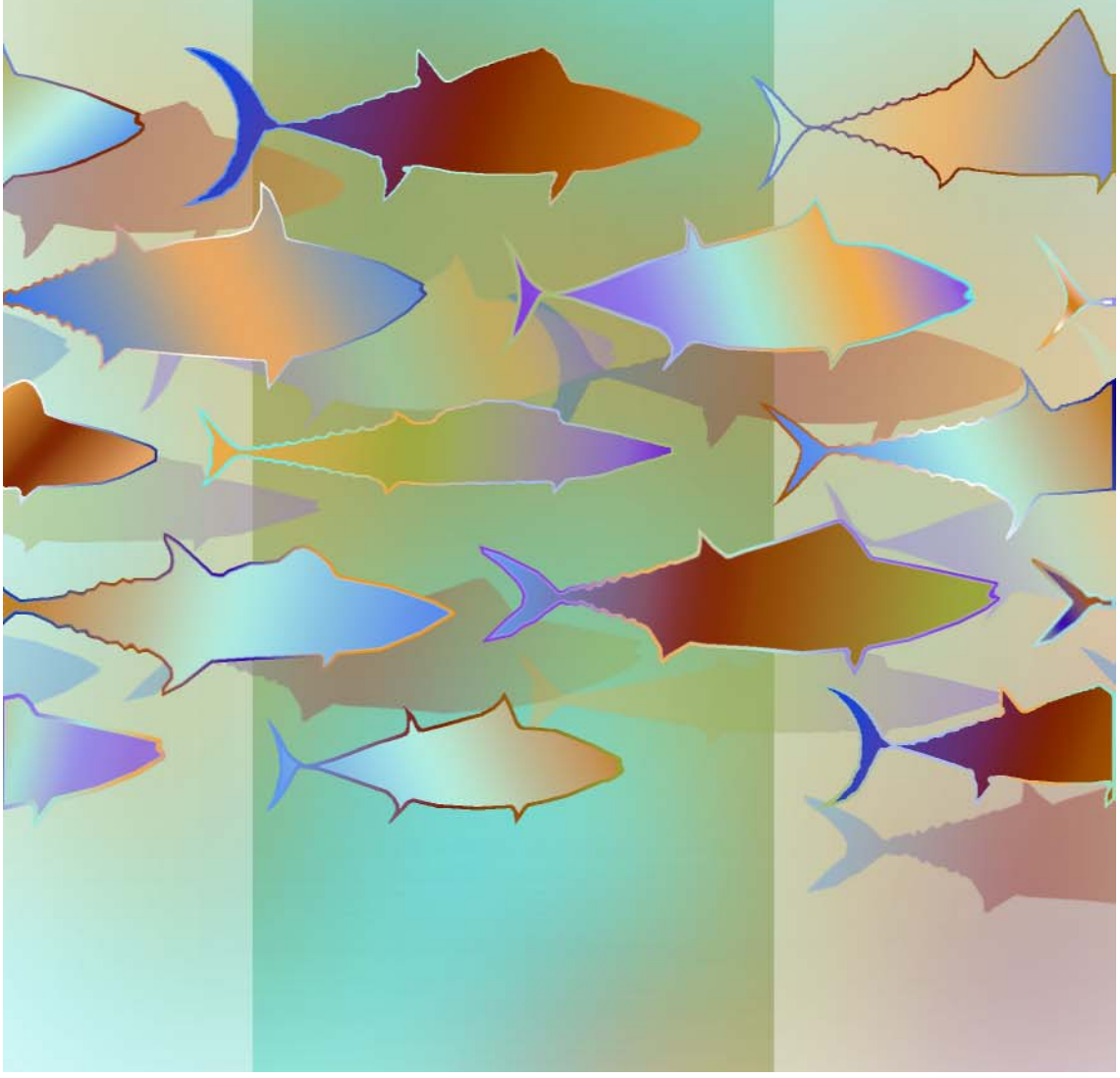
Status of Exploited Marine Fishery Resources of India



STATUS OF EXPLOITED MARINE FISHERY RESOURCES OF INDIA

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An Appraisal of the Exploited Marine Fishery Resources of India

