CMFRI

Winter School on

Towards Ecosystem Based Management of Marine Fisheries – Building Mass Balance Trophic and Simulation Models

INFORMATION ONLY

Compiled and Edited by

Dr. K.S. Mohamed, Director, Winter School & Senior Scientist,
Central Marine Fisheries Research Institute [CMFRI],
PO Box 1603, Cochin – 682018, Kerala
ksmohamed@vsnl.com

Technical Notes

1

MARINE FISHERIES IN INDIA

M. SRINATH
Central Marine Fisheries Research Institute, Cochin, India

1. Introduction

Endowed with a long coastline of 8129 km, 2.02 million sq.km.of EEZ, and 0.5 million sq.km. of continental shelf and with an annual marine fishery potential of 3.93 million t, India occupies a unique position among the countries bordering the Indian Ocean. India is one of the leading nations in the world in marine fishery exports. From the traditional subsistence level, the Indian marine fisheries grew to an industrial status over a period of half a century since independence. The subsistence fisheries during the early 50's produced about 0.5 million tonnes annually. Currently, the total annual production is of the order of about 2.6 million tonnes. This increase is the result of improvements in the harvesting methods, increase in the fishing effort and extension of fishing into relatively deeper regions. Fleet size and operations underwent quantitative and qualitative change. Traditional boats are being increasingly motorized and the mechanized sector operating trawlers and gill-netters are resorting to multi-day fishing equipped with the state of the art technologies for communication and fish finding, contributing to increase in fishing pressure. The increased effort over time and space is the consequence of ever-increasing demand for marine food both from external and internal markets. This growth, no doubt resulted in increased yields, employment and exports but, has also led to increased and excessive fishing effort, overexploitation of certain resources from the inshore grounds and increased conflicts among different stakeholders. In spite of the phenomenal growth, the marine fisheries sector has been largely depending upon inshore fisheries and did not make any headway in harvesting the resources available beyond the shelf. Over the years this situation has led to concentration of fishing in the inshore waters, poaching in the EEZ mainly for the oceanic resources and the attempts made by the government for introducing the so called deep-sea fishing have not been fully successful owing to several reasons including the conflicts in different sectors of the industry.

2. Marine fish production

2.1 Resources

Characteristic of the tropical seas, the Indian marine fisheries are multispecies comprising over 200 commercially important species of finfishes and shellfishes and multigear with fishing practices varying between different regions depending on the nature of the fishing grounds and the distribution of the fisheries resources. Pelagic fish (mackerel, sardines, whitebaits, ribbonfish, carangids, seerfishes, tunas), demersal fish (croakers, threadfin breams, silverbellies, catfish, lizard fish, flatfish, snappers, breams, groupers, bull's eye, goatfish), crustaceans (prawns, crabs, lobsters and stomatopods) and molluscs

(gastropods, bivalves and cephalopods) are the major resources exploited. The abundance of these stocks is different between regions, with the large pelagics like tunas being more abundant around the islands and small pelagics like sardines and mackerel supporting a fishery of considerable magnitude along the southwest and southeast coasts. The Bombay-duck (*Harpodon nehereus*) and non-penaeid prawns form a good fishery along the northwest coast (Devaraj *et al.,* 1998). Croakers are important all along the coast (Rao *et al.*, 1994), threadfin breams are predominant along west coast (Murty *et al*., 1994a), pomfrets along northwest coast and perches (pigface breams, groupers and snappers) are dominant in the southwest and east coasts, especially in the Gulf of Mannar, Palk Bay and Wadge Bank areas (James *et al*., 1994). Silverbellies form a major fishery along the southeast coast (Murty *et al*., 1994b).

Currently 2251 traditional landing centres, 33 minor and six major fishing harbours serve as bases for about 208000 traditional nonmotorised crafts, 55,000 small scale beach landing, motorised crafts, 51,500 mechanised crafts (mainly bottom trawlers, drift gill netters and purse-seiners) and 180 "deep-sea" fishing vessels of 25m OAL (Anon., 2001).

2.2 **Production trends**

It was estimated that the total marine fish production in the country during 1947-48 was only 3.73 lakh tonnes. The estimated total marine fish production in India had risen to about 2.6 million tonnes in the year 2003. The growth rate since 1981 had been on the decline and during 1991-2000 it was only 1.9%. The trend in the production since 1961, over different phases of development of marine fisheries is depicted in the Figure 1. Phase –I corresponds to the predevelopment stage where the fishing was predominantly by the indigenous craft and gear and the process of mechanization was in the initial stage. Phase – II is characterized by the substantial increase in the use of synthetic gear materials, export trade expansion, increased use of mechanised craft, establishment of fishing harbors, introduction of purse-seining and initiation of motorization of country craft. Phase –III witnessed substantial growth in motorization of artisanal fleet, increased use of ring-seines, extension of fishing grounds and increase in fishing hours by resorting to voyage fishing and introduction of seasonal closure of the fishery.

