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Number 30

SEMINAR ON POTENTIAL MARINE FISHERY RESOURCES

April 23, 1986

Central Marine Fisheries Research Institute
(Indian Council of Agricultural Research)
P. B. No. 2704, E. R. G. Road, Cochin-682 031, India
October 1987

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PREFACE

The Central Marine Fisheries Research Institute Cochin, is the premier organisation in the country conducting research in marine fisheries leading to rational exploitation, management, development and conservation of living marine resources. The Institute, ever since its early days of inception, has been collecting data on the catch and effort along with the biological information on the exploited marine fisheries resources of the country, through a standardised, stratified, multistage random-sampling method. In addition to making use for biological studies, including assessment of stocks, conducted by the Institute these data have been processed and utilised to furnish estimates of annual marine fish production in different States over the past 38 years.

With the changed objectives and functions of the Institute in recent times, greater emphasis has been laid on the assessment of stocks for better management of the exploited stocks and to indicate the possible sources of additional production in the context of modern technological innovations in fishing practices and consequent increase in the capability of fishing of both traditional and mechanised sectors.

With continued increase in fishing effort and intense exploitation of certain resources in different parts of the country, a need now arose to examine critically the present status of the exploited stocks, the fishing intensity, the number of boats and different types of gear, other infrastructural facilities for handling storage, transportation and marketing of the catches, the status of the under exploited resources, and new or additional resources available beyond the presently exploited areas

of each maritime state for providing necessary technical advice to the respective Governments to manage and conserve the resources.

It is with this in view that the data relating to each maritime state for the period 1975-84 are consolidated and processed and presented as a separate Special Publication. This Number gives the appraisal of the marine fisheries of West Bengal, highlighting the status of the exploited resources and the level of exploitation. It also gives guidelines for increasing the catches by proper development, management and conservation of resources.

I thank Shri Varughese Philipose, Dr. K. S. Scaria, and S/Shri G. Venkataraman and G. Subbaraman for the pains taken in the preparation of this report. My thanks are due to Shri S. S. Dan who was in charge of data collection. S/Shri Sapan Kumar Ghosh and Pulin Behari Dey collected the catch and other details which form the base of this report. I deeply appreciate the earnest efforts put by them in this regard.

P. S. B. R. James
Director
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Seminar on Potential Marine Fishery Resources

PROCEEDINGS AND RECOMMENDATIONS

The seminar was organized by the Central Marine Fisheries Research Institute at Cochin on 23rd April 1986, marking the occasion of the Institute's moving into its own permanent building.

The objective of the seminar was to find ways and means of bridging the gap between the estimated potential marine fishery resources of the country and the present level of actual yield from the exploited stocks. Considering the increasing demand for marine fish and the potential for export of marine products, critical information on the presently exploited stocks and those identified as under-exploited or unexploited resources is vitally essential for suggesting management and other measures to obtain optimum yields from these resources.

Besides fulfilling the need for more precise information on potential resources, much remains to be done on the harvest and postharvest technology related to these resources. Although the country is well equipped with research and survey vessels to undertake the responsibility of exploration and assessment of resources, so also with trained manpower and expertise in several areas, a co-ordinated effort by all the institutions is urgently needed to evolve the necessary strategies for harnessing the potential resources. The industry also can play a more purposeful role in this effort by giving correct and timely feedback information. The seminar had thus the objective of providing the common platform to discuss the above aspects of resources exploitation, and the utilization and management of potential resources.

A. PROCEEDINGS

Inaugural Session

The inaugural session was presided over by Dr. S. Jones, a former Director of CMFRI. Dr. P. S. B. R. James, Director, CMFRI, welcoming the distinguished participants, stated that the subject of potential resources was of considerable importance to all the concerned Government departments, universities, industry and developmental agencies for giving proper orientation and impetus to their future programmes. In view of the present stagnation in the marine fish production, a number of factors were to be examined. The yield from inshore fishing in the currently exploited grounds was not likely to increase even if the fishing effort were increased. The changing pattern in the fishery such as large-scale introduction of purse seiners in the same exploited grounds was also unlikely to result in increased production, but was likely to bring about further conflict between local fishermen and purse-seine operators.

Considering the large population of artisanal fishermen depending on the resources in the narrow coastal belt, it was also essential to safeguard their interests and livelihood. A shift in our emphasis from capture fisheries to culture fisheries for increasing production might perhaps result only in a marginal increase in the overall marine fish production. The total area of the Exclusive Economic Zone, on the other hand, was very vast and the potential resources available in it varied in extent and quantity, according to depth zones and areas. But heavy capital investments were necessary for exploiting and utilizing these potential resources, and a great deal of information was necessary, too, in understanding the existing exploited resources and the underexploited potential resources of the shelf and oceanic regions. In this regard, Dr. James gave an overview of the pivotal role played by CMFRI in the stock assessment of various fishery resources. He drew attention also to the work done by other Institutes engaged in fisheries resources survey and stressed the need for a coordinated programme for greater

understanding of the resources and called for necessary inputs needed for future development of fisheries and an action plan for increasing production, giving due consideration for improving the socio-economic status of fishermen.

In his presidential address, Dr. Jones said that the scientists and planners were now dealing with a dynamic environment much different from the static resources such as of coal or minerals. Considering the fact that a wealth of information was already available on the marine fish resources, he stated that the country was passing through a transitional period from purely artisan-based fishery to industry-oriented development. In a concerted effort by different departments and institutes to tackle the problem of exploiting the potential resources, it would be worth while to put the effort together rather than debating on issues as to who should do what. Such an effort would usher in something good for the society as a whole and fishermen in particular.

Dr. K. Gopalan, Vice-Chancellor of Cochin University of Science and Technology, inaugurating the seminar, drew attention to the large gap between India's potential marine resources and the present production, and stressed the need for intensification of research and development efforts to harness the resources that are beyond our reach at present. Dr. P. V. Rao, Senior Scientist, CMFRI, then read out felicitation messages from Dr. S. Z. Qasim, Secretary, Department of Ocean Development, and others who could not attend the seminar. Following this, the chief guest released a Bibliography of the CMFRI publications prepared by the Institute. Dr.P.V. Ramachandran Nair, Joint Director, CMFRI, proposed a vote of thanks.

Technical Sessions

The Seminar consisted of 4 Technical sessions, in which 8 papers were presented by eminent scientists, administrators and representatives of the industry on various aspects of the potential resources. About 300 delegates drawn from different organizations participated in the Seminar.

The Technical Sessions were as follows:

Session I — *Potential Marine Fishery Resources*

Chairman : Shri M. Devidas Menon

Repporteurs : Dr. K. C. George, CMFRI,
Shri. K. V. Narayana Rao,
CMFRI.

Session II — *Exploitation of Potential Marine Fishery Resources*

Chairman : Dr. S. N. Dwivedi, Director,
CIFE.

Rapporteurs : Shri. P. Appukutta Panickar,
CIFT,
Dr. P. Vedavyasa Rao, CMFRI.

