,903

3.4. Major pelagic stocks

Out of the 240 species that contribute to the pelagic fisheries along the Indian coast, only about 60 species belonging to 7 groups *viz.*, the oil sardine, lesser sardines, anchovies, Bombayduck, ribbonfishes, carangids and Indian mackerel form the major fisheries.

The average landings of pelagic groups and their percentage contribution in the total pelagic during 1985-2003 are given in Table 4.

Table 4 The average landings of pelagic finfishes (in tonnes) and their percentage contribution during 1985-2003

Groups	Catch in tonnes	%
Oil sardine	190,092	16.27
Mackerel	158,089	13.53
Carangids	133,565	11.43
Anchovies	130,998	11.22
Ribbonfishes	115,924	9.92
Bombayduck	105,088	9.00
Other sardines	92,473	7.91
Other clupeids	46,879	4.01
Seerfishes	41,463	3.55
Tunas	41,444	3.55
Hilsa shad	18,179	1.56
Wolfherring	15,585	1.33
Barracudas	12,360	1.06
Miscellaneous	65,902	5.66

The percentage contribution ranged from 1.1 in the case of barracudas to 16.3 in the case of oil sardine. The groups whose average annual production exceeded one lakh tonne were oil sardine (1.9), mackerel (1.58), carangids (1.34), anchovies (1.31), ribbonfishes (1.16) Bombayduck (1.05). The annual production of these groups during 2003 is 1.15 mt forming 81 % of the pelagics and 43 % of the total marine fish landings (Fig. 5).

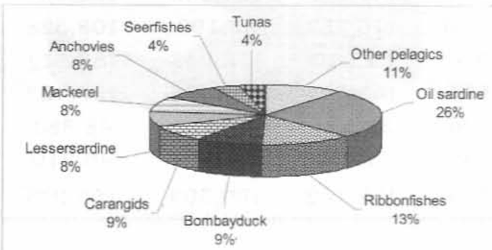


Fig. 5 Major components of pelagic finfish landings during 2003

The major single-species fisheries of the pelagic resources, the oil sardine (*Sardinella longiceps*), the Indian mackerel (*Rastrelliger kanagurta*) and the Bombayduck (*Harpadon nehereus*) showed wide inter-annual fluctuations in their availability for exploitation. The fluctuations in abundance of these species is due to fishery independent factors such as spawning success, recruitment strength and environmental factors affecting the resources. The distribution, production, biology, utilization and status of the stock of the major pelagics are summarised below.

3.5. Indian oil sardine

3.5.1 Production trends

During the last fifty years, the all–India production of the oil sardine ranged from 14,000 t in 1952 to an all-time high of 3.77 lakh t in 2003 contributing 0.1 % to 31.9 % to the total marine fish landings in India. The oil sardine catch increased from 78,000 t in 1986 to 279,000 t in 1989 declined to 47,000 t in 1994. The resuscitation of the oil sardine stock after an ever-lowest landing of 47,000t in 1994 was manifest from the heavy recruitment that followed, which culminated in a highest production of 3.77 lakh t in 2003 (Fig.6).

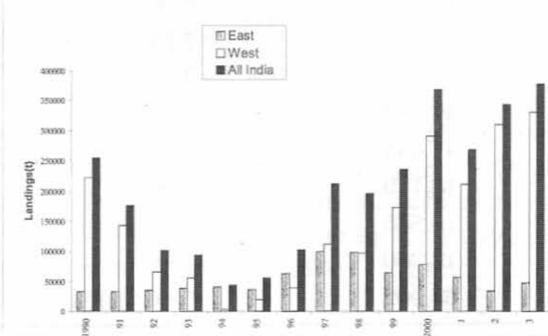


Fig. 6 All India Oil sardine landings during 1990-2003

The average (1999 to 2003) annual landings of the oil sardine along the west coast were 147,989 t (73 %) and the east coast 53,984 t (27 %).

3.5.2 Management

Fisheries of small pelagics like oil sardine is characterized by high inter-annual and decadal variability making management difficult. There was an unprecedented failure of oil sardine fishery during the forties which had disastrous effects on industries based on it, which provoked the British administration to introduce restrictive legislation in 1943 to prevent capture of juveniles and spawners. Under the Marine Fishing Regulation Act passed in the 1980s by various maritime states, fishing by mechanized vessels, especially purseseines during monsoon is banned to protect spawners, but the implementation of the same is not uniform in all the states. Moreover, traditional motorized crafts continue to engage in seining operations using extremely small meshed mass harvesting nets like ringseine during this period, which destroy both spawners and young fish .Any fishery which allows uncontrolled exploitation of both juveniles and adults from a stock is likely to experience stock decline. Therefore it is imperative that destructive fishing practices using small meshed seines are effectively controlled by enforcing mesh size regulation (minimum 18mm), closed season and restricted fishing (June - September) besides strict licensing and optimum deployment of fishing units especially ringseines and purseseines.

3.6 Lesser sardines

3.6.1 Production trends

During the fifteen-year period the lesser sardine landings ranged from a low of 68,267 t in 1986 to a high of 128,021 t in 1995 (Fig.7).