2.3 Sectoral trends

Among the different gears, drift and set gillnets and bag nets of varied mesh sizes are widely used along both the coasts while ring-seines, purse-seines and mechanized gillnets are confined to the southwest coast. Trawlers upto 11 m OAL are operated along the entire coast, while the second-generation large trawlers (13-17m) are operated from selected harbours along both the east and west coasts. The share of mechanized sector to the total landings increased from 20% in 1969 to 65% during the year 2003. The total landings increased from about 1.8 lakh tonnes in 1969 to 16.9 lakh tonnes in the year 2003. The motorized fishing craft accounted for 25% of the total landings in India. The landings by this sector have increased from about 1.8 lakh tonnes in 1986 to 7.1 lakh tonnes in the year 2003. The unit-operations by the mechanized craft during the last 15 years has been fluctuating around 3.05 million operations annually. However, the unit-operations by the motorized sector have significantly increased from about 0.94 million unit-operations in 1986 to about 5.91 million in the year 2003. The constancy in the unit operations by the mechanized sector does not however imply that the fishing activity has remained constant over the years. The amount of time expended for actual fishing by this sector has almost

doubled during the last 15 years rising from about 17.4 million hours during 1986 to 46.8 million hours during the year 2003. This was mainly due to introduction and increase in voyage fishing activity by this sector in all the maritime states of India. In the motorized sector not only has there been increase in the unit operations but also in the fishing hours from about 3.3 million hours in 1986 to about 27 million hours during the year 2003. Consequent on the growth in these sectors, the purely artisanal sector has gradually been marginalized over the years. The average annual growth of the different sectors during the five-year periods from 1986 is summarized below (see also Fig. 2).

Average annual landings (lakh tonnes) and growth rate(%)during the five year periods

YEAR	Mechanised	Motorised	Artisanal	TOTAL
1986-90	12.84	2.76	3.34	18.93
1991-95	16.05	3.70	2.84	22.59
Growth	6.2	8.6	-3.7	4.8
1996-00	18.04	5.30	2.20	25.54
Growth	3.1	10.8	-5.6	3.3

Average annual unit operations(millions) and growth rate(%)during the five year periods

YEAR	Mechanised	Motorised	Artisanal	TOTAL
1986-90	3.018	1.785	8.764	13.567
1991-95	2.926	2.601	6.451	11.978
Growth	-0.8	11.4	-6.6	-2.9
1996-00	3.201	4.622	4.367	12.190
Growth	2.3	19.4	-8.1	0.4

Average annual fishing hours (millions) and growth rate (%)during the five-year periods

YEAR	Mechanised	Motorised	Artisanal	TOTAL
1986-90	20.803	6.639	31.204	58.646
1991-95	27.373	12.330	23.595	63.298
Growth	7.9	21.4	-6.1	2.0
1996-00	35.039	18.774	14.731	68.544
Growth	7.0	13.1	-9.4	2.1

2.4 Resource trends

The production from the pelagic fish resources in the country had a three-fold increase since 1961, reaching 1.39 million tonnes in 2003 with a peak of 1.41 million tonnes in 2002 (Fig. 3). However, its relative contribution to the total landings declined from about 71% in 1965 to 50% in 2000 There was a quantum leap to 1.34 million tonnes in 1989 from 0.92 million tonnes in 1988. From 1989 to 2003 the landings fluctuated around 1.3 million tonnes annually. The major constituents of the pelagic resources such as the oil sardine, mackerel, Bombayduck and lesser sardines fluctuated with high inter-annual variations. Other pelagic groups such as the carangids, seerfish and tunnies, showed a general increasing trend.

The landings of the demersal resources including the demersal finfish, crustaceans and molluscs (only cephalopods) have enhanced from 0.23 million tonnes (34% of the total) in 1961 to 1.19 million tonnes (50% of the total) in 2003 (Fig. 3). A steep increase in the demersal landings occurred in 1973, especially along the southwest coast. On an all India

basis, except the landings of the resources such as catfish, elasmobranchs, whitefish, silverbellies and pomfrets the landings of all other major resources namely, the perches, croakers and the soles including the penaeid and non-penaeid prawns and cephalopods (squids and cuttlefish) had shown increasing trend. However, the trend in the aggregated landings of the demersal fish resources leveled off since 1994.

The overall trends may mask the regional differences in the development of fisheries and variations in resources availability and abundance. Hence the resource trends in each of the four regions namely the northeast (West Bengal and Orissa), southeast (Andhra Pradesh, Tamil Nadu and Pondicherry), the southwest (Kerala, Karnataka and Goa) and the northwest (Maharashtra and Gujarat) are discussed separately (The island territories of Lakshadweep and Andaman & Nicobar are not taken into account).