Session III — *Utilization of Potential Marine Fishery Resources*

Chairman : Shri. R. C. Chaudhary,
Secretary, Govt. of Kerala.

Rapporteurs : Dr. G. Gopakumar, CIFT,
Mr. Edward Samuel, IFP.

Session IV — *Management of Potential Marine Fishery Resources*

Chairman : Dr. S. Jones, Former Director,
CMFRI.

Rapporteurs : Shri. T. Jacob, CMFRI,
Dr. K. Alagaraja, CMFRI.

Session I

POTENTIAL MARINE FISHERY RESOURCES

In this session two papers were presented, one by Shri. K. M. Joseph, Department of Agriculture, Government of India, and another by the CMFRI Director and his associates. In his paper, Shri. Joseph gave an appraisal of the various resources based on the surveys carried out by the Government vessels. He drew attention to the regionwise estimates and potentials of under-exploited demersal resources such as perches, nemipterids, carangids, lizard fishes, catfishes, pomfrets and pelagic resources such as mackerel, lesser sardine and cephalopods. He pointed out the resources such as sciaenids, ribbonfish, barrakuda and elasmobranchs as having the possibility for exploitation by at least 50% more than the current level of production if the fishing effort was extended to outer shelf areas.

The fish stocks along the continental slope of both west and east coasts were totally unexploited. These consisted of non-conventional species such as Big eye, Black ruff, Green eye, *Cubiceps* and deepsea crustaceans. He also highlighted the results of recent surveys by FSI vessels which had reconfirmed the availability of many species identified as potential resources along the Kerala coast, western slope of Wadge Bank, Gulf of Mannar and off the Konkan coast. The results of the survey by purse-seining for resources of coastal species of tunas, horse mackerel and other carangids were also highlighted. The potential of oceanic species such as tunas, bill fishes pelagic shoals and other varieties in the Arabian Sea, Bay of Bengal, Andaman Sea and equatorial waters were also discussed. He concluded in general, that the Indian EEZ was highly productive of various resources such as ground fishes pelagic fishes and oceanic species.

In the paper prepared by the CMFRI and presented by Mr. M. S. Muthu, Senior Scientist, the present rates of exploitation of different resources in the different coastal zones of India were given in terms of trends in production of major species, average annual productions of species of medium importance and the annual fluctuations from year to year. Pointing out the stagnation in the yield of exploited stocks in 0-50m zones, the paper emphasized the need for looking for resources beyond 50 m zones. The estimates of annual potential yields from EEZ as arrived at by the Institute and other organizations were presented, indicating the production potential in the depth region up to 200 m as very high in the southwest coast, followed by northwest, northeast and southeast coasts. In the depth regions beyond 200 m the oceanic resources were observed to have a potential of 500,000 tonnes.

The paper drew attention also to the estimates of potential demersal resources, crustacean resources and cephalopod resources based on the Institute's own observations by participating in the exploratory surveys of different vessels belonging to the Institute and other organizations. The paper pointed out the prospects for increasing production, giving information on (i) the type and magnitude of the most promising resources, capable of yielding additional production, in the presently exploited inshore regions along our coast, (ii) the potential fishing grounds and abundance of resources in different depth zones immediately beyond the 0-50 m and (iii) the potential non-conventional and oceanic resources in the deeper waters of the EEZ. The paper brought into view the levels of under-exploited and unexploited resources and suggested ways and means of exploiting them. It also discussed the measures such as regulation on purse-seining, prevention of destructive fishing of spawners and young fish, deployment of vessels for bulk capture and marketing storage and other inputs needed to handle increased production. It discussed also the needs for conducting simulated commercial fishing on identified resources in order to work out the economic viability and for creating infrastructural facilities and marketing means, such as fishing harbours and other major places of landing.

EXPLOITATION OF POTENTIAL MARINE FISHERY RESOURCES

Dr. S. N. Dwivedi, who was the Chairman of this session, stated that we had a large resource potential to be utilized properly and that the industry was now able to invest a greater share of capital. Therefore, many incentives were needed in the form of package plans to help the entrepreneurs to go ahead with increased phase of exploitation. A great deal of information on the resources and their availability in different areas and seasons had to be provided by research and survey organizations and, in this regard, computerization of data would reduce the time lag. He also stated that 80% of the EEZ was less productive compared to nearshore regions and exploitation of the potential resources could be possible through such actions as joint ventures with technologically developed countries. He cited the example of White Fish Authority in England and the Inter American Tropical Tuna Commission in the U.S.A. and the role they played to help the industry. He also indicated the needs for efficient methods of post-harvest technology and economics of operation and adequate manpower to handle modern fishing methods.

Two papers were presented by the reprentatives of the industry during this session. Shri. R. K. Verma, President of the Association of Indian Fishery Industries, New Delhi, presenting his paper on exploitation and utilization of the resources, stated that the industries, attitude had remained largely shrimp-oriented and no tangible headway had been made in increasing the production of other varieties. In the opinion of the industry, he stated, it was possible to achieve a target of at least 50% of the projected potential almost in the immediate future by

organizing more effective effort to exploit the offshore and deep-sea areas. Such a step called for a new, bold, imaginative and multi-dimensional approach through application of innovative action plan. The industry was at present looking forward to more specific data on resource assessment on an area-wise and species-wise basis. He stated that based on the existing information on resources modern fishing methods such as long-lining, purse-seining, deep-water trawling and squid jigging could be undertaken in unexploited areas.

He emphasized that the industry had to determine the economy of the scales of operation and to identify the right type of vessels for fishing operations. It was expedient to think of 3 sizes of vessels: 20-25 m, 26-30 m and 31-35 m. The industry wanted at least 250 fishing vessels to be added to the present fleet. Any delay in the procurement of these would result in wastage of the resource, and, in this context, the country should also go in for joint venture for diversification of the fishing industry. He suggested taking up of a national fishery infrastructure development programme. Touching upon the management of resources, he suggested minimizing control and regulation and a thrust for technological upgradation. For this purpose he suggested that the Government of India establish a Fisheries Guidance Bureau for transfer of innovative technology, rendering the valuable to the industry on various aspects.

Mr. S. M. Shukla, Managing Director, Golden Fisheries Limited, New Delhi, presented his critical view points of the industry. He was of the view that the country had not developed a national fishery policy which could form the back bone of the growth of the industry. The policies evolved so far had been basically on ad hoc basis and interpretation of these policies had been largely in the hands of not-so-well-informed bureaucrats. He stated that the funds India allotted for fisheries development during successive Five Year Plans had been very paltry, compared to other countries like Taiwan, S. Korea, Thailand or Sri Lanka.

Mentioning the advantages of the policy of chartering vessels, he opined that the chartering scheme resulted in new experiences such as on working on long voyages, leadership coordination, team work for optimum utilization of plants and equipments, coordination of navigational aspects while harvesting fish during rough weather, and the confidence and experience necessary for the companies for new types of fishing operations. However, he stated, the industry had not registered the anticipated growth for want of sound technologies, information on economics of operation and adequate infrastructure for storage and marketing.