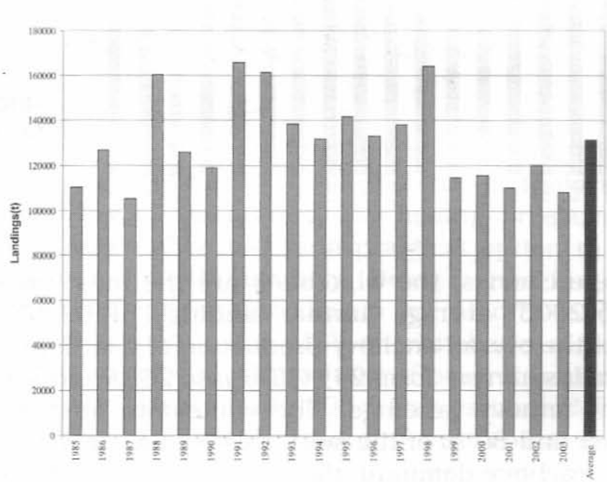


Fig. 7 All India lesser sardine landings during 1985-2003

3.6.2 Management

The total annual stock of the lesser sardines is estimated to be 280,000 t comprising 20,000 t in the Andaman waters, 30,000 t in the northeast, 140,000 t in the southeast, 80,000 t in the southwest and 10,000 t in the northwest coasts. The MSY was estimated at 140,000t. The average annual production was 80,328 t during 1986-90; 94,387 t during 1991-95 and 122,243 t during 1996-2000, and it is still below the estimated MSY. Studies on the stock assessment on *S. gibbosa* indicated that the yield along the southwest coast is considerably lower than the MSY and hence there is further scope of increasing the catch from this region.

3.7 Anchovies

3.7.1 Production trends

The average annual catch during 1985-2003 was 1.31 lakh t forming 11.2 % of the total pelagic fish landings in India. The annual landings ranged from 1.05 lakh t in 1987 to 1.66 lakh t in 1991 (Fig. 8).

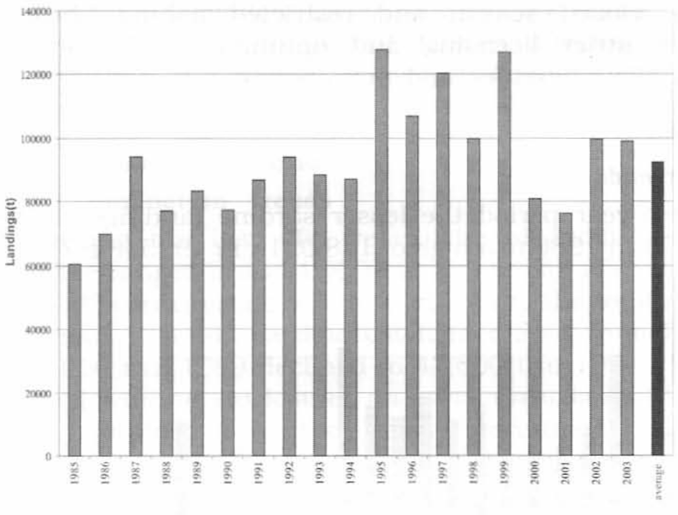


Fig. 8 All India landings of anchovies during 1985-2003

Among the anchovies, the whitebaits are the most important with current (1985-2003) average annual landings of 62,437 t forming almost 48 % of the overall anchovy production of 1.31 lakh t, grenadier anchovy *Coilia dussumieri* form 24 %, *Thrysssa* 26 % and settipinna 2 % of the current anhovy landings. The whitebaits form 60 % of the southeast coast and 80 % of the southwest coast anchovy production. The grenadier anchovy dominate the anchovy fishery in the northwest and northeast regions with an average landing of 32,050 t during 1985-2003.

3.8 Whitebaits

The whitebaits are the dominant component of the anchovy landings in India. The whitebaits that comprise a group of small pelagic fishes belonging to the genus *Stolephorus* and *Encrasicholina* are widely distributed in our waters. This resource contributes on an average 64,000t (1991- 2003) forming 1.7-5.8 % of the total marine fish landings in the country (Fig.9).

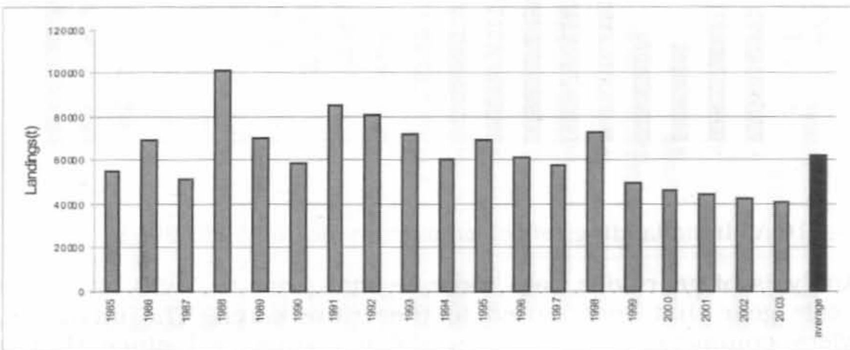


Fig. 9 All India landings of whitebaits during 1985-2003

Ten species of whitebaits have been found to occur in our seas. They are *Encrasicholina devisi, E. heterolobus, E. punctifer (Stolephorus buccaneeri), Stolephorus andhraensis, S. baganensis (S. macrops), S. commersonii, S. dubiosus, S. indicus, S. insularis* and *S. waitei (S. bataviensis)*. Among these species, *E. devisi, E. punctifer, S. waitei, S. commersonii* and *S. indicus* supported the fishery.