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1. Introduction

The marine fisheries sector in India has witnessed a phenomenal growth during the last five decades both quantitatively and qualitatively. The subsistence fisheries during the early 50's produced about 0.5 million tonnes annually. Currently, the total production is about 2.7 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. The increased effort over time and space is the consequence of ever-increasing demand for marine food both from external and internal markets. This phenomenal growth also brought in imbalances in the exploitation across the regions and among the resources. Besides, with production levels for most of the commercially important resources showing signs of approaching saturation levels, inter sectoral conflicts increased due to competition to exploit the common resource. Fleet size and operations underwent quantitative and qualitative change. Traditional boats are being increasingly motorised and the mechanised sector operating with trawlers and gillnetters are resorting to multi-day fishing, thus contributing to increased fishing pressure. The situation thus calls for an appraisal of the status of the resources on a regional and all India basis, taking into consideration the scientific database developed over a period of about half a century to enable formulate suitable strategies of exploitation and management.

Monitoring and assessment of the exploited marine fishery resources of India is one of the important mandates of the Central Marine Fisheries Research Institute (CMFRI).

Stock assessment of the exploited resources would enable evolving the management reference points to facilitate judicious exploitation of the stock for long-term sustenance. To accomplish this, a strong and reliable database on the various aspects of the fisheries is essential. With this in view, the CMFRI has developed a multistage stratified random sampling design to collect the required information to estimate the marine fish landings along with effort expended and other biological information. The Institute has a strong database on the exploited marine fishery resources of the country and the National Marine Living Resources Data Centre (NMLRDC) is the repository of information, which manages the database.

The assessment of exploited stocks would ideally be carried out using the fishery dependent factors and the biological information such as growth and mortality. However, in a multispecies-multigear system, it would not be possible due to obvious reasons. So, it was necessary to analyse the multispecies - multigear system in its entirety and to assess the status of the fishery by identifiable patterns in the time series of landings. Towards this, a macro approach is followed to assess the status of the exploited resources based on the long-term trend in the landings. This paper attempts to appraise the status of the fishery through the regional and temporal production trends besides the trends in the component resources and the different sectoral production trends. Using the production trends, an attempt is also made to estimate the potential yield obtainable from the currently exploited regions and based on the rate of growth in production, the total landings were projected for the year 2005. The estimates of marine fish landings are made from the stratified multistage random sampling design adopted by the CMFRI. Estimates (gear wise, resource wise and region wise) obtained during 1961-2000 are used for the present study.

2. Means of production

Before an analysis is made on the trends in the production, it would be appropriate to examine the quantitative growth in the means of production namely, men and material. The CMFRI has conducted frame surveys including census of fishermen and craft and gear during 1961-62, 1973-77, 1980 and 1998. During 1998, a rapid census of fishing craft and gear was conducted. The results are summarised in Table1.

Table 1. Growth in manpower and fleet size

Year	1961-62	1973-77	1980	1993*	1998
Active fishermen (in lakhs)	2.3	3.2	4.7	8.0	10.0 **
Artisanal craft					
Motorised	–	–	–	26171	50922
Non-motorised	90424	106480	140833	155925	76596
Total	90424	106480	140833	182096	127518
Mechanised	–	8086	19013	34571	49070
Trawlers	–	NA	11316	NA	30979

* Source: Ministry of Agriculture, Govt. of India

** Projected NA - Not available

Introduction of mechanised fishing and motorisation of country craft are the significant events which gave a good boost to the marine fish production in India. It is seen from the above Table that there has been very high growth in the number of motorised and mechanised crafts. The motorisation was started in the early eighties in Maharashtra and Gujarat. Later on, the process of motorisation was initiated in all the other maritime states, more extensively in Kerala. As per the 1998 census, there are 30,979 trawlers followed by gillnetters (9,968), dolnetters (5,538) and other craft (81,033). Maximum number of motorised craft is in Tamil Nadu followed by Kerala and Andhra Pradesh. These three states accounted for 75% of the total motorised craft in the country.

3. 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 2.7 million tonnes in the year 2000. However, 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 mechanisation was in the initial stage. Phase-II is characterized by substantial increase in the use of synthetic gear materials, export trade expansion, increased use of mechanised craft, establishment of fishing harbours, introduction of purse seine and initiation of motorisation of country craft. Phase-III witnessed substantial growth in motorisation of artisanal fleet, increased use of ring seine, extension of fishing grounds and increase in fishing hours by resorting to voyage fishing, introduction of seasonal closure of the fishery.