Mr. Shukla also added that, taking into account the national objectives, talent available and financial resources, we could safely state that the potential resources could be profitably exploited in the first phase in the 20-40 fathoms zone, which would give better economic returns. He was of the opinion that increased production could also be obtained by round-the-clock utilization of traditional and small mechanized boats by renovation and upgrading of craft and gear. He urged that better infrastructural facilities such as cold-storage, handling equipments, refrigerated cargo vessels, supply of ship stores and ship maintenance facilities be provided in the near future at a number of fish landing centres over the coastline and pointed out the need for a declared support price for fish as was in agriculture. In conclusion, he called for a coordinated effort from all fisheries Institutes and decision-making bodies for aiming at a target-oriented, time-bound national fishery policy.

Session-III

UTILIZATION OF RESOURCES

Two papers were presented at the session. In the first paper, on the utilization of the potential marine fishery resources, by Shri M.R. Nair and Shri T.K. Govindan of CIFT (read by Dr. P.V. Prabhu), the most important methods of utilization of fish in our

country at present were outlined. It was pointed out that 87% of the catches were utilized in fresh, salt-cured and dry conditions. Only 5% were utilized for freezing for export and for reduction into fish meal, and a very small percentage for canning and other purposes. With the anticipated introduction of more fishing craft and gear and modern methods of fishing, a major portion of our potential resources was expected to be available for utilization without wastage, a purpose aiming at which the CIFT had carried out researches on post-harvest technology. Improved methods of curing, prevention of bacterial attack, fast methods of freezing and prevention of wastage in processing were some of the methods highlighted as suitable. Researches carried out on recently introduced fishery products, such as cuttlefish and squids, had resulted in the development of proper technical know-hows for the utilization of such nonconventional resources. Further, several of the less popular varieties commonly referred to as trash fishes were yet to find better utilization, and technology were being developed to make use of them for many diversified products. The Kheema developed out of this had found greater accessibility. Fish protein concentrate was another product, which could be added without disfavour in many Indian traditional recipes. Lastly, there was the need for more effective utilization of the industrial waste products, such as prawn shell and wastes, discarded by processing industries in large quantities.

In the second paper, by T. K. A. Nair of MPEDA, read by Dr. K. P. P. Nambiar, attention was drawn to the existing gap between potential resources and the present yield from pelagic, demersal, crustaceans and other ancillary resources. Considering the fact that more than 67% of the total catches were still made by traditional fishermen and 32% by the small mechanized crafts, the production by the larger trawlers was very meagre. He pointed out the present stagnation in yield from the presently exploited grounds, the stagnation in marine products exports and the low per capita consumption of fish. Stressing the need for intensifying our fishing efforts in deeper waters, he listed the major constraints such as the absence of reliable data on the resources

in the deeper areas; lack of specific information about the suitable types of vessels and gear required; lack of technical skills to conduct different types of fishing; and absence of basic infrastructure and marketing outlets. Commercial fishing in deep sea waters was capital intensive, technology-oriented and risk-prone. It would be unrealistic to expect the traditional sector to contribute significantly to the exploitation of potential deepsea resources and therefore organized effort with adequate financial, managerial and technological backing would have to be made for tapping the available resources. He drew attention to the urgent need for diversifying our export products in view of the limited scope for increasing shrimp catches.

After identifying new fishery items that could be exploited on commercial scale, strategies and specific plans aimed at finding suitable international markets for them would have to be evolved. The MPEDA, with its experience in marketing promotion, would be the appropriate body for finding the scope of export of diversified products. Side by side with creation of a domestic marketing chain, it was suggested, plans should be developed for the involvement of the fishermen community in the development of fishery sector, in the context of emerging technological and socio-economic compulsions.

Session IV

MANAGEMENT OF POTENTIAL MARINE FISHERY RESOURCES

The session was presided over by Dr S. Jones, former Director of CMFRI. In his opening remarks he pointed out that the management of marine fishery resources was an extremely difficult job and expressed his hope that the seminar would bring out some new ideas.

In the absence of Shri R. C. Choudhury (Secretary, Department of Public Works, Fisheries and Ports, Govt. of Kerala)

Shri. K. Appukuttan, (Project Chief, Fisheries and Port Department, Govt. of Kerala), presented the paper on the "Management of Potential Fishery Resources".

The paper emphasized the point that, while a number of estimates were available in regard to potential resources, no accurate micro-level estimates were available depthwise and region-wise. It stressed the need for sufficient coordination between the research institutes and state departments of fisheries so that the accumulated information got translated into realistic policy measures; so also the need for considering the complexities of the larger political and economic systems to which the fisheries sector was integrally linked while framing Management policies. It also pointed out the need for diversification of fishing in the deeper areas and for development of culture fisheries to augment fish production.

In the absence of Shri K. Chidambaram, Mtsyasagar Consultancy Services Pvt. Ltd , Madras), the paper on "Manage-of Potential Fishery Resources" prepared by him was presented by Dr. P. V. Rao, Senior Scientist, CMFRI, Cochin. The paper dealth with aspects such as Exclusive Economic Zone, Indian fishery resources, traditional fishery, mechanized fishery, development of deep sea tuna fishery, national policy on fisheries, etc. He pointed out that commercial exploitation of the important fisheries in the EEZ was a specialized and capital-intensive venture and could be effectively initiated only through joint ventures. He spelt out a number of points like collaborative programmes, proper monitoring of operations, exploitation of deep-sea demersal and midwater fisheries through charter of fishing vessels and development of processing technology to suit domestic and export markets. He suggested the formation of a National Fisheries Development Board, which would be responsible for deciding and implementing inter-dependent programmes involving production, consumption and marketing of marine fish.

The Chairman in his concluding remarks pointed out that the management of fishery resources was not as simple as many thought and stressed the need for concerted efforts jointly by the concerned agencies to arrive at viable policy decisions.

PLENARY SESSION

In the plenary session Dr. P. S. B. R. James, Director, CMFRI, summed up the proceedings and the important points that had been raised in the course of the different sessions. He said that the potential resources of our country had been surveyed by different Institutes at different times and valuable information had been gathered. The resources which were considered as under exploited were those of anchovies, catfishes, perches, etc. The resources which were unexploited were the deep-sea crus-taceans, lizard fishes, bulls-eye, Psenes, oceanic tunas and squids. The resources of Wadge Bank had been studied more intensively and the next approach would be to provide quantitative estimates of the resources in different regions and depth zones.

The exploratory surveys of the deepsea resources of the EEZ called for intensive effort by the scientists and staff of many Institutions, and, in this context, adequate incentives should be given to the scientists to undertake the hard work at sea. The potentials of the east coast had to be explored, for which the surveys such as the industrial fisheries survey by M.T. MURENA conducted along the north-west coast would be very useful. The industry would be pressing for cost-benefit ratios before venturing to exploit the deepsea resources. The State Governments and Union Territories would need sound advice on the resources both exploited and unexploited and on production means to harvest such resources.

