MARINE BIODIVERSITY CONSERVATION AND MANAGEMENT

Edited by

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X. MARINE FISHERY RESOURCES OF INDIA - PRESENT STATUS AND MANAGEMENT CONCERNS

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The marine capture fishery of India is in the cross roads at the present juncture. It has two options with regard to the coastal fisheries: either to sustain the production by harvesting the resources in a rational manner or to succumb to the economic, ecological and social pressures leading to resource depletion and continued conflicts.

INTRODUCTION

The world marine fisheries scenario has, over the years, undergone vast changes due to the technological advancements made in the harvesting of the resources and in the postharvest sectors, the increasing demand for seafood by the growing human population and for earning valuable foreign exchange. While such changes resulted in increased production and employment, improved economy, upliftment of coastal fisherfolk and other developments, the limited nature of the fishery resources was realised only recently and this formed the subject matter of discussions in several regional and international fora and the large number of publications on the fisheries resources. Although several measures for rational exploitation of the fishery resources have been formulated and considered in the past, their implementation has been found to be, in several instances, ineffective owing to many reasons. Following closely this worldwide trend, in India too, the exploitation of the resources from the seas around the country is also facing a similar situation. While Rao and Murty (1993) examined the complexities of management of inshore fishery resources of India, this paper attempts to review the present status of the fishery and the issues concerning its management and conservation.

EXPLOITED FISH STOCKS AND PRODUCTION

A total of 24 stocks (groups/families) are presently exploited (Table 1) from the inshore waters extending upto a depth of 50 meters

by mechanised craft using gears such as trawls, purse seines, gill nets, hooks and lines and a variety of indigenous crafts and gears. A large number of them are exploited not only by the same gear but by different gears also. Technological innovations, increasing fishing effort and investments kept the production expanding from about 0.6 million tonnes in the fifties to about 2.30 million tonnes in the nineties. During 1989-93 (Table 1), the estimated annual landings varied from 2.16 million tonnes in 1990 to 2.30 million tonnes 1992 with an annual average of 2.24 million tonnes. Regionwise, the southwest coast comprising of Goa, Karnataka and Kerala contributed to the highest average annual catch of 877513 t (1989-93) followed by northwest coast (Gujarat and Maharashtra-728168 t). Along the east coast, the bulk of the catch (483877 t) was landed along southeast region covering Andhra Pradesh and Tamil Nadu coasts. The northeast coast along west Bengal and Orissa contributed only 115385 t (Fig 1).

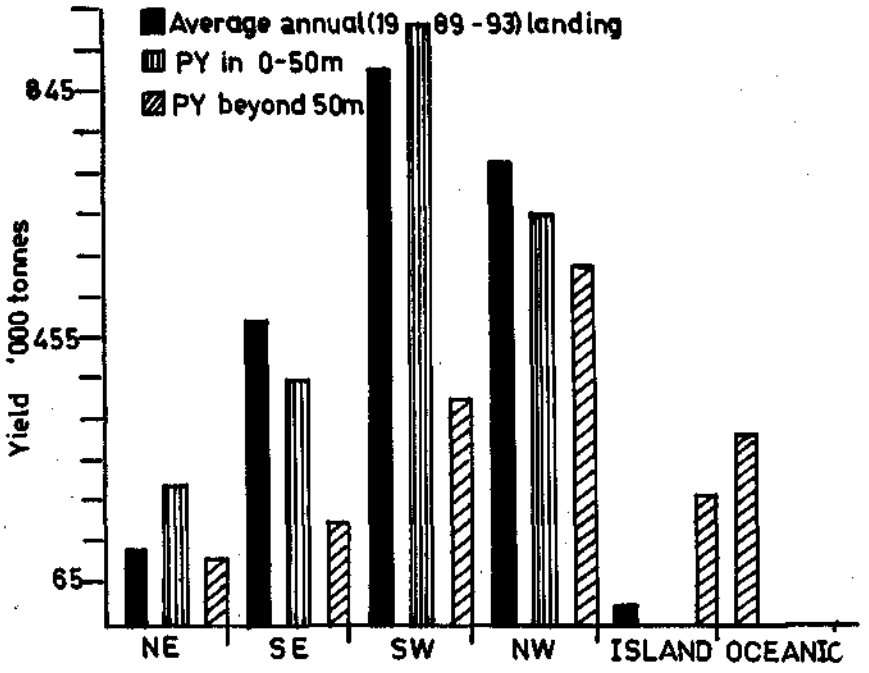

Fig. 1 : Estimated total marine fish landings and potential yield from the 0-50 m depth zone and potential yield from beyond 50 m depth upto EEZ limit along different regions in the Indian coast.