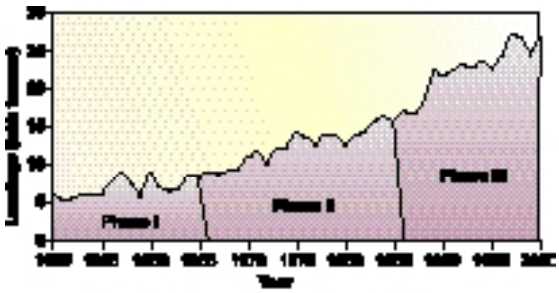

Fig. 1. Marine fish landings in India over different growth phases

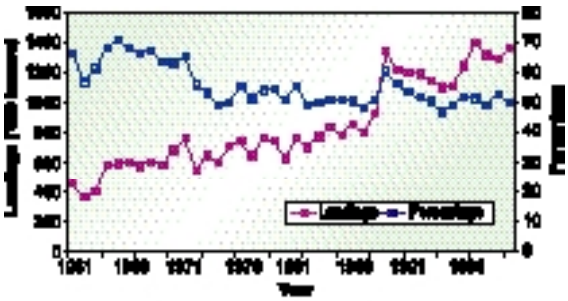

Fig. 2. Trend in pelagic fish landings in India during 1961-2000

The production from the pelagic fish resources (Fig. 2) in the country had a three-fold increase since 1961, reaching 1.36 million tonnes

in 2000 with a peak of 1.40 million tonnes in 1997. 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 2000 the landings fluctuated around 1.2 million tonnes annually. The major constituents of the pelagic resources such as the oil sardine, mackerel, Bombay-duck and lesser sardines fluctuated with high inter-annual variations. Other pelagic groups such as the carangids, seerfishes and tunnies, showed a general increasing trend.

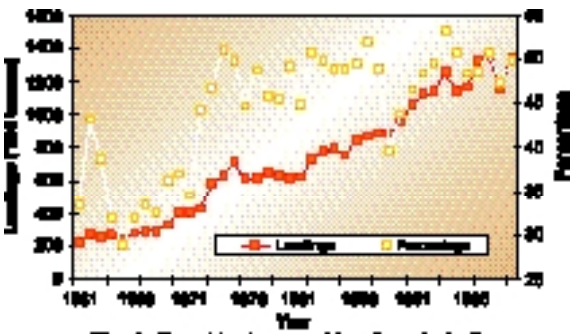

Fig. 3. Trend in demersal landings in India during 1961-2000

The landings of the demersal resources (Fig.3) including finfishes, crustaceans and molluscs (only cephalopods are considered) have increased from 0.23 million tonnes (34% of the total) in 1961 to 1.33 million tonnes (50% of the total) in 2000. 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 catfishes, elasmobranchs, whitefishes, silverbellies and pomfrets, the landings of all other major resources namely, the perches, croakers, soles, penaeid shrimps and non-penaeid prawns and cephalopods (squids and cuttlefishes) had shown increasing trend. However, the trend in the aggregated landings of the demersal fish resources levelled off since 1994.

The general increasing pattern in production discernible at all India level for most of the resources may not truly represent the trends in the resources exploited from different hydro-climatic zones of the country. 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 were not taken into account in this study).

Northeast

The landings in this region increased from 9,200 tonnes during 1961 to about 1,56,000 tonnes during the year 2000 forming 1.3 and 5.9% of the total all India landings (Fig. 4). Up to the year 1991, the state of Orissa used to be the major contributor to the regional landings. Since 1992, 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 4.4% 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 West Bengal and Orissa are grouped as a single region, there are differences in the development and type of fisheries between the two 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 and since then the landings of the pelagic groups were about double that of the demersal resources. Contrastingly, in Orissa the landings of the demersal resources were generally higher than that of the pelagic resource. The landings of the latter fluctuated around 16,000 tonnes. However, the landings of the demersals showed a declining trend from about 40,000 tonnes in 1993 to 19,000 tonnes in 1998.

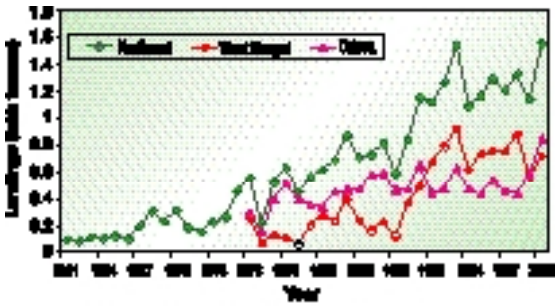

Fig. 4. Trend in the total marine fish landings in the northeast region

The major constituents of the pelagic landings in West Bengal are the Hilsa, Bombay-duck, carangids and seerfishes. The landings of carangids had exhibited an increasing trend. The Bombay-duck production which was very low up to the year 1988, suddenly began to increase, reaching a peak of about 20,000 tonnes in 1993 and since then fluctuated around 10,000 tonnes annually.