Fisheries management involved better utilization of the mechanized sector, better storage and marketing facilities, avoiding wastage of the existing infrastructure such as idling of freezing plants, and building up of sound data base on fishery resources and related environmental factors.

The CMFRI had evolved sound scientific bases for resources assessment, acquisition of data from various sources, and their analysis and speedy dissemination, The Institute had laid stress on vessel-based programmes, especially with the advent of the scientific cruises of Sagar Sampada, and would strive to work side by side with the exploratory and commercial operations carried out by the Government of India Institutions and the industry.

The immediate task before the industry was to handle efficiently the already established resources and for this purpose they should have a meaningful dialogue at different levels with various organizations engaged in research, planning and development.Exploiting the deepsea resources called for such heavy capital investments that the industry would naturally shy from the idea of venturing, especially if proper methodsof utilization of the new resources were not available. The industry should gradually switch from their exphasis on shrimp to other resources and they should find ways and means 'of stabilizing the domestic market by developing better marketing facilities to take the products to the interior regions and develop better consumer acceptance.

There was a general feeling that, as there was shortage of protein- rich food, the weaker sections would welcome availability of fish food in remote places as well. So fish stalls should be established like milk booths in different parts of the country. In our effort to harvest the only high unit-value groups, such as shrimp, many of the trawl operators used to discard the accompanying miscellaneous small fish in the sea itself as trash. It would be a national waste if this protein rich fish were not utilized too for human consumption. Those representing the industry suggested for establishment of a Fisheries Guidance Bureau and for export promotion of non-conventional products. The Institutions engaged in harvest and post-harvest technologies, such as CIFT had important role to play in this regard, in the utilization of different resources. Even the processing of krill, so abundant in the Antartic region, should be explored.

In our effort to utilize potential resources, the large population of traditional fishermen should also be enlisted for cooperation

and involvement. Fisheries extension and transfer of technologies developed at different institutions were important to be considered. The most important thing was that there should be coordinated effort by all the institutions and organizations, pooling of the infrastructure facilities, manpower and expertise to tackle the problem of exploration, exploitation and utilization of the potential resources.

After further discussions by different participants a number of important points were raised, by Dr. Jones, Dr. Dwivedi, Shri Nambiar, Shri U. K. Gopalan, Shri V. C. Shukla, Dr. Lal Mohan, Mr. Verma and others. The Director, CMFRI, then placed before the Seminar the draft recommendations, which was later approved by the different chairmen participants.

RECOMMENDATIONS OF THE SEMINAR

The text of the recommendations of the seminar is as follows:

The Seminar, (a) having taken into consideration the total potential marine fishery resources of the country in the EEZ at the estimated level of 4.5 million tonnes and the present stagnation in the production around 1.4 million tonnes. (b) being concerned about the urgent need to bridge the gap between the potential and the present yield, (c) realizing the immediate need for:

i. necessary impetus for future development of fisheries,

ii. action needed for increasing production,

iii. safeguarding the interests of fishermen and

iv. exploiting the deepsea resources,

and (d) in consideration of the view points expressed by the participants, recommends that:

1. Surveys of the potential resources with related environmental factors on an area-wise, depth-wise and season-wise basis be carried out on a continuous basis in the waters of the EEZ, and for this purpose the vessel facilities, manpower and

other infrastructure be pooled together and a *co-ordinated action plan* be developed.

2. Comprehensive reports on the information available at present in respect of unexploited resources be prepared for each of the maritime States and Union Territories and made available for developing suitable exploitation and utilization strategies.

3. Economic viability of exploitable resources in the offshore and deeper sea region be worked out by conducting simulated commercial fishing and the data be made available to the industry so as to facilitate acceleration of deep-sea fishing and its establishment on a sound basis.

4. The data collected by the exploratory, experimental and commercial fishing operations be made available to the NMLRDC of CMFRI for analysis and speedy dissemination.

5. Immediate steps be taken by introducing suitable craft and gear to exploit the already established fishery resources such as anchovies, coastal tunas, seerfishes, pomfrets, trevalis, etc. available in the continental shelf region, for realizing increase in their production.

6. The introduction of medium-size vessel, of about 15 m, which could operate up to 200 m depth zone, should be encouraged for harvesting various identified potential resources.

7. Suitable management measures such as regulation of introduction of additional crafts and conservation of stocks of young fish resources be evolved in the currently exploited inshore waters and the suggested regulations be implemented.

8. Suitable boat and gear combination with adequate storage facilities on board be developed and introduced for exploitation of the resources in the areas beyond the traditional exploited zone and the deep sea.

9. Adequate infrastructure facilities such as berthing, handling, storage, ice production and marketing at the fishing harbours and proper distribution mechanism and storage facilities at major terminal markets be established not only

for better utilization of production but also for ensuring remunerative price to the producer.

10. As the resources to be exploited from the offshore and deep-sea regions form largely unconventional resources at present, a viable marketing system and consumer acceptance of these new resources be developed.

11. In view of the distinct advantages of chartering vess els and collaborative joint ventures in the present context of development of deepsea fishing, the policy regarding these be reviewed and viable procedures be formulated and implemented till such time that the national agencies establish the deepsea fishing industry.

12. The deepsea fishing being capital intensive, necessary incentives be provided to attract entrepreneurs and for the accelerated establishment of this sector.

13. Sufficient incentives be provided to scientists participating in the cruises of research and survey vessels, by way of hardship allowance or Triple Daily allowance.

14. As the marine fisheries of the country, from the research, development and administrative aspects, have considerably changed over the years to become a multi-disciplinary subject involving inputs from different organizations and agencies, an organizational set up of the fisheries in the country linking with different sectors be reconsidered and suitably evolved to provide the thrust and emphasis required for sustained development and expansion.

15. As, with the declaration of EEZ, the exploitation of living resources has become an imperative need not only to meet the increased proteinous food requirement of the growing population of the country, to obtain valuable foreign exchange and to uplift the economy of the fisherman and coastal rural population, but also to avoid wastage of the resources, a pragmatic national policy for the development of marine fisheries of the country in general and deepsea resources in particular be developed.

POTENTIAL MARINE FISHERY RESOURCES

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INTRODUCTION

Among the countries bordering the Indian Ocean, India has strategic advantages in exploitation of marine fish resources with its long coast line of 6100 km and rich and varied fishery resources within 2.02 million sq. km Exclusive Economic Zone. The present marine fish production of 1.85 million tonnes is less than half of the conservative potential estimate of 4.2 million tonnes (George *et al*, 1977). The trends in marine fish landings of past few years indicate that the coastal fisheries viz. oil sardine, mackerel, Bombay duck and penaeid and non-penaeid prawns may not contribute significantly for further increase in marine fish production of our country. Hence, while monitoring the resources for management of these stocks for conservation as well as exploitation up to the sustainable-yield level, we have to be on the look out for new potential resources in our EEZ.

Having assessed the demersal fisheries resources from the coastal areas within 70 m depth along east and west coasts at 1.71 million tonnes (Joseph, 1980) and about 0.15 million tonnes from 55-360m depth along north-west coast (Anon, 1979 and Bapat *et al*, 1982), Fishery Survey of India, since 1980, has been making all efforts to locate new fishing grounds and resources in our EEZ.