2.5 Northeast

The landings in this region increased from 9.2 thousand tonnes during 1961 to about 262 thousand tonnes during the year 2003 (Fig. 4) forming 1.3 and 5.9% of the total all India landings. Up till the year 1991, the state of Orissa used to be the major contributor to the regional landings. Since 1992, the state of West Bengal emerged as the dominant contributor. The annual rate of growth for each decadal period from 1961 was gradually declining (27% during 1961-'70; 16.9% during 1971-'80; 11.7% during 1981-'90 and 404% in 1991-2000). Thus, the declining trend in the rate of growth clearly suggests that the production from this region would soon reach an asymptotic level.

Although the states of West Bengal and Orissa are grouped in a single region, there are differences in the development and type of fisheries between there to states. In West Bengal the contribution of the pelagic and demersal resources were more or less the same from 1976 to 1988. However since 1989, there was quantum leap in the production of pelagic groups, especially the *Hilsa shad* and since then the landings of the pelagic groups was about double that of the demersal resources. Contrastingly, in Orissa the landings of the demersal resources were generally higher than the pelagic resource landings. In Orissa, the landings of the latter fluctuated around 16 thousand tonnes. However, the landings of the demersals showed a declining trend from about 40 thousand tonnes in 1993 to 19 thousand tonnes in 1998.

Major constituents of the pelagic landings in West Bengal are the *Hilsa shad*, Bombayduck, carangids and seerfish. The landings of carangids had exhibited general increasing trend. The Bombayduck production which was very low up to the year 1988, suddenly began to increase, reaching a peak of about 20 thousand tonnes in 1993 and since then it fluctuated about 10 thousand tonnes annually.

Elasmobranchs (sharks, skates and rays), catfish, croakers, pomfrets, penaeid prawns and non-penaeid prawns are the major contributors to the demersal resources landings. The production of the catfish and pomfrets leveled off after the year 1991 to around 4,500 and 2,500 tonnes annually. There was a general increasing trend in the landings of the penaeid and non-penaeid prawns, with some inter annual variations.

2.6 Southeast

Although the total landings in the region increased by 3.5 times from the year 1961 to 5.62 lakh tonnes during the year 2003 (Fig. 4) its share in the all India total landings

fluctuated, with little variation, between 26% in 1961 to 21% in the year 2003. The increase in the landings was mainly due to spurt in the landings of the small pelagics especially the oil sardine, mackerel and carangids. In each of the three decadal periods since 1961 the rate of growth was gradually declining with 3.8, 3.8, 2.8 and 2.3% respectively. The declining rate of growth during these periods amply suggests that the landings will soon level off.

The main feature of the fisheries of this region is the increased landings of the pelagic resources. Up till the year 1985, both the pelagic and demersal resources were increasing with more or less same rate of growth, however from 1986, there was a sudden jump in the rate of pelagic fish landings. A significant development in this region was the emergence of oil sardine as an important source of production. Its landings increased from about 19 thousand tonnes in 1989 to 110 thousand tonnes in 1997. During the year 1997 and 1998, it had been the single largest contributor to the total landings in the states of Andhra Pradesh and Tamil Nadu. The combined landings from these two states was higher than the traditionally high yielding states of Kerala and Karnataka. Similarly, the landings of mackerel, carangids had increased considerably.

The demersal fish landings had much less rate of growth than the pelagics. In Andhra Pradesh, the demersal fish landings were more or less about 20 thousand annually during the period 1961 to 1971. It rose to about 60 thousand tonnes in the year 1975 and from 1976 to 2000, the annual landings were more or less invariant around 40 thousand annually. The major demersal fish resources are the elasmobranchs, catfish, perches, croakers and silverbellies. Penaeid prawns, crabs and non-penaeid prawns form the bulk of the crustacean landings. Cephalopods form an economically important component of the trawl fishery.

2.7 Southwest

The region comprising the states of Kerala, Karnataka and Goa had been the most productive region and was the largest contributor to the country's total marine fish landings till 1994. Since then, it had been relegated to the second position by the northwest region. The relative contribution of the southwest region to the country's total production had dwindled from about 51% in the year 1965 to 31% in the year 2000 (Fig. 4). The marine fish landings of the region are characterized sudden jumps in production after periods of stabilized production. However, after registering peak landings of about 1.02 million tonnes in the year 1989, there had been gradual decline. The growth rates during the different decadal periods since 1961 were 9.4, - 3.2, 10.7 and 0.7%. The growth during the latest phase is the indicative of the present status of the fishery. This clearly indicates that from the presently exploited grounds off this region with existing technology, there would not be any augmentation in the total landings.