3.8.1 Management

Whitebaits are annually renewable resources and hence their periodic harvest during seasons of abundance is important to make full use of the fishery. Increasing the fishing pressure during the peak seasons of availability may be a practical option to enhance the whitebaits production in the country. Being a non-target species in most of the gears (except the *Choodavala* operated by ringseine units), the effort required to obtain the MSY of whitebaits could be decided only in consideration with stock position of other resources caught in the gears. A potential yield of 240,000 t was estimated for whitebaits in the EEZ of India, of which the share of west coast, east coast and Andaman and Nicobar Islands is in the proportion of 69 %, 29 % and 2 % respectively. This indicates scope for a three-fold increase over the present yield of whitebaits in India

3.9 Golden anchovy

3.9.1 Production trends

C.dussumieri landings ranged from 19,048 t (1987) to 46,268 t (1998) with an average of 32,050 t (Fig. 10).

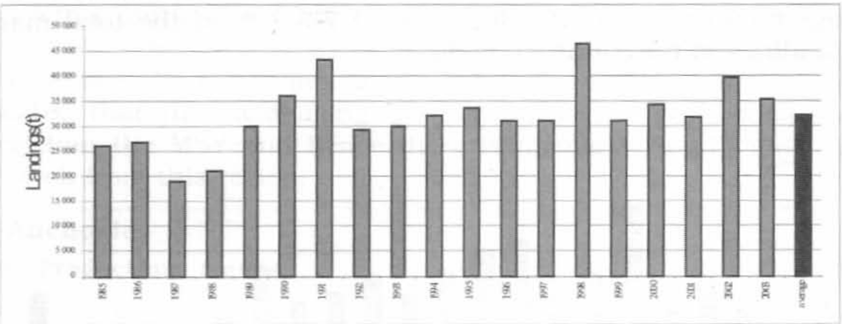


Fig. 10 All India landings of golden anchovy during 1985-2003

Analysis of gear-wise data indicate that prior to 1980 *dol* net was the sole gear that contributed to the entire catch. The incursion of trawlers commenced in 1985 in *dol* net zone and since then the contribution of trawl catch is on the increase. During 1986-90 trawl and *dol* contributed 38 % and 60 % respectively, while during 1996-2000 contribution by the former increased to 70 % of the total catch. Time series analysis of the data on the landings of golden anchovy during the last 15 years together with co-existing species like *H. nehereus* and non-penaeid prawns indicated that decline in landings of Bombayduck coincided with that of *C. dussumieri*. However, the landings of non-penaeid prawns have increased during the same period (Khan, 2003).

3.9.2 Management

The management strategies of *C. dussumieri* cannot be considered in isolation. The golden anchovy is one among many components exploited by the *dol* net, the other resources being non-penaeid prawns, Bombayduck, unicorn cod and juvenile pomfrets. In a multispecies fishery it would be rather difficult to suggest optimum mesh size for each species. However the resource is currently underexploited and can sustain increased fishing effort.

3.10 Indian mackerel

3.10.1 Production trends

The annual production of the Indian mackerel is also characterized by wide fluctuations as evident from the catch records of the past fifty years. During the last 20 years, the production ranged from 113,000 t in 1991 to 290,000 t in 1989. The mackerel fishery showed a declining trend from 1999 (2.1 lakh t in 1999 to 0.9 lakh t in 2001) and showed marginal improvements during 2002 and 2003 when the catch increased to 0.96 lakh t and 1.12 lakh t respectively (Fig.11).