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

Southeast

Although the total landings in the region (Fig. 5) increased by 3.5 times from the year 1961 to 5.92 lakh tonnes during the year 2000, its share in the all India total landings fluctuated, with little variation, between 26% in 1961 to 23% in the year 2000. 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.

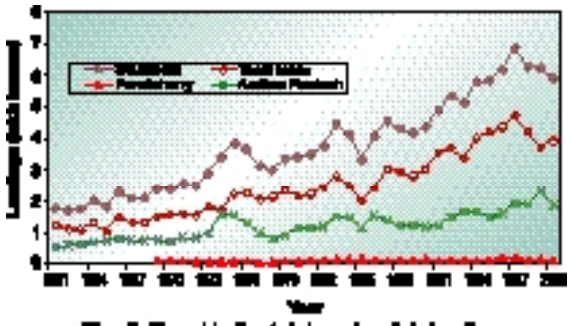

Fig. 5. Trend in the total marine fish landings in the southwest region

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 a commercial fishery. Its landings increased from about 19,000 tonnes in 1989 to 110,000 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 were higher than the traditionally high yielding states of Kerala and Karnataka during those years. Similarly, the landings of mackerel and carangids had increased considerably. Mackerel landings exhibited very high inter annual variation from the year 1985, with a peak of about 60,000 tonnes in the year 1992. Contrary to the trend in other pelagics, the ribbonfish landings are declining along both coasts of the Tamil Nadu and Andhra Pradesh. The landings of the seerfishes have been increasing since 1991 especially along the Tamil Nadu coast. However, it has been oscillating with an annual average landing of about 5,000 tonnes along the coast of Andhra Pradesh.

From the year 1989, there had been gradual increase in the gillnet operations both by the mechanized and motorized craft, especially the latter. In Andhra Pradesh, the unit operations by motorized craft (employing gill nets) increased from about 76,000 in 1992 to about 6,00,000 during the year 2000. Along the Tamil Nadu coast it increased from 2,11,000 in the year 1991 to 19,56,000 in the year 2000. These operations are mainly targeted to harvest the small pelagic resources.

The demersal fish production indicated a lesser rate of growth than that of the pelagics. In Andhra Pradesh, the demersal fish landings were more or less about 20,000 tonnes annually during the period 1961 to 1971. It rose to about 60,000 tonnes in the year 1975 and from 1976 to 2000, the annual landings were around 40,000 tonnes. The major demersal fish resources are the elasmobranchs, catfishes, perches, croakers and silverbellies. Penaeid shrimps, crabs and non-penaeid prawns constituted the bulk of the crustacean landings. Cephalopods formed an economically important component of the trawl fishery. In Andhra Pradesh, sharks formed the bulk of the elasmobranch landings where as in Tamil Nadu it was the rays. The production along Andhra Pradesh showed a general decline from the year 1973, whereas in Tamil Nadu, the landings tended to increase from the year 1992. The declining trend in the landings of catch of this region from a peak of

about 27,000 tonnes in 1973 the production had gradually dwindled to 3,000 tonnes in 1990. Later, there was sign of only a marginal recovery. Similarly, the landings of croakers reached an all time peak of 32,000 tonnes in the year 1981. From the year 1985, it levelled off to an annual average of about 20,000 tonnes. The landings of silverbellies also exhibited a similar trend and Tamil Nadu contributed to the bulk of the production. The penaeid shrimps, economically the most valuable component of the trawlers, are being increasingly landed, from about 5,000 tonnes in 1961 to about 45,000 tonnes in 2000.

Southwest

The region comprising the states of Kerala, Karnataka and Goa had been the most productive and the largest contributor to the country's total marine fish landings upto 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% during 2000. The marine fish landings of the region are characterized by sudden jumps in production after periods of stabilized production (Fig. 6). 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 true state of the fishery. This clearly indicates that with existing technology, there could not be any significant augmentation in the total landings from the presently exploited grounds off this region.