TABLE - 1 : Marine Fish Landings in India during 1989 - '93

Stocks	1989	1990	1991	1992	1993	Average
Elasmobranchs	51124	50690	51063	62377	67586	56568
Eles	4888	4852	6873	6546	5980	5828
Cat fish	49794	38230	39374	36247	42514	41232
Oil sardine	278877	261012	176887	104062	94848	183137
Other sardines	83167	77447	86317	94094	88729	85951
Anchovies*	71020	58682	85526	80774	71925	73585
Other clupeoids	144425	136235	188446	196000	170125	167046
Bombay duck	120193	130234	136450	127164	93730	121554
Lizard fish	20923	24840	27573	28939	25504	25555
Perches**	102722	120778	103136	115734	148144	118103
Sciaenids	101154	119224	145584	162700	161105	137953
Ribbonfish	65256	74301	95428	111271	91682	87588
Carangids	135609	141787	168626	190287	129064	153075
Silverbellies	49337	53876	52133	51934	62304	53917

* Whitebait only

** Threadfin breams most dominant

Stocks	1989	1990	1991	1992	1993	Average
Pomfrets	42876	39862	42649	34074	41899	40272
Mackerel	291077	184402	113675	135034	250983	195034
Seerfish	40984	29841	37408	43109	41986	38666
Tunas	45230	52060	36248	43272	43929	44148
Billfish	1017	1048	791	1504	1810	1234
Flatfish	33385	29887	37270	63344	46576	42092
Penaeid prawns	146637	164580	190434	186917	175228	172759
Non penaeids	76369	79773	100606	91274	68968	83398
Cephalopods	54487	56237	65337	89493	95739	72259
Others	219674	232392	254616	243444	254338	240893
Total	**2230225**	**2162270**	**2242450**	**2299594**	**2274696**	**2241847**

Of the 24 stocks exploited, ten comprising of Indian mackerel, oil sardine, penaeid prawns, other clupeoids, carangids, sciaenids, Bombay duck,perches (principally threadfin breams), ribbonfish and lesser sardines form the most dominant (Table 1), together forming about 64% of total marine fish landings of India. While certain stocks such as those of mackerel, oil sardine, lesser sardines, white bait, ribbon fish, seer fish, coastal and oceanic tunas among pelagic group; croakers, threadfin breams, pigface breams, groupers, snappers, catfish, lizard fish, silverbellies and goatfish among demersal group ; penaeid and non-penaeid prawns, crabs, lobsters and stomatopods among crustaceans and squids and cuttlefish among molluscs are exploited all along the Indian coasts, some stocks are exploited from restricted regions only: Bombay duck is caught mainly along the Gujarat and Maharashtra coasts and to a lesser extent along certain pockets of Andhra, Orissa and west Bengal coasts. *Hilsa* is harvested principally along the west Bengal coast. Bulk of the non-penaeid prawn catch is taken from Gujarat and Maharashtra coasts although a small quantity is taken from Andhra pradesh coast. Among the molluscs, mussells are caught from Kerala, Tamil Nadu and Andhra Pradesh coasts; clams along Karnataka, Kerala, Tamil Nadu and Andhra Pradesh; window-pane oyster along Andhra and Gujarat; edible oyster from Tamil Nadu and Kerala and chanks along Tamil Nadu and Kerala coasts. An important feature of the marine capture fisheries of India has been the targetted fishing for penaeid prawns in view of their continuous and increasing demand in the export trade.

ARTISANAL AND MECHANISED FISHING

A review of the marine fishing activities of the country reveals that the contribution by the artisanal gears to the total marine fish production was significant during fifties and sixties. Consequent upon the popularisation of the mechanised fishing during seventies and eighties alongwith motorisation of indigenous crafts particularly during the past decade, the percentage contribution of artisanal gear to the total landings declined. Figure 2 shows the percentage contribution of different categories of fishing units to the landings in the northeast, southeast, southwest and northwest coasts. Presently, the landings by mechanised (for propulsion as well as for fishing) units are the highest