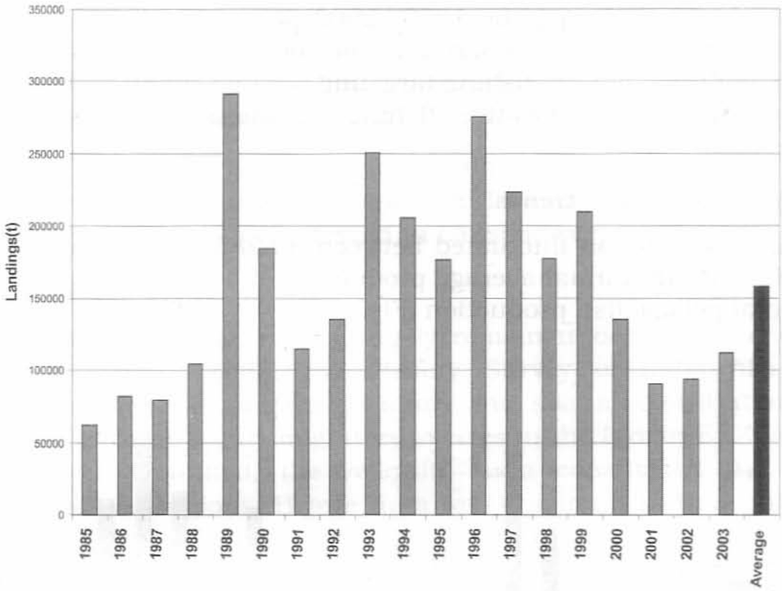


Fig. 11 All India landings of mackerel during 1985-2003

3.10.2 Management

There are no signs of any serious decline in the mackerel catches in spite of constantly increasing pressure of exploitation (Yohannan and Sivadas, 2003). The large scale exploitation of the juveniles along the southwest coast is the key factor which limits the yield from the mackerel stock. Fishes below the size of 150 mm form about 42 % of the catch from west coast. Increasing the size at first capture from 140 mm to 160 mm by controlling exploitation during the major recruitment period (July-September) or increasing the mesh size of the larger seines to minimum of 35mm can be employed to control the growth over fishing.

3.11 Tunas

Tunas, being highly valued food fishes, are targeted by coastal as well as distant water fishing nations throughout the Indian Ocean region with varying intensity of exploitation. Tunas occur in the coastal, neritic and oceanic waters and are caught using diverse types of crafts and gears. Tuna fishing and fisheries have become a focal point while addressing issues of development, utilization and management of fisheries in the Indian Ocean in the light of EEZ regulations and other international conventions (Somvanshi *et al.*, 1998). In India, tuna fishing is mainly an artisanal activity except for a brief phase of chartered and joint venture tuna fishing by longliners during the 1990s. However, tuna catches have substantially improved by nearly 58 % during the 1990- 2003 period compared to the early eighties, mainly due to motorization of traditional crafts, distant water multiday gill net fishing targeting oceanic tunas and adoption of progressive and innovative fishing techniques by the mainland fishermen.

3.11.1 Production trends

Tuna production fluctuated between 30,285 t (1987) and 54,007 t (2000) with an annual average production of 41,443t forming 3.6 % of the total pelagic fish production (Fig. 12).

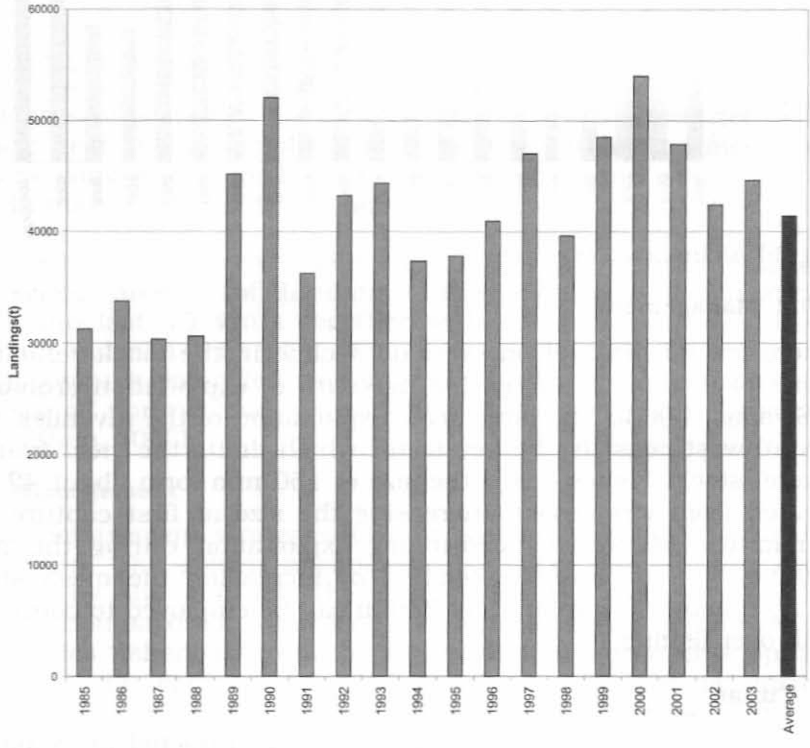


Fig. 12 All India landings of tuna during 1985-2003

Of the 8 major species of tunas occurring along the Indian coast, five are coastal and three are oceanic and migratory. The tuna fishery in India is limited to the small-scale sector with negligible inputs from the industrial sector. The commonly occurring coastal tuna species in the small-scale fisheries are *Euthynnus affinis* (little tuna), *Auxis thazard* (frigate tuna), *A. rochei* (bullet tuna), *Sarda orientalis* (oriental bonito), *Thunnus tonggol* (long tail tuna) and the oceanic species *Katsuwonus pelamis* (skipjack tuna), *T. albacares* (yellowfin tuna). *E. affinis* and *A. thazard* constituted the major species along both the coasts whereas *T. tonggol* and *T. albacares* along the northwest coast.

3.11.2. Means of exploitation

The drift gill net is operated all along the Indian coast, the purseseine southwest and the hooks and line off Vizhinjam. The pole and line and troll lines are operated in Lakshadweep Island.