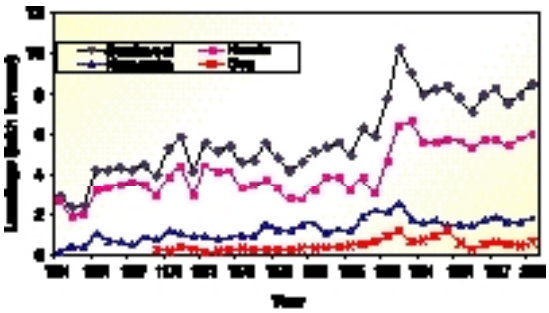

Fig. 6. Trend in the total marine fish landings in the southwest region

The striking 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 3,000 tonnes. However, the landings tended to increase and registered a peak landings of 2.9 lakh tonnes in the year 2000. The other pelagic resources such as the mackerel, carangids, tunnies and seerfishes, 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 35,000 tonnes in 1961 to about 1.6 lakh tonnes in 1998, attaining a peak of 1.8 lakh tonnes in 1993. Except the landings of the elasmobranchs (mainly sharks), catfishes and silverbellies, other demersal fish resources exhibited general increasing trend in the production. Among the resources which recorded decreased landings over the years, catfish resource was the most affected. From a historical peak of about 38,000 tonnes in the year 1975, the landings dwindled to 250 tonnes in 2000.

The landings of the crustacean resources attained an all time peak of about 1.6 lakh tonnes in the year 1994 and suddenly slumped to about 90,000 tonnes in 1995. Since then there has been an improvement in the landings. The penaeid shrimps reached a production peak of about 95,000 tonnes during the year 1973 and declined alarmingly to a low of 25,000 tonnes in the year 1981. However, it soon revived and reached a peak of 83,000 tonnes in 1984. It was observed, however, since 1987, the annual landings fluctuated around an annual average of about 60,000. In Karnataka, the landings exhibited much high inter annual variations. Another economically important resource, namely the cephalopods had been increasing up to 1993, and since then the landings levelled off around 50,000 tonnes annually.

Northwest

The 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 was spectacular owing primarily to the rapid development of fisheries in Gujarat (Fig. 7). 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 for the region was about 11.8% during 1961-98 (for Gujarat alone it was 18% and for Maharashtra it was 7%). 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 total marine fish landings in Maharashtra increased up to 1984 and for 12 years from 1985 to 1996, the production fluctuated around 3.3 lakh tonnes per year. However, in 1997 and 1998 it increased to 3.8 and 4.2 lakh tonnes respectively and production declined to 3.7 lakh tonnes in the year 2000. In Gujarat, the landings gradually increased from about 0.9 lakh tonnes in 1961 to 2 lakh tonnes in 1988, and since then there was much higher growth rate and reached a high of about 7 lakh tonnes in 1998.

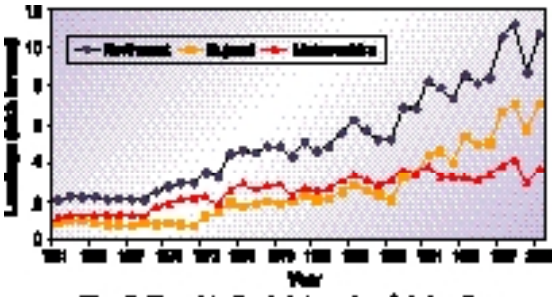

Fig. 7. Trend in the total marine fish landings in the northwest region

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, ribbonfishes, carangids, mackerel, seerfishes and tunnies are the major components of the pelagic finfish production. In Maharashtra, the landings of Bombay-duck have been declining from about 82,000 tonnes in 1980 to about 10,000 tonnes in 1996, whereas in Gujarat, the production is fluctuating between 60,000–80,000 tonnes during 1991-2000. In both the states, the ribbonfish landings had registered high growth rate reaching the peak production in the year 1997. The landings of the carangids levelled off in Maharashtra fluctuating between 10,000-20,000 tonnes, whereas in Gujarat it was still increasing. A similar trend was observed in the landings of seerfish also. The mackerel landings, the bulk of which was from the lower Maharashtra coast, was quite marginal during 1973 to 1988, but suddenly shot up and since then it was increasing with oscillating trend and reached a peak of about 40,000 tonnes in 1996.