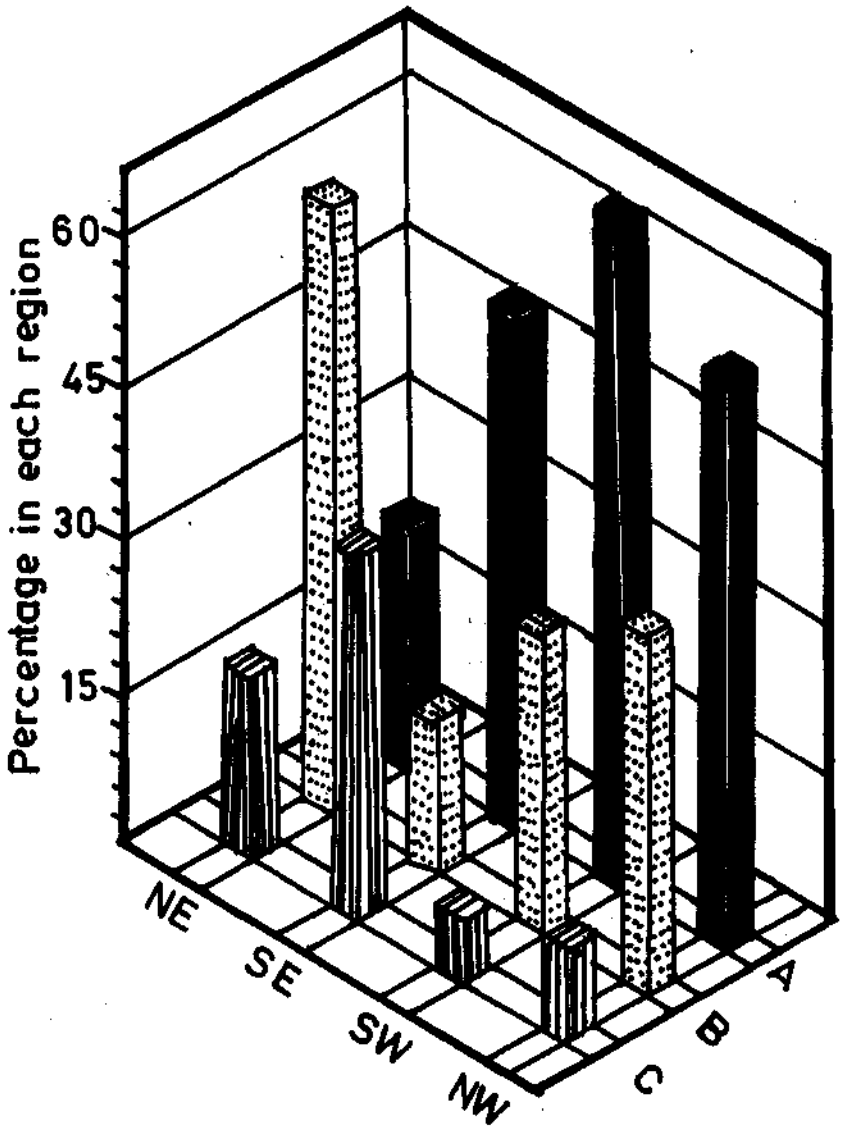

Fig. 2 : Percentage contribution of different categories of fishing units (A. Mechanised; B. Motorised; C. Artisanal) to the landings along different regions (NE. Northeast coast, SE. South east coast; SW. South-west coast; NW. Northwest coast) along main land coast.

in the different regions except northeast coast, followed by those of motorised (for propulsion only) and artisanal units. Along the north-east coast, however, the motorised units contribute the highest landings followed by mechanised and artisanal units.

PRESENT STATUS OF EXPLOITED STOCKS

The topographical features, nature of continental shelf and distribution pattern of fish and shellfish species in this region as well as in the Exclusive Economic Zone (EEZ) vary from region to region. The studies carried out on the physical, chemical and biological oceanography of the seas around India have shown that inshore waters (0-50m) are relatively more productive. The large scale upwelling during southwest monsoon off the west coast of India and the strong convergences developing along the east coast and Andaman sea during the northeast monsoon, the current system at surface layers which change direction from season to season and the seasonal distribution of thermocline, phyto and zooplankton biomass greatly influence the fisheries in different regions of the coast.

Exibiting great diversity in the species complex, typical of tropical waters, the different fish and shellfish stocks coexist in the same ground. Studies on the biological and fishery characteristics of the important groups have shown that most of the species supporting the fishery are shorter-lived with an average life-span in the fishery not exceeding 4 to 5 years, the fishery, however, being supported largely by under-an-year olds and one year olds; are highly fecund and spawn over longer periods mostly with fractional spawning and exibit wide annual variations in recruitment. The availability and abundance of major exploited species such as oil sardine, mackerel, lesser sardines and whitebait show wide seasonal and annual fluctuations (Table 1).

With a view to critically understand the present state of the exploited stocks and to improve the fishery by suggesting suitable management measures, the Central Marine Fisheries Research Institute carried out detailed studies on 23 species of commercially important exploited pelagic fishes, 13 demersal fishes, 7 crustaceans and 3 molluscs on the basis of data collected during 1984-88. These studies showed that 4 species of pelagic finfish (*Sardinella longiceps, Restrelliger*