3.11.3 Management

Tunas of the oceanic region largely remain under-exploited in the Indian EEZ. Since 1983, the Fishery Survey of India has been undertaking longline surveys to study the spatial distribution and abundance of these highly migratory species in the Indian EEZ. Among the resources identified, the yellowfin tuna constituted the major species in all the regions. Bigeye tuna was dominant in the equatorial region, while skipjack tuna was abundant in the northwestern region. Extension of fishing to the offshore and oceanic waters through multiday drift gillnetting, pole and lining, purseseining, longlining and intensification of troll lining and hand lining may help to augment tuna production from the Indian waters.

3.12. Seerfishes

Seerfishes are one of the commercially most important pelagic finfish resources of India. The seerfish catch of 50,376 t in 2000, which was just 1.85 % of the marine fish production, was valued at 4.03 billion rupees. Owing to high unit value and economic returns, seerfishes support artisanal fisheries and are a major source of income for gill net and hooks and line fishermen. Out of the four species *viz.*, the king seer (*Scomberomorus commerson*), the spotted seer (*S. guttatus*), streaked seer (*S. lineolatus*) and the wahoo (*Acanthocybium solandri*), the fishery is sustained by the first two species. During 1985-2003 the all India seerfish catch was constituted by the kingseer (60 %) spotted seer (39 %) and the rest by streaked seer and wahoo. The king seer was dominant along the mid-eastern (Orissa, Andhra Pradesh), southeastern (Tamil Nadu), southwestern (Kerala) and mid-western (Karnataka, Goa) coasts. The spotted seer is more abundant than the king seer along northeast coast (West Bengal) and northwest coast (Maharashtra, Gujarat).

3.12.1. Production trends

The trend in the annual all India seerfish production during the years 1985-2003 is presented in Fig. 13.

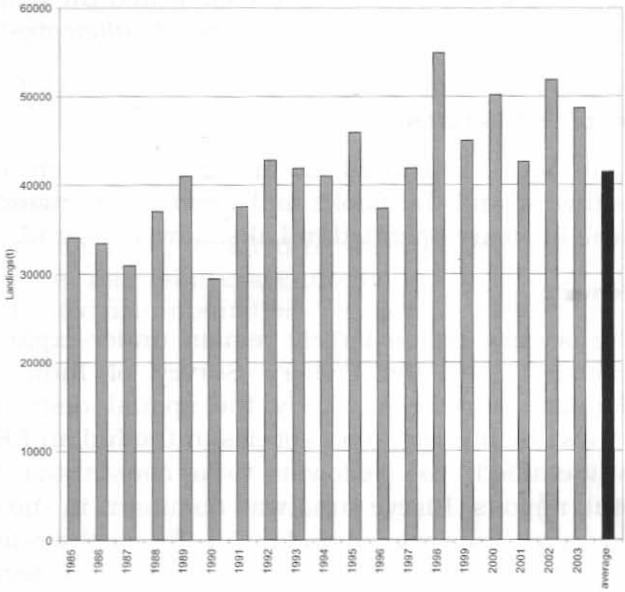


Fig. 13 All India landings of seerfishes during 1985-2003

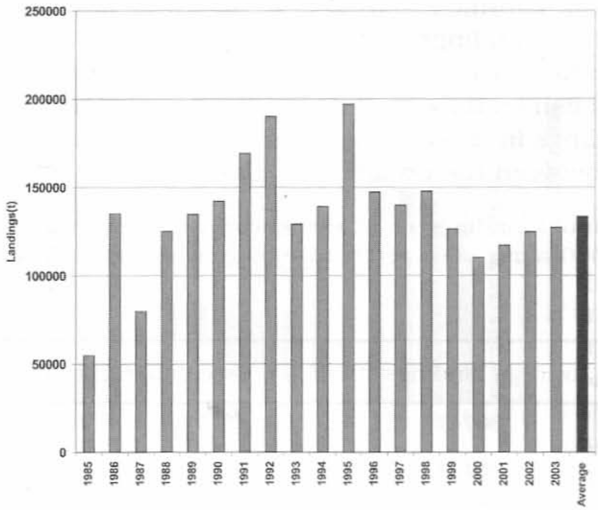
The annual seerfish catch showed an increasing trend during the past five decades with fluctuations ranging from a mere 4,505 t in 1953 to an all time peak of 54,998 t in 2003. Though the production increased along both the coasts over the years the increase along the west coast was remarkable.

3.13. Carangids

Carangids occupy a dominant position with a production of 1.33 lakh t, constituting 4.1 % of the total marine fish production. There are 46 species of carangids occurring along the Indian coast, but the fisheries comprised mainly of horse mackerels, round scads, selar scads, queenfishes, trevallies, leatherjackets and pompanos. Their distribution is confined mostly to the shallow coastal waters upto a depth of 80 m. The resource has emerged as one of the important pelagic fish groups especially in the mechanized sector.

3.13.1 Trends of production

The landings increased from a meagre 24,560 t in 1969 to a phenomenal 1.97 lakh t in 1995, but decreased to 1.11 lakh t in 2000. The average annual production of carangids during 1985 to 2003 was



1.33 lakh t of which scads alone formed 52,618 t (39 %) followed by horse mackerel 19,215 t (14 %), (Fig.14).