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 levelled off around 80,000 tonnes since 1985, whereas the production of the crustaceans and cephalopods showed a general increasing trend in both the states. There was differential trend with respect to some of the important demersal resources. In Maharashtra, while the landings of elasmobranchs, catfishes, perches, penaeid shrimps and non-penaeid prawns were showing declining trend, these resources recorded increased landings in Gujarat.

4. Sectoral production trends

Exploitation by mechanised units especially by trawlers received a boost with the increase in export trade of the shrimps. Since the 1970s the pace of mechanization has been very fast and now the mechanized sector has emerged as the single largest contributor of the total landings in India, accounting for nearly two-thirds of the total production. The landings by all the mechanized craft including the trawlers, dol netters, purseseiners, gillnetters and other mechanized units have increased from 8.4 lakh tonnes in 1981 to 17.1 lakh tonnes in the year 2000 with a peak landings of 19.4 lakh tonnes in 1997 (Fig. 8). More than 80% of the landings was by the trawlers. In Tamil Nadu and Kerala, a declining trend was observed during the last five years mainly due to the poor landings by the trawlers. In

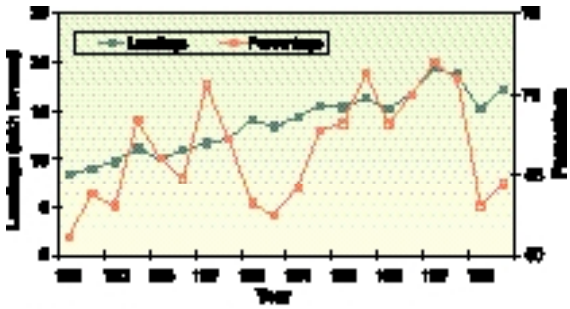

Fig. 8. Trend in total landings by mechanised craft in India during 1981-2000

Maharashtra, mechanized dol net fishery suffered a set back declining from 1.90 lakh tonnes in 1985 to an all time low of 30,000 tonnes during 1995. However, in Gujarat the mechanized dol net fishery grew from about 20,000 tonnes in 1981 to 1.2 lakh tonnes in the recent years. The trawler landings have been gradually increasing since 1981 and there was a spurt in the landing during 1994. Since 1997, the mechanized landings in the state have been fluctuating with an annual average of about 5.4 lakh tonnes.

The analyses of the trend in the effort expended by the different mechanized crafts revealed interesting results. Although there has not been any significant increase in the effort expended in terms of the unit operations, there has been gradual increase in the actual fishing hours. In many maritime states, most of the mechanized operations especially the trawlers are increasingly resorting to multiday fishing. Thus the increased catch per unit landed may not perhaps indicate the true status of the exploited stocks. Rather, it would be appropriate to examine the trend in the catch per actual fishing hour to understand the true status of the fishery. The change in the catch per unit in terms of the units landed and the actual fishing hour for some of the dominant trawl landing states from 1991 and 2000 is summarized in Table 2.

Table 2. Statewise changes in catch rates

State	Unit operations (x 000)		Actual fishing hours (in million)		Catch per unit effort (kg/unit)		Catch per hour (kg/hr)	
	1991	2000	1991	2000	1991	2000	1991	2000
Andhra Pradesh	98	115	1.2	4.12	457	631	38.5	17.5
Tamil Nadu	471	518	4.7	7.1	383	339	38.2	24.7
Kerala	554	413	2.9	4.0	384	552	73.6	57.4
Maharashtra	231	244	3.6	7.3	842	976	54.0	32.5
Gujarat	80	121	1.5	4.8	2154	3319	113.0	87.4

Motorisation of country craft has been one of the significant technological advancements that has facilitated easy mobility, faster access to the fishing grounds and ability to venture into deeper grounds. This process has had significant impact on the marine fishery supplemented by introduction of efficient gears such as the ring seines. The landings by the motorized craft increased from about 1.28 lakh tonnes in 1985 to 6.81 lakh tonnes (Fig. 9). Kerala accounted for the bulk of the landings by the motorized craft in the country. In other states, the contribution by this sector has been gradually increasing. Bulk of the landings by this sector