The feature of the marine fisheries of the region is the predominance of the pelagic resources. However, their contribution to the total marine fish production had fallen from about 80% during 60's and 70's to just above 50% in the late nineties, this was compensated by increased representation from the demersal resources. The total landings of pelagic groups remained more or less around 3.3 lakh tonnes annually during the period 1964-'88. There was a quantum jump to 7.2 lakh tonnes in the year 1988, owing mainly to bumper landings of oil sardine and mackerel. A significant event had been the set back to the oil sardine fishery during the year 1994, yielding a meager 3 thousand tonnes. However, the landings tended to increase and registered a peak landing of 3.1 lakh tonnes in the year 2003. The other pelagic

resources such as the mackerel, carangids, tunas and seerfish, though generally exhibited increasing trend up to 1990 and of late, their production seemed to level off.

Unlike the pelagic fish production which had shown high inter annual variations, the demersal fish landings increased steadily from about 35 thousand tonnes in 1961 , attaining a peak of 1.8 lakh tonnes in 1993. Except the landings of the elasmobranchs (mainly sharks) catfish and silverbellies other demersal fish resources exhibited general increasing trend in the landings. Among the resources which recorded decreased landings over the years, Catfish resource was the most prominent. From a historical peak of about 38 thousand tonnes in the year 1975, the landings dwindled to 250 tonnes in 2000.

The landings of the crustacean resources (mainly the penaeid prawns, non-penaeid prawns, crabs, lobsters and stomatopods) attained an all time peak of about 1.6 lakh tonnes in the year 1994 and suddenly slumped to about 90 thousand tonnes in 1995. Since then there was an improvement in the landings.

2.8 Northwest

There was a spectacular growth of marine fish production of this region from about 0.2 million tonnes in the year 1961 to 1.1 million tonnes in 2000 (Fig. 4) owing primarily to the rapid development of fisheries in the state of Gujarat. Since the year 1994, this region had emerged as the single largest contributor to the total marine fish landings in India. The annual growth rate during each of the decadal periods since 1961 were 3.9, 5.1,3.8 and 3.9%. For the last phase the growth rates in Gujarat and Maharashtra were 6.2 and –0.46% respectively, indicating differential growth pattern among the constituent states of the region.

The pelagic finfish production in this region increased from about 1.2 lakh tonnes in 1961 to 3.9 lakh tonnes in 1998, the relative contribution however declined from about 57% in 1961 to about 35% in 1998. Bombay duck, ribbonfish, carangids, mackerel, seerfish and tunas are the major components of the pelagic finfish production. In Maharashtra, the landings of Bombay duck have been declining from about 82 thousand tonnes in 1980 to about 10 thousand tonnes in 1996, whereas in Gujarat the production is fluctuating between 60–80 thousand tonnes during 1991-2000. In both the states the ribbonfish landings had registered high growth rate reaching the peak production in the year 1997.

Unlike the pelagic landings, the development of demersal fisheries was spectacular which registered an eight-fold increase in the landings from about 0.85 lakh tonnes in 1961 to 7.1 lakh tonnes in 1998. This phenomenal growth was mainly due to increased production from Gujarat. In Maharashtra the demersal fish production leveled off around 80 thousand tonnes since 1985, whereas the production of the crustaceans and cephalopods (molluscs) showed a general increasing trend in both the states.

3. Status of exploitation, resources and the fisheries potential

Until the 1970s, the emphasis of marine fisheries management in India was to increase production through improved fishing technology, infrastructure (harbours, roads, processing and market facilities) development and incentives and subsidies to the fishermen. This has led to increasing the marine fish production from 0.5 in 1950 to 2.6 million tonnes in 2003 (Fig. 1). However, during the 1980s, concerns were expressed on the unrestricted growth of the fishing fleet and its possible adverse impact. The researches

carried out on different species stocks also voice these concerns (See Murty and Rao 1996). As already indicated the mode and method of exploitation over the years has under gone tremendous changes, resulting in increased fishing pressure. The coastal fisheries exploit a large number of species using different craft and gear combinations mostly in the depth range of 0 to 50 m though in recent years, this has been extended to about 120 m in some regions.

From the analysis of the resource trends it is evident that in most of the regions the production from the exploited resources appears to have been fast reaching the asymptotic level and in some cases the production seems to have reached the limiting value. Some of the resource-region combinations have exhibited even declining trend. The stock assessment studies carried out by the CMFRI for more than 50 resources (or species) have also indicated in most of the regions the stocks are either fully exploited or over exploited. The exploitable potential fishery resources have been revalidated at 3.93 million tonnes. This revalidation was done in the year 2000 by the Ministry of Agriculture, Govt of India. The working group on revalidation observed that the fishing effort expended in the shelf waters was optimal and recognized that chances of any significant improvement in the total landings would be remote. For exploiting the potential yield there was urgent need to diversify the fishing activities in the EEZ through directing the fishing towards deep-sea resources such as sharks, tunas, squids etc. Oceanic resources consist of tunas (*Thunnus albacares, T.obesus, Katsuwonus pelamis*), billfishes, myctophids (*Benthosema* spp., *Myctophum* spp. and *Diaphus* spp.) and oceanic squids (*Symplectoteuthis oualaniensis, Onychoteuthis banskii, Thysanoteuthis rhombus*). But there was no directed fishery for these species, except some exploitation by chartered vessels which operated under the deep-sea fishing schemes in the nineties. Logline surveys conducted by Fishery Survey of India (FSI) have also revealed the abundance of yellowfin tuna and pelagic sharks (Somavanshi, 2001).