kanagurta, Euthynnus affinis and Thunnus tonggol), 2 species of demersal finfish *(Nemipterus japonicus, N. mesoprion)*, 2 species of crustacean shellfish *(Metapenaeus monoceros, M. dobsoni)* and one species of molluscan shellfish *(Loligo duvauceli)* are fully exploited in the present fishing grounds of 0-50 m depth all along the Indian coast (Table 2). These species together constitute about 23% of the total marine fish production in the country. Certain species (7 pelagic, 9 demersal, 2 crustacean, 2 mollusc-Table 2) which contribute to the fishery significantly along certain regions of the Indian coast are also fully exploited at those regions. Species such as *Scomberomorus commerson, Parastromateus argenteus, Formio niger, Trichiurus lepturus, Tachysurus tenuispinis, T. thalassinus, Penaeus indicus, P. semisulcatus and Panilurus polyphagus* are exploited beyond sustainable levels in different regions in the 0-50 m depth range. However, some species which are not fully exploited at the all India level *(Encrassicolina devisi, Auxis thazard, A. rochei, Katsuwonus pelamis, Decapterus russelli)* offer scope for marginal increase in yield (Table 2) (James, 1994; Murty *et al.* 1994 a, 1994 b; Menon *et al.* 1994; Rao *et al.* 1994; Bensam 1994; Pillai *in press*; Suseelan and Pillai 1995; Narasimham *et al.* 1995). In respect of these species, however, it has been observed that the increase in fishing effort in the endeavour of increasing the yield, is likely to result in decreased catch per unit effort, making the exploitation uneconomic. In most of the trawl-caught species, the studies have shown, the presently-used cod end mesh size of the trawl nets needs to be increased by 30-40% to obtain sustained returns in the long run.

POTENTIAL AND CATCHABLE RESOURCES

The working group constituted by the government of India for revalidating the potential marine fishery resources of the country's Exclusive Economic Zone, estimated the potential yield to be 3.9 million tones (2.2 million tonnes from 0-50 m depth zone and 1.7 million tonnes from beyond 50 m depth in the EEZ), utilising the data on primary and secondary production, characteristics of the exploited stocks in the 0-50m depth zone and the results of the exploratory surveys beyond 50 m depth (Anon 1991). As the multispecies nature is the characteristic feature of Indian marine fisheries and all relevant information for making estimates by species is not available in respect of all species (over 300),

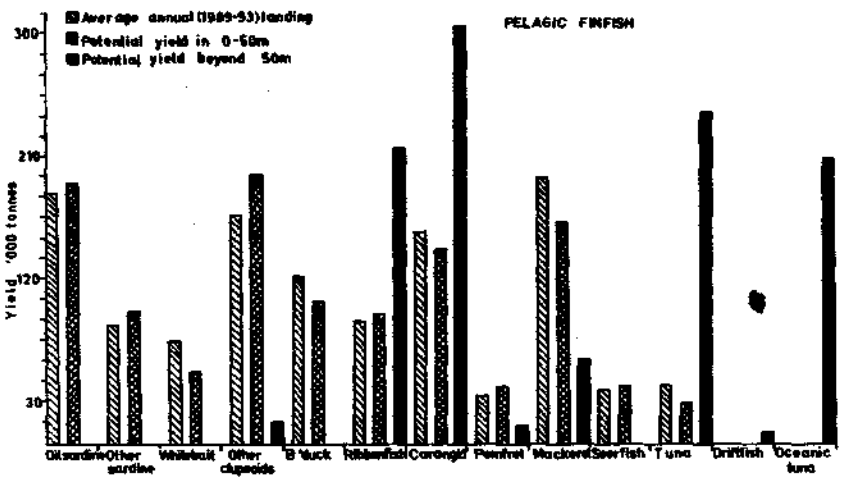

Fig. 3 : Estimated landings and potential yield in 0-50 m and beyond 50 m upto EEZ limit, of major pelagic finfish.

TABLE-2 : Present Status of Exploitation of Different Species-Stocks Along Indian Coast in the 0 - 50 m depth zone

Sl. No.	Species	State of Exploitation		
		Full	Over	Under
1	*Sardinella longiceps*	All along	—	—
2	*S. gibbosa*	SE Coast	—	West coast
3	*Hilsa ilisha*	NE coast	—	—
4	*Encrassicolina devisi*	—	—	All along
5	*Stolephorus waitei*			
6	*Rastrelliger kanagurta*	All along	—	—
7	*Scomberomorus commerson*	—	SE & SW coasts	—
8	*Euthynnus affinis*	All along	—	—
9	*Thunnus tonggol*	All along	—	—
10	*Auxis thazard*	—	—	All along
11	*A. rochei*	—	—	All along
12	*Katsuwonus pelamis*	—	—	All along
13	*Megalaspis cordyla*	—	—	SW Coast

Sl. No.	Species	State of Exploitation		
		Full	Over	Under
14	*Decapterus russelli*	—	—	All along
15	*Selaroides leptolepis*	SE Coast	—	—
16	*Atropus atropus*	NW Coast	—	—
17	*Alepes kalla*	SW Coast	—	—
18	*Atule mate*	—	—	SW Coast
19	*Caranx carangus*	SE Coast	—	—
20	*Parastromateus argenteus*	—	West Coast	—
21	*Formio niger*	—	SW Coast	—
22	*Trichiurus lepturus*	—	East Coast	West Coast
23	*Harpodon nehereus*	NW Coast	—	—
24	*Nemipterus japonicus*	All along	—	—
25	*Nemipterus mesoprion*	All along	—	—
26	*Leiognathus bindus*	East Coast	—	—
27	*L. dussumieri*	Tamil Nadu	—	—
28	*L. jonesi*	Tamil Nadu	—	—
29	*Secutor insidiator*	East coast	—	—