Results of the surveys conducted by the exploratory survey fleet in a number of sections of the EEZ for assessing demersal, pelagic and oceanic resources have been examined to provide knowledge on possible avenues of increasing fish production.

The marine fishery resources could be categorised into exploited, under-exploited and un-exploited resources. Among the under-exploited resources perches, nemipterids, carangids, lizard fish, catfish, barracuda, squids and cuttle fish along both the coasts and mackerel and lesser sardines along east coast could be mentioned. Of the un-exploited potential stocks, 'black ruff', 'big eye', Indian drift fish and deep sea crustaceans are few of the deep water resources recently located. There is no organised fishing by India for oceanic resources, viz, tuna and allied species and pelagic sharks, excepting the skipjack fishing around Lakshadweep islands. The recent long line survey for the larger pelagics have indicated possible commercial fishing in seas around India.

The major survey projects undertaken by Fishery Survey of India during 1980–85, the regions investigated under each project and details of the vessels deployed thereon are given in appendix-I.

UNDER-EXPLOITED DEMERSAL RESOURCES

The shrimp oriented growth of marine fisheries sector in India has left several parts of EEZ not supporting commercially viable concentration of crustacean stocks as unexploited. Besides, several species having protracted distribution over the continental shelf are exploited only up to about 50m depth owing to the limited operational range of large majority of mechanised trawlers.

The survey data collected by Fishery Survey of India vessels from different regions of Indian coast are examined and catch per unit effort of the major species/groups including the exploited stocks are furnished in Table 1.

Perches

Principally consisting of serranids, lutjanids and lethrinids, the group perches offer immense scope for increased exploitation along both the coasts. George *et al* (1977) has estimated potential yield of 2.5 lakh tonnes from Indian waters whereas

Table 1: Species-wise catch per unit effort obtained in demersal trawl survey from different regions of Indian coast

Species/group	Catch per hour (kg)				
	North-West coast	South-West coast	Wadge Bank &Gulf of Mannar	Lower east coast	Upper east coast
Elasmobranchs	44.46	4.73	12.67	6.70	10.65
Catfish	11.68	12.82	14.07	7.25	40.22
Perches	21.56	1.50	27.69	11.55	11.50
Pomfret	15.10	0.19	1.61	2.19	4.61
Ribbon fish	28.45	0.79	0.72	2.53	3.50
Sciaenids	30.09	0.14	0.38	9.57	16.04
Leiognathids	0.98	1.31	3.43	13.44	0.64
Nemipterids	25.49	30.15	17.40	6.56	10.92
Lizard fish	3.86	10.75	5.04	0.77	0.01
Caranx sp	3.78	3.58	8.70	8.96	7.10
Other carangids	20.95	9.63	3.90	15.83	26.65
Barracuda	0.81	1.19	7.13	3.02	3.37
Mackeral	1.19	1.56	2.56	5.75	28.26
Clupeids	5.03	0.48	0.57	5.17	10.87
Psenus indicus	0.10	6.72	1.38	9.51	5.21
Priacanthus sp.	0.23	12.69	5.21	7.08	9.32
Centrolophus sp.	—	21.60	0.21	1.80	0.71
Other deep sea fishes	—	7.09	0.02	0.21	0.18
Deep Sea prawns	—	3.00	0.14	0.78	0.05
Deep Sea lobster	—	8.83	0.25	0.10	—
Cephalopods	12.58	5.18	5.80	1.07	1.15
Other varieties	99.96	6.90	10.75	8.66	25.62
Total	331.30	132.80	129.63	128.50	228.45

the present landing is only about 12% of the estimate. Catch rate of this group obtained from the different regions and depth zones of Indian coast are given in Table 2.

Table 2: Catch per hour (kg) of perches in different regions and depth zones

Depth range (m)	North-west coast	South-west coast	Wadge Bank & Gulf of Mannar	Lower east coast	Upper east coast
Below 50	24.66	4.36	61.79	12.41	12.74
50-100	21.90	1.76	38.60	13.84	13.45
100-200	6.12	2.08	21.60	7.67	4.20
200-500	—	0.18	1.30	—	—

Wadge Bank indicated to have an encouragingly high density of perches, with catch rate of 67 kg/h. A highly productive perch ground yielding on an average 94.26 kg/h was located south-east of Cape Comorin below 50m depth. During July-September catch rate of perches obtained from this area was 153.4 kg/h and in April-June 130.7 kg/h. This conspicuous seasonal variation in yield pattern has been attributed to the presence of two stocks viz. the resident stock which is present on the fishing ground throughout the year and the migrant stock that appears on the bank during south-west monsoon (Sivalingam & Medcof, 1957; Sivalingam, 1969). In Gulf of Mannar higher concentration (26.5 kg/h) was recorded in 50-100 m depth zone. Along west coast Menon & Joseph (1969) have observed possibilities of handling fishing for serranids in the rocky patches beyond 60 m depth of Kerala coast. Survey of *M. T. Murena* in north-west coast indicated the highest catch rate of rock cods in lat 19° between 125-360 m depth yielding 43.5 kg/h in February-April. The group occured in fairly good concentration along east coast where average catch rate of 12-14 kg/h was recorded from areas up to 100 m depth.

Nemipterids

Nemipterids form one of the major components of trawl catches in west coast, contributing 38.7% in Kerala coast, 21.9% in Karnataka coast, 22.3% in Maharashtra coast south of Bombay and 23.8% in Wadge Bank. In east coast it formed rather low proportion making up 2.4% to 6.6% of trawl catch. The relative abundance represented by catch per hour of nemipterids obtained from the various depth strata of different regions is furnished in Table 3.

Table 3. Catch per hour (kg) of perches in different regions and depth zones.

Depth Range (m)	North-west coast	South-west coast	Wadge Bank & Gulf of Mannar	Lower east coast	Upper east coast
Below 50	10.88	26.68	3.64	2.88	6.66
50-100	30.52	18.75	14.81	9.71	14.32
100-200	44.20	66.90	81.77	13.38	4.81
200-500	—	—	2.87	—	—

From the table it will be seen that the highest yield of nemipterids was obtained from 100-200 m strata of Wadge Bank and Gulf of Mannar. Taken for Wadge Bank alone excellent catch rate of 425-430 kg/h has been reported between 70-100 fm. (128-183 m) depth with the nemipterid concentration reaching as high as 13.6 tonnes per sq. mile (Joseph *et al*, in press). It was observed that nemipterids enjoy dense distribution along the west coast in 100-200 m depth belt up to Maharashtra coast with peak catches in southern extremity of shelf gradually declining northwards. Stock from this zone is virtually unexploited and has good scope for exploitation.