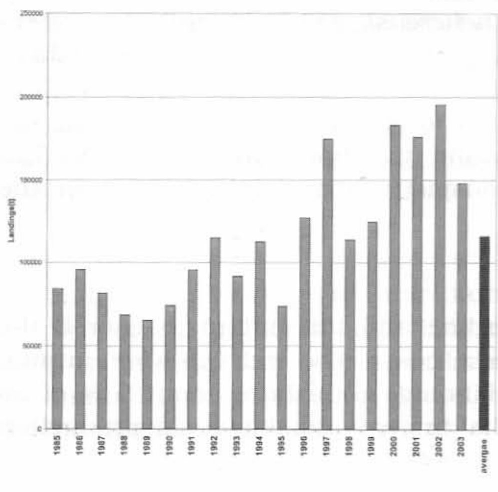
Fig. 14. All India landings of carangids during 1985-2003

Many species support the carangid fishery and the species composition in the catch depends on the selective properties of the gears employed. The non-selective trawls exploit scads such as *Decapterus dayi, D. macrosoma, Selar crumenophthalmus, Megalaspis cordyla,* and *trevally Caranx para, C. carangus, Selaroides leptolepis.* The peak season for scads along the Kerala coast is August-October, corresponding with the monsoon and post monsoon months.

3.14. Ribbonfishes

The ribbonfishes, also known as hair-tail or cutlass are widely distributed along the Indian coast and form major pelagic fishery resources of the Indian seas.

3.14.1. Production trends



The ribbonfish landings have shown an increasing trend with considerable annual fluctu ations. During the years from 1956 to 2003, the landings fluctuated between 16,452 t in 1963 to 182,383 t in 2000 with an average landings of 63,669 t (Fig. 15).

Fig. 15 All India landings of ribbonfishes during 1985-2003

The trend over the period showed a 5 to 8 year cycle in the landings. Ribbonfishes formed 2 to 6.7 % (in 1960 and 2000 respectively) of the total fish landings and 4.6 to 13.4 % (in 1970 and 2000 respectively) of the total pelagic fish landings. On an average it formed 4.4 % of the total fish landings and 9 % of the pelagic landings. The average annual landings in different decades (1956-2000) and the percentage growth rate between the decades are given in Table 5.

Table 5. The average annual landings of ribbonfishes in different decades during 1956-2000 along with percentage of growth rate between decades

Period	Average landings (t)	Percentage growth
1956-60	30741	-
1961-70	28171	-8.4
1971-80	57147	102.9
1981-90	65360	14.4
1991-2000	120461	84.3

Trichiurus lepturus is the dominant species among ribbonfishes and supports a fishery all along the Indian coast. It forms more than 95 % of the total ribbonfish landings. Other species in the catches are *T. russelli, Lepturacanthus savala, L. gangeticus, Eupleurogrammus muticus and E. glossodon.* Ribbonfishes are exploited all along the coast and the bulk of the landings is from Gujarat and Maharashtra followed by Kerala, Tamil Nadu and Andhra Pradesh.

3.15. Bombayduck

The Bombayduck (*Harpadon nehereus*), which inhabit the waters upto the 50 m to 70 m isobath, form a major single species fishery along the northwest coast from Ratnagiri in Maharashtra to the Gulf of Kutch in Saurashtra coast. They form a seasonal fishery along the coasts of West Bengal, Orissa and the northern part of Andhra Pradesh. Bombayduck are inconspicuous or totally absent in the southwest and southeast coasts.

3.15.1. Production trends

As in the case of the oil sardine and the Indian mackerel, the Bombayduck along the northwest coast also exhibit wide annual fluctuations in production. The landings contribute about 5 % of all India marine fish landings. The annual Bombayduck production ranged from 67,392 t in 1988 to 136,442 t in 1991 (Fig. 16).

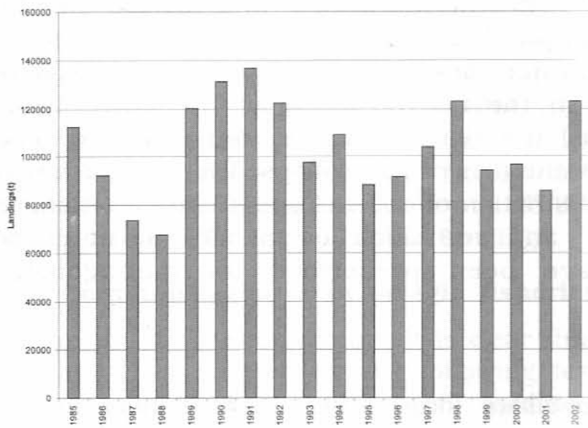


Fig. 16 All India landings of Bombayduck during 1985-2003

The average annual catch of Bombayduck has been estimated at 105,087 t by traditional and mechanised sector (trawlers) along the northwest (88 %) and northeast (12 %) coasts of India. The annual catchable potential yield is estimated as 1.16 lakh t (Anon.2000). Though *Harpadon nehereus* was the sole contributor along the northeast coast, another species, *H. squamosus* (195-214 mm, recently recorded at Kakinada)) accounted for 56 % of the Bombayduck landings at Kakinada. The fishing season shows two distinct phases of productivity: (i) September to January, which is more productive, with the predominance of adults over the juveniles, and (ii) February-March, which is less productive, with juveniles forming a major part of the catch.