Sl. No.	Species	State of Exploitation		
		Full	Over	Under
30	*Tachysurus tenuispinis*	—	West coast	—
31	*T. thalassinus*	—	W & NE Coasts	—
32	*Otolithus cuvieri*	NW Coast	—	—
33	*Johnius macrorhynus*	NW Coast	—	—
34	*J vogleri*	NW Coast	—	—
35	*J. sina*	SW Coast	—	—
36	*J. carutta*	SE Coast	—	—
37	*Penaeus monodon*	East Coast	—	—
38	*P. indicus*	—	East Coast	—
39	*P. semisulcatus*	—	SE Coast	—
40	*Metapenaeus monoceros*	All along	—	—
41	*M. dobsoni*	All along	—	—
42	*Acetes indicus*	NW Coast	—	—
43	*Panilurus polyphagus*	—	NW Coast	—
44	*Loligo duvauceli*	All along	—	—
45	*Sepia aculeata*	East coast	—	West Coast
46	*S. pharaonis*	East coast	—	West Coast

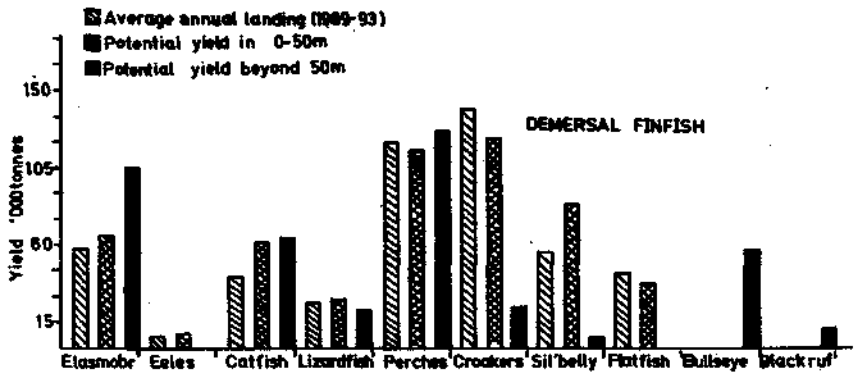

Fig. 4 : Estimated landings and potential yield in 0-50 m and beyond 50 m upto EEZ limit, of major demersal finfish groups.

the working group made the estimates of potential yield in the 0-50 m depth and beyond 50m depth in the EEZ, by clubbing all the species into 30 more or less homogenous groups adapting the classification followed by the Central Marine Fisheries Research Institute. A comparison of the potential yield estimates and the average annual landings during 1989-93 in respect of oil sardine,, other sardines, whitebait, other clupeoids, Bombay duck, ribbon fish, carangids, pomfrets, mackerel, seer fish, tuna, drift fish and oceanic tuna in the case of pelagic finfish (Fig. 3); elasmobranchs, eles, catfish, lizard fish, perches, croakers, silverbellies, flatfish, bull's eye and black ruff in the case of demersal finfish (Fig. 4); and penaeid and non-penaeid prawns, deep sea prawns, deep sea lobsters, squids and cuttlefish in the case of crustacean and molluscan shellfish (Fig.5) shows that most of the stocks in the 0-50 m depth zone are either exploited at close to or beyond potential yield levels. Of the 24 stocks presently fished in the 0-50m depth range, 10 stocks are at the level of optimal exploitation, 6 at that of

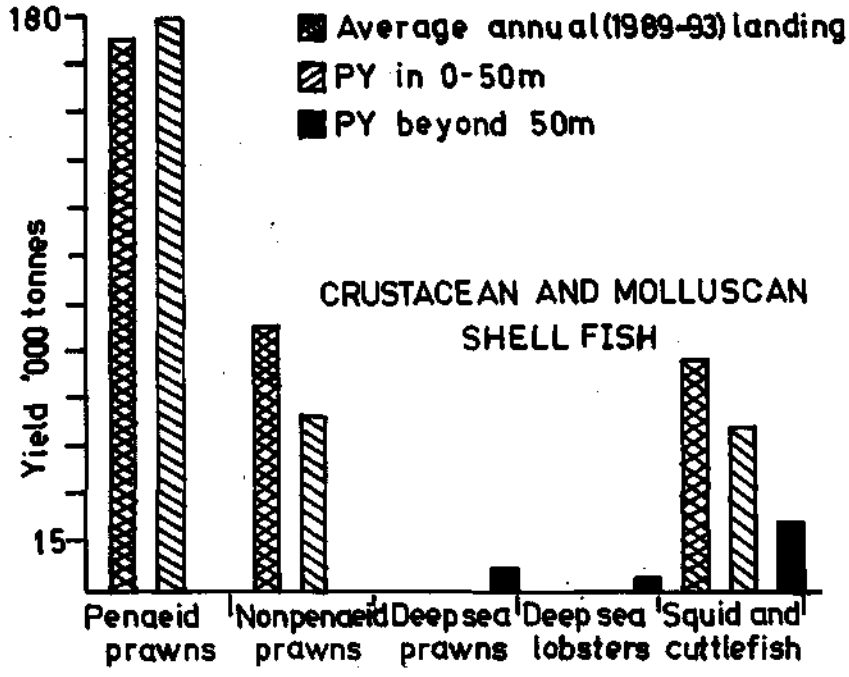

Fig. 5 : Estimated landings and potential yield in 0-50 m depth and beyond 50 m depth upto EEZ Limit, of major crustacean and molluscan shellfish.