Carangids

The landings of carangids comprising *caranx spp*, scads, horse mackeral, *Rachycentron sp.*, *Seriola sp* etc are about 0.43 lakh tonnes against the potential yield estimate of 2.65 lakh tonnes indicating considerable gap between the exploited and exploitable stocks. The survey results indicated that along both the coasts carangids contributed significantly to the demersal stock, forming 19 to 23% of catch in east coast and 15 to 21% in west coast. The group has very wide distribution in the entire shelf area, the choice varieties contributing bulk of catch in demersal landings from inner shelf and scads and horse mackeral chiefly making up the columnar resources in areas upto 200 m depth. Distribution pattern of carangids as revealed from trawl surveys in different regions of Indian coast is given in Table-4.

Table 4. Catch per hour (kg) of carangids in different regions and depth zones

Depth range (m)	North-west coast	South-west coast	Wadge bank & Gulf of Mannar	Lower east coast	Upper east coast
Below 50	7.69	24.87	19.45	13.65	46.11
50-100	14.64	20.85	14.77	39.26	31.77
100-200	77.96	4.31	14.28	33.01	22.82
200-500	—	1.20	0.52	—	—

Lizard fish

Lizard fish was reported from the entire shelf area of west coast with highest average catch of 10.75 kg/h from south-west coast, 5.04 kg/h from Wadge Bank and 3.86 kg/h from north-west coast. Distribution of the species was more concentrated in 100-200 m depth zone with catch rates ranging

from 12 to 25 kg/h. Along south-west coast lizard fish was found to have extended distribution even to the continental slope. The survey observation of Fishery Survey of India vessels indicated availability of lizard fish as furnished in Table 5.

Table 5. Catch per hour (kg) of lizard fish in different regions and depth zones

Depth range	North west coast	South West coast	Wedge Bank & Gulf of Mannar	Lower east coast	Upper east coast
Below 50	1.70	4.62	1.30	0.98	—
50-100	2.41	7.48	12.09	0.78	0.01
100-200	24.81	18 67	12.25	0.40	0.01
200-500	—	9.27	1.02	—	—

Catfishes

Catfishes formed 17.4% of catch in upper east coast, 5.6% in lower east coast, 2.8% in Wadge bank, 9.6% in south-west coast and 3.5% in north-west coast. The current landing is about 0.67 lakh tonnes against the potential yield estimate of 3.1 lakh tonnes. Relative abundance of catfish in different depth zones of various sections of Indian coast is given in Table 6.

Table 6. Catch per hour (kg) of lizard fish in different regions and depth zones

Depth range (m)	North-west coast	South-west coast	Wadge Bank & Gulf of Mannar	Lower east coast	Upper east coast
Below 50	13.31	45.68	11.67	2.53	24.22
50-100	11.98	17.92	3.37	13.62	53.21
100-200	2.59	2.35	0.75	8.34	15.77
200-500	—	—	0.08	—	—

Highest catch rate of 53.21 kg/h was recorded in 50–100 m depth belt of upper east coast followed by 45.68 kg/h from the inner coastal belt of south-west coast. Though the resource within 50m depth is being tapped to some extent, the stock in deeper water extending up to 150m remains largely unexploited.

Pomfrets

Some potentially rich demersal trawl grounds of pomfrets were located in relatively deeper water along both the coasts. In north-west coast it formed 4.6% of demersal catch and higher concentrations (18.83 kg/h) were recorded in 50-100 m depth zone. *M. T. Murena* identified productive grounds of the silver pomfret, *Pampus argenteus*, south of Veravel in 90–125 m depth range yielding 26.5 kg/h in January-February and 25.2kg/hr in September-October. The black pomfret, *Parastomateus niger*, was found to occur in high concentrations in 55-90 m off Bombay with 53.4 kg/h during April-May and 14.7 kg/hr in January-February. In Gulf of Mannar pomfrets contribute 3% of catch, predominantly formed of *P. argenteus* fished from the area 9-79. Maximum yield of 112.9 kg/h was obtained in December followed by 42.9 kg/h in March. Along east coast 1.7 to 2.0% of demersal catch was made up by pomfret, the lat. 15° N and 16° N in 50-100 m depth zone yielding 5.3 kg/h. In the northern latitudes 10.2 kg/h was obtained from the coastal belt within 50 m depth and 4.2 kg/h from 50-100 m range.

The present level of production of pomfret in the country is about 0.53 lakh tonnes and as per the potential yield estimates of George *et al* (1977) there is scope for expanded fishing to increase the production by another 60% of the current level.

Mackerel

In contrast to the dwindling catch trend in west coast mackerel landing has been steadily on the increase in east coast over the past several years. The recent figures of annual catch from the east coast has reached upto 0.2 lakh tonnes, a good percentage of which is reported to be taken by the mechanised trawlers.

From the demersal survey it was observed that distribution of mackerel extends along the entire east coast inside the 100 m contour with increasing catch rates in northern latitudes. In lower east coast it formed 5.4% of catch yielding 6 to 8 kg/h within 100 m depth. 12.4% of catch in upper east coast was formed of mackerel with an average catch rate of 28.3 kg/h. During 1985 *Matsya Darshini* recorded an average catch rate of 105 kg/h in lat. 20°-21°N within 60-120 m depth which formed 61.5% of trawl catch. The area 20-88 yielded the best results, mackeral catch in some of the hauls exceeding 2.5 tonnes. The ocuvrrence of mackerel in considerable magnitude in trawl catches from deeper waters indicates a possibility for development of mackerel fishery along the upper east coast.

Lesser Sardines

Productive areas of lesser sardines were identified in trawl surveys during 1983 and 1984 from the deeper waters along upper east coast. An average yield of 42 kg/h was obtained from the area 17-82 while the adjacent estern square recorded catch rate of 109 kg/h. The abundance was predominantly in 50-110 m depth range with peak concentration (123 kg/h) in 71-100 m belt. Though possibilities of higher production of this group from other sections of Indian coast is only marginal, it appears to have promising potential in the deeper waters of upper east coast.

Cephalopods

The interest of fishing industry for squids and cuttle fish is on the increase with some of the foreign markets quoting highly lucrative offers. The group which formed less than 0.1% of total marine landing during early seventies now represents over 1% of the catch landed. Being the principal target group, cephalopods are taken in sizeable quantity by the foreign trawlers operating in Indian waters under joint venture programmes. Survey reports indicate the cephalopods forming 4.1% of demersal catch from west coast and 0.6% from east cost. The general distribution pattern is given in Table 7.

Table 7. Catch per hour (kg) of Cephalapods from different regions and depth zones

Depth Range (m)	North west coast	South west coast	Wadge Bank & Gulf of Mannar	Lower east coast	Upper east coast
Below 50	9.22	3.33	6.97	0.66	1.30
50-100	14.81	6.80	9.04	1.06	1.19
100-200	8.02	6.00	3.34	1.05	—
200-500	—	0.04	0.33	3.86	0.90

Further examination of survey results revealed certain sections of Kerala coast, Maharashtra coast as well as Gujarat coast in 60–30 m depth yielding very high catch rates. Wadge Bank stock was characterised by the dominance of conspicuously large specimen of *Sepia pharaonis*. Sulochana & John (1983) have identified two productive grounds off Quilon and Calicut-Ponnani area along Kerala coast. The most recent observations of Matsya Nireekshani in October 1985 indicated the cephalopod component of above 200 kg in many of the hauls taken between 8°N and 11° N in 60–80 m depth. The most productive haul yielded 1.5 tonnes cuttle fish from the area.