For conservation and for obtaining sustainable yields many of the maritime states have enacted marine fishery regulation acts banning fishing activities by certain section of the fishery sectors during certain period of the year. In the west coast, there is ban on fishing by the trawlers during the monsoon season for a period ranging from 45 to 60 days. In the east coast the ban on fishing was implemented from 15 April to 31 May. Whether such a regulation yielded the desired results is still a debatable issue. However, it was felt such a regulation would give respite not only to the resources, which are under heavy exploitation but also to the ecosystem to regain its productivity.

4. Issues

4.1 Declining catch rates and excess fleets

The annual growth rate of marine fisheries sector increased from 4.3% during the seventies to 4.8% during the eighties and declined to 4.0% during the nineties (Anon, 1997) and the fall in the growth rate is reflected in the annual catch attaining the optimum levels in the inshore fishing grounds (upto a depth of 50 m) of about 0.18×10^6 sq km area. The substantial increase in fishing effort since the 1970s has resulted in the decrease in per capita area per active fishermen and per boat in the inshore fishing grounds and also in the

catch rates, which in turn have given rise to conflicts among different categories of fishermen, especially artisanal and mechanised sectors (Sathiadhas, 1996). Technological improvements in capital-intensive fishing implements have also rendered existing older units less economical or non-operational, leading to substantial idling of fleets and underemployment (Sathiadhas *et al*., 1999).

4.2 Impact of bottom trawling on sea bottom and benthic biota

At present about 45,000 bottom trawlers operate (mainly targeting shrimps) in the entire inshore region. This kind of excessive bottom trawling is feared to have far reaching consequences such as degradation of the sea bed ecosystem and its biodiversity as a large number of non-target groups comprising of juveniles and sub-adults of economically important finfishes and shellfishes and also benthic organisms, most of them with little edible value but occupying key positions in the marine food web are also destroyed (Anon, 2000a).

4.3 Discards/exploitation of juveniles and sub adults

The discards in the Indian Ocean region account for 2.27 million t forming nearly 8.4% of the total global discards (Alverson *et al*., 1994). Though there are no precise estimates of discards in the Indian seas, certain studies suggest that about 0.3 million tonnes is discarded by shrimp trawlers annually. The trawl by-catch includes on an average of 10% juveniles/sub adults of several coastal species. Large-scale removal of young fishes by gears like ring-seine has been a cause for major concern in respect of certain pelagics. Large-scale removal of juveniles of fishes and prawns along southwest and southeast coasts respectively has been going on by 'mini trawls' and certain artisanal gears in shallower regions less than 5m. The quantity of discards from trawlers may further increase in view of the rapid expansion of the multiday fishing. Therefore there is an urgent need to devise suitable measures for reduction/prevention of juvenile exploitation along with measures for onboard collection/preservation of 'discards' and their value addition to prevent economic waste.

5. Initiatives for Fishery Resources Conservation and Management

5.1 Policy support: In 1979 the Ministry of Agriculture (GOI) prepared a Model Bill to regulate coastal fishing and circulated it to all coastal states of India. It suggested demarcating an area upto 10 km from the coast exclusively for traditional craft and beyond the 20 km limit for deep-sea vessels. Subsequently, from 1980 onwards, the Marine Fishing Regulation Acts (MFRA) aiming at sustainable fishing were passed by various maritime states with measures like:

- ? Imposing closed season during monsoon
- ? Restricting fishing effort
- ? Banning destructive gears/ fishing methods

Recently, based on discussions the Ministry of Agriculture (GOI) had with coastal states/UT and CMFRI and FSI, the GOI has initiated a move to impose a uniform ban on trawl fishing during the monsoon months along the entire Indian coast.

Potential yield of Fishery Resources in the Indian EEZ was estimated in 1991. Revalidation of this estimate has been done in 2000 (Anon. 2000b) taking into account the additional information on commercial catches, exploratory surveys and fishing results from chartered/ joint ventures that have accrued since the estimate of 1991. This will help in proper management of the fisheries by suitably redeploying the effort.

The Government of India have appointed an Expert Group to formulate the National Marine Fisheries Policy. The expert group has since submitted the report with several important recommendations (Anon, 2001).