overexploitation and 8 at the level of underexploitation (Fig. 6). In the region beyond 50 m depth in the EEZ, 15 stocks, which are also harvested from 0-50m depth range presently, offer potential for exploitation. In addition to these, six stocks comprising of bull's eye, black ruff, Indian drift fish, deep-sea lobsters and prawns and oceanic tunas which are presently exploited to a very limited extent, offer scope for commercial expolitation beyond 50m depth in the EEZ (Fig. 3-6).

Thus the conglomeration of resources within 50m depth, by and large, are exploited close to or beyond the levels of their catchable potentials. This situation necessarily calls for action plans not only to increase the landings but for formulating and implementing effective management and conservation measures so as to ensure sustained yields.

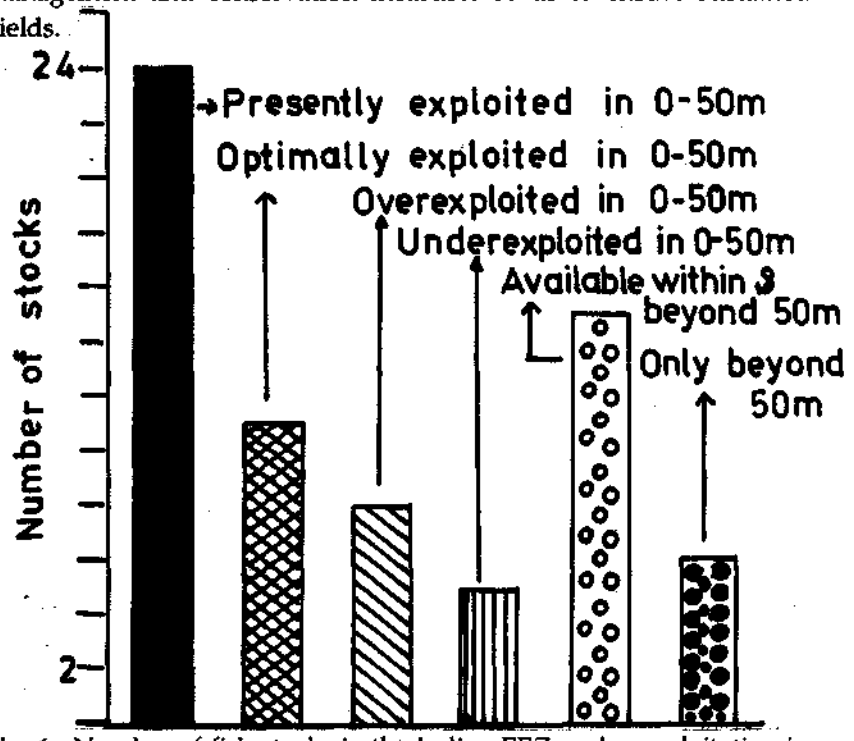

Fig. 6 : Number of fish stocks in the Indian EEZ under exploitation in the present fishing grounds, their present exploitation status and number of fish stocks under exploitation in the fishing grounds of 0-50 m depth and available beyond 50 m depth also and the number of fish stocks available only beyond 50 m depth in the EEZ.

ISSUES

The development of marine fisheries of the country from a modest beginning in the post-independence period to the level of an industry as it exists today, where modern techniques of catching, processing, preservation, storage and marketing are available, has definitely contributed to the increased harvest and utilisation of the resources. In this process, however, it has unwittingly brought several issues. They relate mainly to:

— limitations of growth and production in the inshore fishing grounds, less profitability and economic returns due to increasing cost of fishing operations;

— management problems in the context of common property, multigear, multispecies nature of fisheries;

— widening imbalance in the socio-economic conditions of fishermen operating artisanal craft and gear on the one hand and motorised and mechanised craft on the other;

— targetted fishing for shrimps and such other prime value fishes by different sectors in the same fishing ground leading to competition and conflicts among different sectors of resource users;

— slow pace of development and emphasis on the fishing by larger vessels in the offshore grounds where a segment of littoral population of fish and shellfish are available;

— controversy over the seasonal ban on trawling as managerial and conservation measure; and

— ecological problems arising from pollution and habitat degradation.