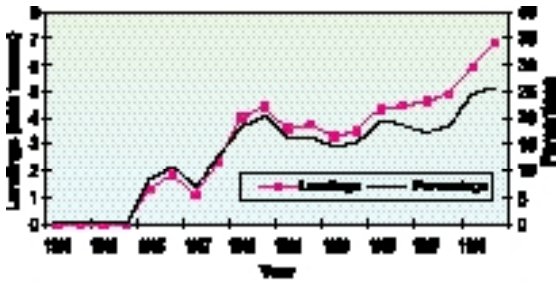

Fig. 9. Trend in total landings by motorised country craft in India during 1991-2000

consists of the pelagic resources such as oil sardine, mackerel, anchovies, carangids, etc. In the west coast, the landings by the ringseiners constitute the major component. In the east coast, the bulk of the landings is by the motorized craft operating the gill nets. In recent years, the operation of ringseiners has been causing concern. The dimension of the nets has increased manifold both vertically and horizontally. There is also reduction in the mesh size. In the initial years, the ring seines with mesh sizes of around 20 mm were in operation, now it was observed that there were large number of ring seines having mesh sizes in the range of 8 to 10 mm. Of late, increasing number of juveniles of the commercially important resources are landed posing threat to the long-term sustenance of the resources and economic viability of the dependent fishery. There is an urgent need for regulation of these units.

In the early sixties, almost the entire landings were by the indigenous craft and gear. With the introduction of mechanization and motorisation of country craft, the non-motorised artisanal sector has suffered set back and its contribution has been gradually dwindling (Fig. 10). In some of the states such as Gujarat, Maharashtra, Karnataka and to some extent in Kerala, the sector has been marginalized. Only in the states of Orissa, Tamil Nadu and Andhra Pradesh, there is still some prevalence of this sector. With motorisation of country craft fast catching up, it is expected that the non-motorized sector will be further marginalized.

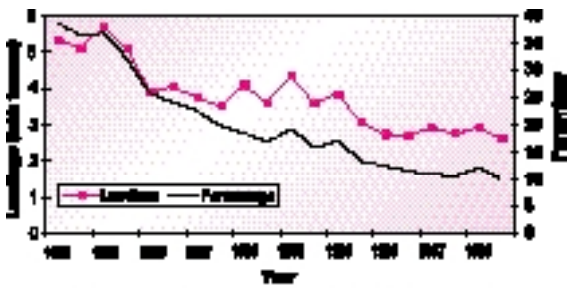

Fig. 10. Trend in total landings by non-motorised country craft in India during 1991-2000

It may be noted that in Orissa, the unit operations of the trawlers in a year had declined from about 1,12,000 during 1993 to about 38,000 during 2000. Similarly, the unit operations of the mechanized gillnetters decreased from 1,18,000 to 68,000 during the same period. However, in tune with increased motorisation of indigenous craft, unit operations of motorized boats (operating gill net) had increased from 10,000 to 2,82,000 t in a year. The unit operations by the trawlers of the Andhra Pradesh varied from 98,000 during the year 1991 to 1,15,000 during 2000, with an annual average of about 1,03,000 unit operations. However, the actual time spent for fishing for unit operations increased from 18 hours during 1991 to 36 hours during 2000. Along the Tamil Nadu coast, the units operated by the trawlers increased from 4,71,000 in 1991 to 5,18,000 in 2000. The fishing time spent per unit operation increased from 10 to 14 hours during the same period.

The unit operations by trawlers did not vary significantly during 1991-2000 in the state of Kerala, it fluctuated around an annual average of about 5,61,000; whereas the actual fishing time per unit operation increased from 5 to 10 hours in this period.

In Karnataka, the unit operations declined from 20,95,000 units operation during 1991 to 1,39,000 unit operations in the year 2000. However, the fishing time spent per unit operation increased from 10 hours to 19 hours during the same period. As regards the ring seine unit operations, there were no significant inter annual variations in both Kerala and Karnataka and they fluctuated around 239 and 10,000 unit operations respectively. In Kerala, the effort expended by motorised craft employing the gill net and trawl net had doubled since 1989, whereas in Karnataka gill net operations by the motorised craft witnessed a four-fold increase since 1989.

In Maharashtra, the unit operation of dolnetters per year declined during 1989 to 1994 and since 1995 they have been steadily increasing. Similarly, the purse seine unit operations had increased from about 8,000 in 1989 to 18,000 in 1998. In Gujarat, there were no significant variations over the years with respect to dolnetter operations. The unit operation of motorised craft employing gill nets had been gradually increasing in Gujarat from about 1,80,000 in 1990 to 5,09,000 in 2000. In Maharashtra, the unit operations of trawlers had increased from 1,71,000 to 2,44,000 in 2000 with a peak of 4,81,000 in 1998, however the actual fishing time per unit operation was observed to have increased to about 19 hours in 2000 from 16 hours in 1991.