5.2 Research Support

Collection and analyses data on landings to understand interannual and seasonal variability, species composition and length composition of catches and research on biology and population dynamics are carried out by the Central Marine Fisheries Research Institute. Holistic models such as the ecopath model are being applied in recent years. Studies are also being carried out on the effect of technological advancements on the socioeconomic conditions of the fishermen community. Training for empowerment of the fishermen community is also undertaken. Installation of Artificial Reefs to enhance productivity of coastal waters to benefit the traditional fishermen and sea ranching (Pearl oysters in traditional Pearl Oyster Banks in Gulf of Mannar, Clams in Cochin and Quilon backwaters, *P. semisulcatus* in sea grass beds off Mandapam) have also been done by the Institute.

6. Projection

The relative annual rates of growth in total landings for three decadal periods from 1961 and during 1991- 2000, by all India bases, by region and by the individual maritime state were considered for making projections. It is observed that in some of the regions and states the rates of growth are approaching or crossed zero growth. In some states there was still a positive growth indicating possibilities of enhanced landings. However, the declining rate of growth over the years indicates that the production would soon level off.

Based on the rates of growth, the projections for the year 2005 were made by taking the year 2000 as the base. The optimistic projections suggest that the total production in the year 2005 will be to the tune of 2.9 million tonnes. The pessimistic projections were made assuming that the growth rate would halve from 2000. These projections indicated that the total production would be around 2.8 million tonnes.

It was mentioned earlier that the pelagic resources dominated the marine fish production in India. Most of these stocks are annual crops, meaning that they are predominantly O year class, whose abundance depends on the variations in the recruitment. It is well known that the abundance of the pelagic stocks depends more on the fishery independent factors, such as the water chemistry, oceanographic parameters, meteorological variable and food availability. Any future projections thus should take into consideration these variables. Among the pelagic resources, oil sardine, mackerel, ribbonfishes, Bombayduck and carangids are the major contributors. The variations in the abundance of any one or all of them would affect the total production. Assuming, for pessimistic projections there is a reduction of 10-30% in resource availability and assuming the resource availability is directly proportion to the landings, the total landings including

all resources is likely to reduce and will be in the range of 24.5 to 26 lakh tonnes. Thus, upto the year 2005, the total production may fluctuate between 2.4 to 2.9 million tonnes.

7. Conclusion

The production trends indicated regional and intra regional variations in the major exploited resources. Trends in the landings of the different resource assemblages such as the pelagic and demersal resources together with the trends in the effort expended by different sectors namely the mechanized and motorized brought out the differential fishery developments between the regions.

Another significant observation was that the landings of the aggregated demersal fish resources in most of the regions had either leveled off without any signs for further enhancement. Thus only expected gains could be from the pelagic resources and other crustacean and cephalopod resources. Stock assessment studies by the CMFRI also indicated in most of the regions, the species of the resources indicated above are either fully exploited or over exploited. The estimates of the potential yields obtained from the currently exploited areas into the existing harvesting practices, indicate a possibility of additional yield of about 4 to 5 lakh tonnes. This is expected to be achieved if the resource groups could be restored to their historical maximum values, through proper fishery management strategy.

REFERENCES

ALVERSON, D., M. FREBERG, S. MURAWSKI AND J.G. POPE. 1994. A global assessment of fisheries by catch and discards. *FAO Fish.Tech.pap.,* 233 pp.

ANON. 1997. *Vision 2020-CMFRI Perspective Plan*. (Ed. Murty, V.S) Central Marine Fisheries Research Institute (ICAR) Cochin, 70 pp.

ANON. 2000a. *Annual Report 1999-2000.* Central Marine Fisheries Research Institute, Cochin, 148 pp..

ANON., 2000b.*Report of the Working Group for revalidating the Potential of Fishery Resources in the Indian EEZ.* Ministry of Agriculture, Dept. Of Animal Husbandry and Dairying. New Delhi, 57pp, 16 tables.

ANON. 2001. *Report of the Expert Group for Formulation of comprehensive Marine Fisheries Policy*. Ministry of Agriculture, Dept. Of Animal Husbandry and Dairying. New Delhi, 27 pp.

DEVARAJ, M., V. SRIRAMACHANDRA MURTY, R. SATHIADHAS AND K. K. JOSHI. 1998. The New Economic Policy and Perspective for Marine Fisheries Research and Development in India. *Fishing Chimes,* **18** (5): 18-29

DEVARAJ, M., V.K. PILLAI, K.K. APPUKUTTAN, C. SUSEELAN, V.S.R. MURTY, P. KALADHARAN, G. SUDHAKARA RAO, N.G.K. PILLAI, N.N. PILLAI, K. BALAN, V. CHANDRIKA, K.C. GEORGE AND K.S. SOBHANA 999. Packages of practices for sustainable, ecofriendly mariculture (land-based saline aquaculture and seafarming). *In:* Mohan Joseph Moadyil (Ed) *Aquaculture and the Environment,* Asian Fisheries Society, Indian Branch : 33-69.