3.15.2 Management

In the past Bombayduck stock has been exploited with a mix of success and failure. Large scale landings of indeterminate and immature fish have been a source of concern since long. The only possible method by which age or size at first capture can be adjusted is by regulating the mesh size at the appropriate size. The *dol* net fishery is multispecies. The optimum mesh size for each species or group is different. Therefore it is not easy to evolve a new single optimum mesh size. The mesh size currently under operation with seasonal shifts appears to be the most appropriate for maximization of the yield.

3.15.3 Pomfrets

Pomfrets belonging to the family Stromateidae, enjoy wide distribution in the depth upto 150 m. They are highly relished table fishes in internal and export markets and command high unit value. The annual average catch of 38,000 t forming about 2 % of all India marine fish landings comprises silver pomfret (*Pampus argenteus*) and the Chinese pomfret (*P. chinensis*). Most of their production is from

Gujarat and Maharashtra in the northwest and Orissa in the northeast coasts. The principal gear exploiting the adult pomfrets are the drift gillnet of 140-155 mm mesh size while the *dol* net exploits essentially the juveniles in the northwest coast. The MSY of the silver pomfret (*P. argenteus*) in Indian waters has been estimated to be 38,194 t (Khan, 2000). As the fishery has collapsed in the northwest coast during the 1990s, restriction of *dol* net operations to minimise recruitment overfishing and regulation of gillnets to minimise growth overfishing have been prescribed as management measures(Khan, 2000).

3.16. Hilsa shad

The Hilsa shad (*Hilsa ilisha*) form a prominent fishery in the northeast coast. They are known to spend most of their life in the inshore areas and migrate into the estuaries and rivers for breeding. During 1999 -2003, the annual catch of shad has been increasing, from 21,086 t in 1999 to 44,734t in 2003 with an average production of 27,940t. *H. ilisha* alone contributed 70.9 % (average: 19, 831t). The gillnetters contributed the bulk of the shad catches in the northeast coast. The bulk of the fishery is constituted by fish in the size range of 260 mm to 480mm.The shads other than *Hilsa* shad form fisheries in all the regions, particularly in the southeast and northwest regions.

3.17. Barracudas

The barracudas, otherwise known as the seapikes of the family Sphyraenidae are important food and sport fishes of the tropical and subtropical waters, which are caught in sizable quantities along the Indian coast. Though they form shoals, the larger ones prefer to be solitary. The annual catch improved remarkably in recent years from a meager 4000 t in 1986 to 18,576 t in 2001. Four species, *Sphyraena obtusata, S. barracuda, S. jello* and *S. forsteri* constitute the barracuda fishery in India, though more number of species occur in the Indian waters. The larger fish are caught in hooks and line, bottomset gill nets and drift gill nets, while the smaller ones are caught in trawls in fairly good quantities. The barracudas are top predators, feeding voraciously on other pelagic fishes.

3.18. Flying fishes

The flyingfish fishery is limited to the Coromandal coast in Tamil Nadu. The average annual catch of flying fish was 4217 t during 1999-2003. The seasonal fishery is supported mainly by *Hirundichthys coramandelensis.* The annual catches are taken almost exclusively by the scoopnets, and fluctuate considerably from year to year contributing only about 0.1 % to the total all India landings.

3.19. Other clupeids

Among the other clupeids, the wolfherring (*Chirocentrus dorab*) form a fishery, and contribute about 0.7 % to the total all India landings of which about 50 % comes from the northwest coast. Clupeids consisting of species of *Dussumiera, Escualosa, Ilisha, Nematalosa, Opisthopterus, Pellona, Reconda, Dorosoma, Chanos etc.* together accounted for an annual average of 46,878t during 1985-2003 forming 1.6 % of the total all India landings.

3.20. Common features of pelagic fisheries

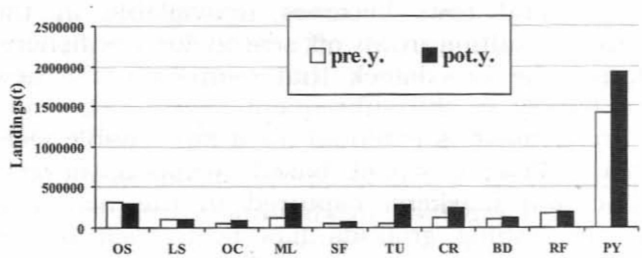
From the foregoing account, it is clear that the pelagic fisheries of India are characterised by the following features: (i) dominance of three species namely, Indian oil sardine, Indian mackerel and Bombayduck; (ii) highly fluctuating nature of their fisheries; (iii) area specific distribution of the dominant species; (iv) crucial role of the environment; and (v) unique biological characteristics. Interactions among these vital features determine the abundance of the pelagics.