5. Projections and conclusions

From the foregoing, it was observed in general that the aggregate landings on all India basis did show increasing trends. However, this may not truly reflect the true state of the fishery in the regional level. The production trends indicated regional and intra regional variations in the major exploited resources. Trends in the landings of 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.

It is well known that the process of development of a fishery as described by the changes in the landings has typical 'boom' and 'bust' characteristics. This process could be due to fishery dependent and fishery independent factors. In general, the development process could be identified from a long time series of the landings to be belonging to the four phases namely (1) under developed, (2) developing, (3) mature and (4) senescent. An analysis was done from the resource trends of the top 51 resource area combinations, referred to as resource groups. These account for more than 75% of the total marine fish landings of the country. The analysis revealed that about 40% of the resource groups are in the mature or senescent phase. The remaining 60% of the resource groups are in the developing phase, some of which are also tending towards the next phase. The stock assessment studies carried out by the CMFRI indicated that most of the resource – region combinations were being exploited at near optimal or beyond optimal levels. Thus, the regional resource trends and the stock assessment studies stressed the need for proper management of the fisheries through regulation of effort and mesh size.

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 are given in Tables 3 to 6. It can be seen 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.

Table 3. Annual relative growth rate (%) in total landings

Region	1961-1970	1971-1980	1981-1990	1991-2000
All India	6.6	0.8	6.3	2.1
Northeast	27.0	16.9	11.7	4.4
Southeast	3.8	3.8	2.8	2.3
Southwest	9.4	-3.2	10.7	0.7
Northwest	3.9	5.1	3.8	3.9

Table 4. Projected landings based on the relative growth rate (lakh tonnes)

Region	Optimistic	Pessimistic
Northeast	1.83	1.69
Southeast	6.46	6.19
Southwest	8.70	8.59
Northwest	12.37	11.53
Based on regional growth rate		
Total	29.36	28.0
Based on All India growth rate	29.12	28.0

Table 5. Annual relative growth rate (%) in total landings

State	1961-1970	1971-1980	1981-1990	1991-2000
West Bengal	-	-	16.4	0.66
Orissa	-	-	9.1	10.3
Andhra Pradesh	3.9	4.2	0.2	6.2
Tamil Nadu (including Pondicherry)	3.8	3.6	4.1	1.2
Kerala	5.1	-4.1	15.7	0.79
Karnataka	60.6	1.2	1.8	1.8
Goa	-	-4.3	10.3	-1.9
Maharashtra	7.3	0.8	3.0	-0.46
Gujarat	-0.3	16.4	4.8	6.2

Table 6. Projected landings based on the relative growth rate (lakh tonnes)

State	Base 2000	
	Optimistic	Pessimistic
West Bengal	0.73	0.72
Orissa	1.20	1.02
Andhra Pradesh	2.36	2.12
Tamil Nadu (including Pondicherry)	4.25	4.16
Kerala	6.23	5.73
Karnataka	1.96	1.90
Goa	0.58	0.60
Maharashtra	3.61	3.65
Gujarat	8.54	7.7
Gujarat (based on average landings from 1997)	7.46	7.10
Total	29.46	28.2
Total (based on average landings of Gujarat from 1997)	28.38	27.60

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 0-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, Bombay-duck 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 the resource availability is directly proportional 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.

The total exploitable potential yield of the marine fishery resources of the Indian EEZ is revalidated at 3.93 million tonnes. The revalidation was done in the year 2000 and was in close agreement with the potential yield estimate made during the

year 1991. The Working Group on revalidation constituted by the Ministry of Agriculture, Govt. of India noted that some resources have reached asymptotic levels and some others were showing declining trends. It was recommended that the research be directed specifically towards such resources. In recent years, the total landings have stabilized around 2.7 million tonnes annually. Now that, the fishing effort expended at present in the shelf waters upto 100 m is near optimal in most of the regions, there is little scope of enhanced production from the current levels. Additional yields could be expected through diversification of the effort to tap the ground fish of the continental shelf edge, finfishes, deep sea lobsters and shrimps and cephalopods from the upper continental slope and squids in the shelf and oceanic region. Similarly, oceanic tunas and sharks are the resources, which hold promise for enhanced production.

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