JAMES, P.S.B.R., V. SRIRAMACHANDRA MURTY AND P. NAMMALWAR. 1996. Groupers and Snappers of India: Biology and Exploitation. 106-136. ***In***: F. Arreguin-Sanchez, J.L. Munro, M. C. Balgos and D. Pauly. (Eds.) *Biology, Fisheries and Culture of Tropical Groupers and Snappers. ICLARM Conf. Proc.,* **48**: 449 pp.

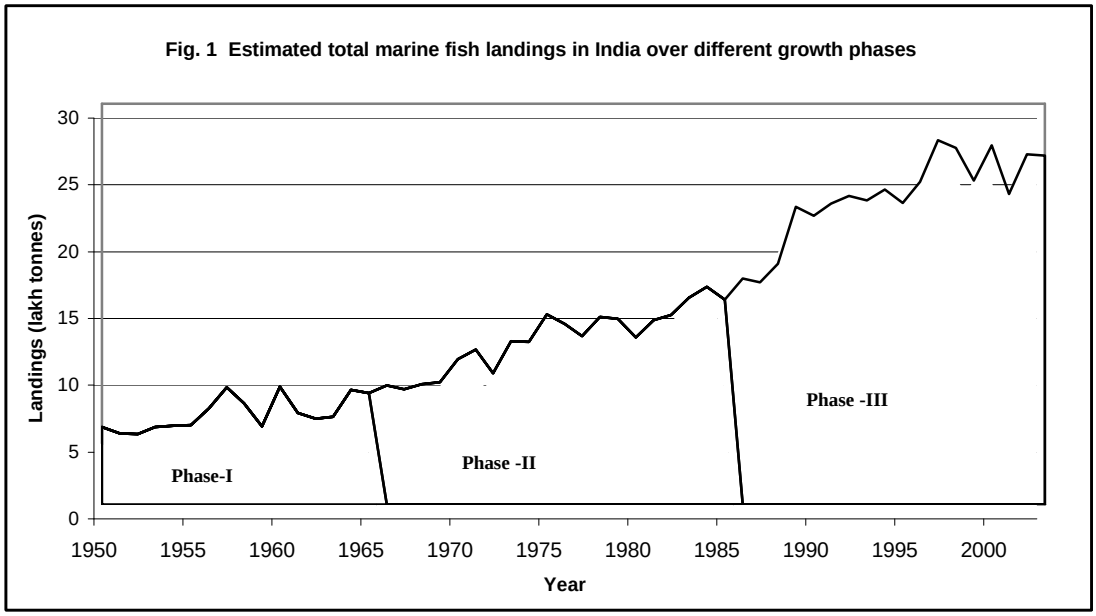
MURTY, V. S., T. APPARAO, M. SRINATH, E. VIVEKANANDAN, K.V.S. NAIR, S.K. CHAKRABORTHY, S.G. RAJE AND P.U. ZACHARIA. 1994a**.** Stock assessment of threadfin breams (*Nemipterus* spp.) of India*. Indian J. Fish.* (1992), **39**: 9-41.

MURTY, V. S., M. SRINATH, P. LIVINGSTON, Y. A. SASTRY AND S. SREENIVASA RENGAN. 1994b. Stock assessment of silverbellies of India with particular reference to Andhra Pradesh and Tamil Nadu. *Indian J. Fish.* (1992), **39**: 42-64.

MURTY, V.S. AND P. VEDAVYASA RAO 1996. Marine Fishery Resources of India – Present status and management concerns. Pp 103-125 *In:* N.G. Menon and C.S.G.Pillai (Eds), *Marine Biodiversity Conservation and Management*, CMFRI, Cochin

RAO, T.A., R.S. LALMOHAN, S.K. CHAKRABORTHY, V. SRIRAMACHANDRA MURTY, K.V.S. NAIR, E. VIVEKANANDAN AND S.G. RAJE. 1992**.** Stock assessment of sciaenid resources of India. *Indian J. Fish.*, **39**: 85-103

SOMVANSHI, V.S. 2001. Problems and Prospects of Deep sea and far sea fishing. *In:* Pandian T.J.(ed.) *Sustainable Indian Fisheries.* National Academy of Agricultural Sciences pp. 71-87.