3.21. Resource conservation

Many of the world's greatest fisheries particularly for pelagics like the sardines have collapsed owing to recruitment failure caused by high fishing pressure on the spawning stock. Hence, there is a need to study stock – recruitment relationship. However, such studies are complicated due to the fact that there is significant influence of environment in determining the recruitment success of pelagic species every year. Hence it is imperative that a precautionary approach whereby spawners are protected and allowed to replenish the population is in place. Most of the pelagic species move in large shoals and exhibit certain characteristic migratory pattern to the inshore, offshore or deeper areas for the purpose of feeding or breeding. In the course of such migration, large schools enter the coastal waters and constitute seasonal fishery along the coastal belt. Towards the close of the season a part of the stock that escapes from heavy fishing probably migrate away from the fishing ground to offshore or deeper areas and thus becomes unavailable in the traditional fishing grounds resulting in an off season for the fishery. This emigrant part forms the broodstock that contributes to new recruits to the coastal fishery in the subsequent years. Therefore conservation of these broodstocks is essential for a sustainable yield from the inshore area. Fishing vessel based stripping of ripe spawners of oil sardine and mackerel captured in the nets and releasing the eggs in the fishing grounds has been tried on an experimental scale. Such programmes in addition to existing restrictions on fishing for spawners and in spawning grounds will have to be strengthened. Fishing by ringseine, purseseine and *dol* net causes growth overfishing to the stocks of oil sardine and mackerel which cause huge economic loss especially during monsoon period when young recruits enter the coastal waters. The mesh size of ringseine and purseseine is normally 14-18 mm and at times as small as 8 mm. Eventhough the 8 mm meshed net is meant for fishing the whitebaits, young recruits of sardine and mackerel measuring 50-80 mm are also caught in large quantities. This will negatively affect these fisheries in the subsequent years, as these stocks are not allowed to grow, mature and reproduce. Similar is the case with the *dol* net where the mesh size is small (10-50 mm) and is employed in Bombayduck fishery along the Maharashtra and Gujarat coast causing large scale growth overfishing of the stock. So mesh size regulation with respect of ringseine, purseseine and *dol* net is inevitable and the minimum size should be fixed as 20 mm. Fishery with 8 mm meshed ringseine should be restricted solely to exploit whitebaits (*Stolephorus* spp.) and not to any other pelagic fish stocks. Further proliferation of ringseiners needs to be checked urgently. It is therefore vital to make periodic assessments of the pelagic stocks, the fishing practices adopted and the juvenile and spawners components of the catches. Based on this, need based management measures can be formulated either as input controls (restriction of fleet size, mesh size, closed season) or output control (restriction on fishery for certain species, size of fish caught *etc.*) Awareness creation among all stakeholders against non-sustainable fishing practices with a participatory management approach has become inevitable in fisheries management.

3.22. Future prospects

Though a progressive trend is noticeable in production of most of the pelagics, many of them, especially the oil sardine, mackerel, Bombayduck, seerfishes, ribbonfishes and coastal tunas have reached the optimum level of exploitation in the conventional fishing ground (Fig.17).



OS – oil sardine;
LS - lesser sardine;
OC – other clupeids;
ML – mackerel
SF – seerfish;
TU – tuna;
CR – carangids;
BD – Bombayduck;
RF – ribbonfish;
PY – potential yield

Fig .17 Average landings of major pelagics during the year 1999-2003 Vs Potential yield

The stock assessment studies conducted for 19 species of exploited pelagic finfishes have shown that the present effort expended is close to or in some cases even exceeded the level of MSY and further increase in effort in the coastal sector would be detrimental to sustain the yield (James, 1992). Under these circumstances, it is imperative to evolve suitable management measures for judicious exploitation so as to ensure a long term sustainable yield from the 0-50/100 m depth zone. The groups, which are expected to contribute significantly to the additional yield from beyond the conventional belt, where the rate of exploitation is limited at present, are the whitebaits, carangids, ribbonfishes, oceanic tunas and pelagic sharks (Pillai, 1992). The options available for the exploitation of these potential resources from the 50-200 m depth zone are extension of the operational range of crafts, introduction of combination vessels (drift gillnetting and longlining) for multiday target fishing, widespread employment of 'light luring purseseiners', conversion of trawlers for offshore drift gillnet and tuna longline fishery, providing chilling and cold storage facility on board the vessel and development of suitable post-harvest and value addition technologies for utilizing the products for domestic as well as export markets (Pillai *et al.*, 2002). The use of high opening fish trawls beyond the traditional grounds indicates good scope of enhancing the production of carangids and ribbonfishes. Besides the above groups, the deeper areas of the oceans contain non-conventional mesopelagic resources, such as file fishes, lantern fishes *etc.* which can be converted into fish meal. According to a recent observation, the mesopelagic fish fauna in the Arabian Sea is dominated by myctophid fishes. Among them, one species *Benthosema pterotum* is arguably the largest single species population of fish in the world, with stock estimates ranging upto 100 million t per year (US GLOBEC 1993). Similar populations, but of lesser magnitude, may be available in the Bay of Bengal also. Economically viable technologies could be developed for their commercial exploitation, handling, processing and utilization. However, the fishing activities in the offshore and the high seas are at present limited since such activities are capital-intensive and require offshore fishing vessels (longliners, purseseiners, midwater trawlers), infrastructures, shore facilities, expertise and skilled manpower. Development of the above facilities for offshore fishing operations, coupled with value added product development, marketing and export would provide the necessary impetus for further development of pelagic fisheries in the country.

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