In spite of the recent progressive trend, current landing of the group is only about 0.15 lakh tonnes as against the potential yield estimate of 1.8 lakh tonnes indicating possibility of a promising export oriented fishery.

Other Exploited Resources with Further Potential

Apart from the stocks described in the foregoing there are few other species/groups, as indicated in Table 8 below, with possibilities of increased exploitation by at least 50% or more of the current level of production, with extension of fishing effort to the outer shelf areas.

Table 8. Current landing, potential yield and area of occurance of other exploited resources having further potential.

Species/ group	Average landing for 1983 & '84 (lakh t.)*	P.Y estimate (lakh t.)	Main region of **occurance	Main depth of occurance (m)	Catch per hr. (kg)
Sciaenids	1.1	2.1	Upper east coast	50–100	24.3
			Lower east coast	50–200	20.8
Ribbon fish	0.6	2.7	North west coast	50-200	27.2
Barracuda			Gulf of Mannar	100-200	90.0
Elasmobranchs	0.5	3.1	Gulf of Mannar	100-200	48.3
			North west coast	upto 100	41.6

* Hand book on Fisheries Statistics 1985 (M,S) Ministry of Agriculture & Rural Development, N. Delhi.

** Potential yield estimate by George *et. al.* (1977)

UNEXPLOITED DEEP SEA DEMERSAL RESOURCES

The fish stocks in peripheral shelf area and continental slope along both west coast and east coast are totally unexploited. In contrast to the multiplicity of species in coastal regions the demersal resources in outer shelf and slope are comprised of a few non-conventional species viz. "Big eye", "Black ruff", "Green eye" *Cubiceps sp, Epinnula sp* etc. and the deep sea crustaceans. Oommen (1985) has estimated the standing stock of deep sea fishes in south west coast between lat 7° to 13° as 8136 tonnes and that of deep sea crustaceans as 18146 tonnes.

"Black Ruff"

The "black ruff", *Centrolophus niger*, is the major component of deep sea resource in south-west coast contributing 21.6% of aggregate catch. The distribution of this species was found to be highly concentrated in areas beyond 200 m between lat 8° and 13° N. Joseph (1986) has reported an average catch of 158 kg/hr of this species from 200–500 m depth zone along Karnataka coast

which represents 68.9% of catch. Proportion of the species from Kerala coast between lat 8°-11° N within the same depth range was also quite significant (59.6%). The same depth zone in lower east coast yielded catch rate of 27.5 kg/hr whereas only trace quantities were obtained from upper east coast and north west coast. The size range of the species was 7-18 cm with modal class 12-14 cm.

"Big Eye"

Priacanthus spp. popularly known as "Big eye" or "Bull eye" is another potential deep water resource located all along south west coast and east coast in 50-400 m depth with peak concentration in 100–200 m. The average catch rates obtained from the different sections and bathymetric zones of the surveyed area are given in Table-9.

Table 9. Catch per hour (kg) of "Bull eye" obtained from different regions and depth zones.

Depth range (m)	North-west coast	South-west coast	Wadge Bank & Gulf of Mannar	Lower east coast	Upper east coast
Below 50	—	12.37	0.45	0.03	—
50-100	0.28	10.22	1.62	1.17	6.09
100-200	0.78	19.05	4.88	49.09	44.23
200-500	—	8.74	1.69	7.59	3.14

The group made up 9.6% of catch in south-west coast 4.02% from Wadge Bank and Gulf of Mannar, 5.46% from lower east-coast and 4.08% from upper east coast.

The genera was represented by four species viz. *Priacanthus hamrur, tayenus, P. cruentatus* and *P. arenatus.* Highest catch rates were obtained from south west coast during April-June and from east coast during December. The size range reported from west coast was 8-29 cm with 13-21 cm as the most dominant size group. The mean length reported from east coast was 16-18 cm. This variety has high demand in Singapore, Thailand, Taiwan, Hong Kong and other countries in the region and is taken in sizeable percentage by the chartered foreign trawlers.

Indian Drift Fish

Psenus indicus commonly called as Indian drift fish is another deep water resource reported from all regions, the percentage of which in total catch varied from 0.03% in north-west coast, 5.06% in south-west coast, 1.06% in Wadge Bank and Gulf of Mannar, 7.40% in lower east coast and 2.28% in upper east coast. In west coast it was observed that occurance of the species is more concentrated in areas south of Mangalore from where catch rate as high as 1700 kg/hr has been reported (Philip *et. al.* 1984). The yield per unit effort obtained in different regions and depth zones are given in Table 10. Size range of the species was observed to be 11-25 cm with 16-20 cm. as the predominant group.

Table 10. Catch per hour (kg) of *Psenus indicus* in different regions and depth ranges.

Depth Zone (m)	North-west coast	South-west coast	Wadge bank & Gulf of Mannar	Lower east coast	Upper east coast
Below 50	0.06	0.15	—	9.35	10.10
50–100	0.13	0.20	0.10	23.44	4.74
100–200	—	30.19	6.20	46.86	1.96
200–500	—	5.80	0.14	—	—

Other Deepsea Fishes

Few other deep sea species viz. *Chlorophthalmusa gassizi* ("Green eye"), *Cubiceps natalensis, Epinnula orientalis, Emmelichthys sp*, *Bathygadus* sp ("rat tail") and deep sea sharks totally accounting for 5.34% of catch was reported from south west coast. The "rat tail" and deep sea sharks were more available in Karnataka coast whereas occurance of the other three species was mainly between lat 8° and 10°N. The "green eye" made up 16.05% of catch obtained from 200–500 m depth zone of Kerala coast.

Due to the unfamiliarity of the deep sea fishes presently there is no local demand, thereby requiring efforts to promote

consumer acceptance of these varieties. On the meat characteristics of "big eye", "black ruff" and "green eye" the recent studies coducted by Fisheries College, Mangalore, revealed that they are quite comparable in nutritive terms to many of the common coastal species. The proximate composition indicated that all the species are protein rich, the values ranging from 14.40% to 17.54% (Philip *et al* 1984).

Deepsea Prawns

Deep sea prawns were found to occur between 150-400 m depth along south-west coast and east coast. The Integrated Fisheries project during late sixties and early seventies had surveyed the continental edge and slope of south-west coast and Gulf of Mannar. Observations on the distribution as well as stock estimates of deep sea prawns have been reported by Joseph (1970), Mohammed & Suseelan (1973) and Oommen (1980, 1985). Very high catch rates (113-224 kg/hr) were obtained from Kerala coast during 1968-70 and the highest density was from the Quilon Bank and the northern grounds extending upto Ponnoni. 43 to 45% of catch from the major squares 9-75 and 10-75 was formed of this crustacean group. Standing stock from south west coast between lat 7°N to 13°N has been assessed at about 5200 tonnes (Oommen, 1985).