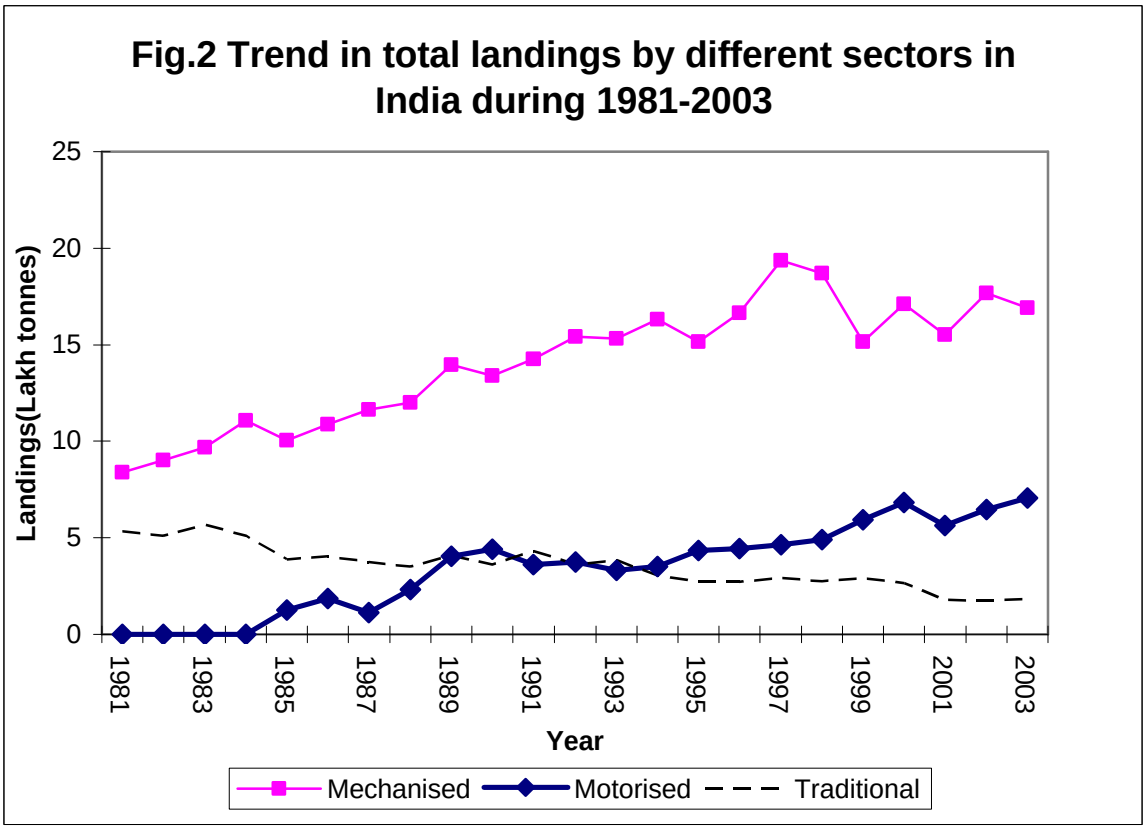


Fig. 3 Trend in pelagic and demeresal resources landings in India during 1961-2003

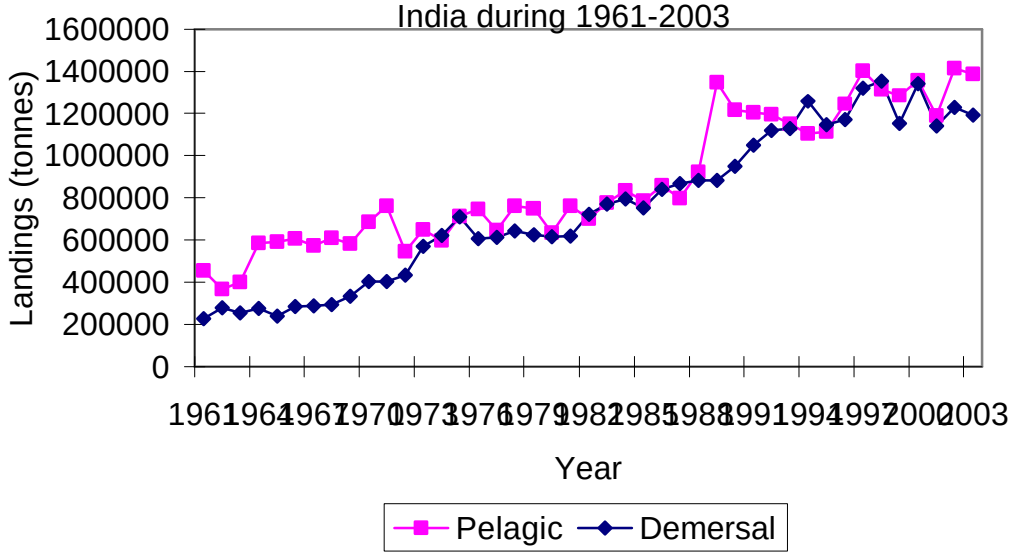


Fig. 4 Trend in the total marine fish landings in different regions (1961 - 2003)