The first two of the above issues are brought about by the uncontrolled fishing effort put into the fishery without any regard to the stock-production-recruitment relationship. Besides the declining stocks of several harvested fishes as discussed earlier, this is clearly evident from the exploitation of large quantities of juveniles of *Nemipterus japonicus* off Madras coast in 1993 (Anon, 1994); of juveniles and mouth-brooding adults of the cat fish *Tachysurus tenuispinis* along Kerala

and Karnataka coasts (Bensam, 1994) during mid eighties, of juveniles of *Penaeus semisulcatus* along Palk bay and Gulf of Mannar and of young ones of several fishes by the innovative, nonselective and smaller-meshed gears such as ring seines and mini trawls in the shallow inshore waters. Indiscriminate exploitation of resources is further aggravated by the large scale seed prospecting of cultivable penaeid prawns from the wild along with the seed of other species which are eventually unused and destroyed.

Another fishery dependant factor adversely affecting the resources is the loss of large quantities of edible and inedible fishes which are thrown overboard to facilitate adequate space for storage of shrimps and such other prime species. Although information on such discards is limited to only a few reports, it is estimated that the by-catch component of trawlers varies from 75 to 90% of the total catch and a significant portion of which is discarded resulting in the wastage of the much-needed protein from the sea. It is also observed that the quantities of such discards is on the increase as several of the trawlers are now engaged in stay-over fishing. The absence of reliable data on such discards as well as non-availability of fishing logs and data on catches taken by commercial vessels make it difficult to estimate the real quantities of biomass actually exploited.

Although technological changes due to the various innovations in fishing craft and gear, techniques of fishing, pattern of fishing and organisation of fishing industry are expected to usher greater benefits to the different sectors, it has been observed that these did not help much in the progressive development. Discussing the technological changes and development of marine fishing industry of India in general and of Kerala in particular, Ramakrishnan (1994) concluded that these changes helped to achieve only 'limited' growth in terms of increase in output, employment, earnings, productivity, regional development and self reliance. Rao and Murty (1993), James (1992) and Ramakrishnan (1994) further discussed the controversies and conflicts arising out of declining catch from traditional sector, rapid expansion of fishing effort in the mechanised sector and the consequent sharing of limited resources in the coastal waters, widening disparity in the social and economic conditions of fishermen operating artisanal craft

and gear on one hand and motorised and mechanised craft on the other hand, multigear multispecies nature of the fisheries imposing restrictions in formulating management suggestions and the efforts made by the government for regulating, restricting and prohibiting fishing in specific zones by specific categories of vessels using specific gears for specific periods in mitigating this problem. However, these issues are still remaining unsettled and the stalemate continues without any improvement.

Entrenched in these issues is the ecological problem created by increasing pollution of coastal waters by release of untreated effluents and pollutants by the agro-industrial complexes operating in the coastal zone. It has been observed that the sediment in certain waters contains high levels of Copper, Zinc and Lead. The Mercury content of oysters at certain places has been found to be higher and fly ash deposits from the thermal power plants at certain other places are on the increase. All these factors contribute to environmental degradation and consequent decline in production in addition to accumulation of pollutants in certain organisms making them unsuitable for human consumption.

A large number of islands along the Indian coasts in the Gulf of Mannar, Gulf of Kutch, Lakshadweep and Andaman group and the mangrove ecosystems along the coasts of Goa, Kerala, Tamil Nadu, Andhra Pradesh and west Bengal constitute rich and diverse environments supporting a variety of resources like corals, sponges, ornamental fish, crustaceans and molluscs. These environments play a significant role in maintaining the ecological balance. Indiscriminate fishing, quarrying and dredging and deforestation of the mangroves are the main threats causing considerable damage to these environments and consequently to the associated flora and fauna

DEEP SEA FISHING

In the currently prevailing situation in the marine capture fisheries sector and in the context of the imperative need to increase production, the options available are to regulate the exploitation in the 0-50 m depth zone to enable harvesting sustained yields and to initiate steps to exploit the resources available in the outer continental shelf. It is estimated that the EEZ beyond 50 m depth supports a potential

of 1.7 million tonnes (Anon, 1991) which is virtually unexploited. Most of its potential is composed of conventionally exploited groups/species such as carangids, ribbonfish, mackerel, pelagic sharks, threadfin breams, groupers, snappers, bull's eye, lizard fish and others. The deep sea prawns and lobsters also offer scope for exploitation

In consideration of the need to extend the fishing to relatively deeper areas, the government's programme to develop deep-sea fishing has only met with partial success. Recently the programmes of promoting this sector by introducing large joint venture vessels in the Indian EEZ have, however, met with severe opposition from the fishing industry resulting in countrywide strikes by fishermen and the Government deciding to demarcate a 'corridor' in the open sea to prevent joint venture vessels entering the inshore regions less than 50 m depth. Even this proposed measure did not receive favourable response.

MANAGEMENT AND CONSERVATION OF RESOURCES

The marine capture fishery of India is in the cross roads at the present juncture. It has two options with regard to the coastal fisheries: either to sustain the production by harvesting the resources in a rational manner or to succumb to the economic, ecological and social pressures leading to resource depletion and continued conflicts. Table 3 summarises the various management options available and their implications.

The management of a fishery through the information on the biology and population characteristics has been suggested in respect of several individual species. Although such management is of considerable scientific importance, the multispecies nature of the resources where the biological characteristics of individual species vary from species to species make it difficult to suggest a single strategy appropriate to all species for their rational exploitation. A common strategy that could be advocated in consideration of the various factors is only the regulation of mesh size of nets thereby avoiding growth and/or recruitment overfishing. Another managerial measure which is being discussed in consideration of biological characteristics of the species is of 'closed season' coinciding with the spawning and nursery season of the species. In this case too, it has been found difficult to pronounce

TABLE -3 : Management measures and their implications in respect of marine capture fisheries of India

S.No. (1)	Management Measure (2)	Information base (3)	Implications (4)
	A. BIOLOGICAL		
1.	Maximum Sustainable Yield	Knowledge of population characteristics by species, catch and effort data	Ideal scientific method of management - difficult to implement - difficult to convince fishermen - effective extension needed
2.	Closed areas/seasons	Spawning ground/ seasons; nursery areas	Protracted spawning in the population and variations in peak spawning periods make it difficult; information on spawning grounds scanty.
3.	Regulation of fish length (Legal size)	Length at first maturity; growth and life-span	Multispecies and multigear nature poses problems; mesh size regulation most suitable and perhaps a recommendable measure
	B. TECHNOLOGICAL		
1.	Control of fishing effort	Gearwise effort and catch; effective effort; maximum sustainable yield or maximum sustainable economic yield.	Regulation of number of fishing fleet; effective monitoring necessary.

(1)	(2)	(3)	(4)
2.	Fishing zone demarcation	Zonewise information on availability and abundance; zone wise total allowable catch.	Difficult to implement due to open access; leads to conflicts among resource users; effective legislation and execution required.
3.	Regulation of gears	Gear survey; effect of the gear on the stocks.	Strict licensing necessary, leads to social and rehabilitation issues.
4.	Deep sea fishing	Availability and abundance of resources in space and time techno-economic viability; quality of resource; post harvest technology.	Capital intensive; licensing and control of fleet, regulation of operation beyond specified depth zones to avoid conflicts with the coastal fishing activities.
	C. OTHERS		
1.	Artificial recruitment (ranching)	Species, seed production, site selection, monitoring of released stocks.	Recommendable conservation measrure; essentially to be implemented by the Government; private sector may not be interested.
2.	Environmental protection	Pollution of coastal waters by agro-industrial pollutants; effect of pollution on organisms.	Monitoring of pollution, regulation on effluent discharges in coastal waters

(1)	(2)	(3)	(4)
3.	Ecological improvement	Interactions of different activities in the coastal zone; effects of trawling and such other gear on the sea bed and the fauna; enviromental factors responsible for toxic blooms	Coastal zone mangement, monitoring the impact of fising activities on the sea bottom ecology.
4.	Conservation of critical ecosystems and biodiversity	Coral reef ecosystem, seagrass ecosystem, mangroves	Prohibition of dredging and quarrying of corals, destruction of sea grass beds and removal of mangrove forests.
5.	Mariculture	Development of viable technology of mariculture	A promising and definite means of augmenting fish production and of improving coastal rural economy; could advantageously be blended with capture fisheries; conflicts among capture fishermen and fish farmers.

a common season on a long term basis as the spawning season varies from species to species and, the peak period of a particular species from year to year. Nevertheless, the trawl fishing ban during monsoon along the Kerala coast is largely based on this premise, besides restriction of fishing in the territorial waters to avoid conflicts between the traditional sector and the mechanised boats in the former region.

Among the fishery influencing parameters, fishing effort has been found to be increasing over the years. It is also shown that in respect of the fishery of several species which has reached the optimum level of exploitation or has indicated some scope for increasing the yield, further increase in effort may not be economical. Obviously, reducing the fishing effort must receive the highest priority among the various management measures considered and given the realistic options and the will to implement, this strategy could be recommended.

Fixing catch quotas and licensing of fishing fleet are the other common measures of management considered to contain the fishery. Although the catchable potential in 0-50m depth zone is estimated, the total allowable catch in different zones within this region is not available. In the absence of such information and in the prevailing social structure and the common property nature of the fishery, this management measure cannot be implemented immediately.

The growth of the marine capture fishery of the country is restricted now due to leveling off of the catch in the currently-fished grounds. Although the status of the wild stocks exploited from the inshore fishing grounds is critical, a collapse of stocks is unlikely if pragmatic measures of management and conservation are taken up immediately. Resource improvement through artificial recruitment (ranching), restrictions on the juvenile fishery, maintenance of fishing effort at least at the present level, improvement of quality and price of captured fishes and extension of fishing to deep sea would provide the much needed reprieve for the exploited wild stocks.