As survey by FSI vessels was not species specific, but aimed at assessment of the fishery resources in general, the catch figures obtained in respect of this group do not fully reflect on the abundance picture of the stock enabling quantitative assessments. However, comparison of the resource structure in different regions and depth zones could be inferred. Highest catch rate of 17.09 kg/hr was obtained from the shelf edge and slope in Kerala coast followed by 10.22 kg/hr in the lower east coast. In Gulf of Mannar and upper east coast percentage of this component was rather low. The species available in south west coast was *Heterocarpus woodmasoni, H. Gibbosus, Aristeus semidentatus, Parapandalus Spinipeo, Plesionika Martia* and *Solenocera hextii,* whereas in east coast *Aristeus sp* and *Solenocere sp* made up the bulk of catch.

Some of the species were found to exhibit very distinct ecological preferences. *Heterocarpus* sp was predominant in 250–350 m depth whereas *Aristeus* sp was found to be more beyond 350 m in west coast. The east coast *Solenocera* sp was reported from 150 m depth onwards. Better catch rates were observed during June to September along east coast and September to February along west coast.

Deepsea Lobster

The deep sea lobster resource is formed of a single species, *Puerulus sewelli* which grows to a maximum size of 205 mm. Joseph (1971) has reported occurrence of the species in commercial concentrations along south west coast based on surveys of the Integrated Fisheries Project. Oommen (1985) has estimated the standing stock of 12,940 tonnes from south west coast and 1860 from Gulf of Mannar. Excellant catch rates ranging from 122 to 164 kg/hr was recorded along the south west coast during 1969-71. A declining trend observed from 1972 continued upto 1977 when abrupt increase in catch rates from 28 kg/hr to 149 kg/hr was recorded.

The recent surveys by FSI vessels, besides re-confirming availability of the species along Kerala coast, western slope of Wadge Bank and Gulf of Mannar identified new grounds off the Konkan coast. In lat. 13° N to 15° N within 200-300 m depth it was found to constitute 5.2% of catch with an yield rate of 12.4 kg/hr. The northern grounds in same depth zone extending upto lat. 18°N gave an average catch rate of 18 kg/hr.

Though Oommen (1985) has reported the most productive season for deep sea lobster fishery along south west coast as February to June the recent survey revealed existence of a protracted season of abundance as evidenced from the results of the most successful hauls recorded by Matsya Nireekshani.

Month	Haul duration (hrs.)	Deep sea lobster (kg)	Lat./Long.
February	2.50	400	8-78
August	2.50	550	8-75
October	1.66	150	8-75
December	2.50	350	8-75

COASTAL PELAGIC RESOURCES

Oil sardine and mackerel are the main coastal pelagic species being traditionally exploited along southwest coast of India. Present landings of these species are 2 and 0.4 lakh tonnes as against the standing stock of 4 and 3 lakh tonnes, estimated by the UNDP/FAO Pelagic Fisheries Project (Anon, 1976 b). The standing stock of 2 lakh tonnes white bait and O.6 lakh tonnes "shallow water mix" comprising scads, silverbellies and *Ambassis* spp has also been estimated within 40 m depth along southwest coast. However, the recent trend in landings of the conventiona species leaves little hope for expansion of the fishery.

Results of Survey by Purse-Seining

The recent purse-seine survey conducted by Fishery Survey of India vessels in 40-200 m depth revealed availability of other resources along the coastal areas falling outside the present zone of exploitation. The catch obtained by *Matsya Varshini* while surveying southwest coast was about 85 tonnes during 1984-85. Though mackerel and oil sardine constituted the major components, forming 33% and 17% of catch, respectively, it was significant to note that their period of availability in deeper waters differed considerably from the season of higher distribution in inner coastal areas. Mackerel catches were obtained mainly during June to November and sardine during September to November. Among the coastal tunas, schools of *Euthynnus affinis* (little tuna) were more often encountered, and a large shoal of 30 tonnes netted along Malpe coast during May 1984 was noteworthy. Frigate tuna (*Auxis thazard*) and bullet tuna (*A. rochei*) were the other species recorded. Among carangids *Alepes djeddaba, Alepes melanoptera* and *Decapterus* sp. were more commonly obtained. Result of a set made off Cape Comorin during February 1985, hauling up 3 tonnes of "rainbow runner" (*Elegatis bipinnulatus*) along with an asortment of 6 tonnes *Alepes melanoptera, Euthynnus affinis* and *Elecate nigra*, was significant.

Along east coast the yield rates were comparatively low. In southern areas the pelagic stock comprised of frigate tuna, horse mackerel and othor carangids, whereas in the upper east coast

esser sardines, frigate tuna, little tuna, pomfret and anchovies made up the catch.

The survey revealed that along both the coasts the shoals were obtainable mainly within 60 m depth. The results do not appear to indicate availability of any sizeable quantities of purse-seinable pelagic resources in deeper waters of continental shelf.

Columnar Resources

The columnar resource of northwest coast and upper east coast were surveyed by midwater trawling during 1979-81 (Sivaprakasm and Somvanshi, 1983). Northwest coast yielded average catch of 431.7 kg/hr, horse mackerel (*Megalaspis cordyla*) forming the mainstay of catches (70.3%). Other important groups contributing to the pelagic trawl catches were elasmobranchs (10%), pomfret (8.6%), ribbonfish (4.3%), sardine (1.5%), mackerel and seer fish (0.2% each). Along the upper east coast catch rate was 266.2 kg/hr, formed of sardine (36.9%), ribbonfish (7.2%), mackeral (5.2%), pomfret (3.0%), seer fish (1.1%) anchovies (0.8%), etc.

The industrial fisheries survey in northwest coast by *M.T. Murena* during 1977 provided fairly good idea on the columnar resources in 55-360 m depth (Anon, 1979; Bapat *et al* 1982). The average catch recorded in pelagic/midwater trawling was 402kg/hr, the yield from different depth zones, viz. 55-90m, 91-125 m and 126-360 m, being 394, 541 and 265kg/hr respectively, indicating the middle depth range as richer in pelagic resources. Encouraging catch rates, as high as 1480 and 1207kg/hr were obtained during February-April in depth ranges 91-125 m and 126-360 m. In April-June the inner depth belt yielded 628 kg/hr, and the pattern of fish distribution indicated declining trends with increasing depths. The catch per unit effort of major pelagic groups obtained from each depth strata and their percentage in total catch is given in Table.11.

Table 11. *Distribution pattern and percentage of major pelagic species from northwest coast recorded by M. T. Murena*

Species	Catch per hour (kg)				Percentage
	50-90m	91-12m	126-360m	Total	
Horse mackeral	51.27	474.15	188.44	158.61	39.45
Ribbon fish	147.53	35.67	53.56	109.57	27.25
Pomfrets	39.10	8.72	1.09	26.73	6.65
Elasmobranchs	46.05	13.93	7.05	33.14	3.23
Catfish	21.28	1.76	0.12	13 87	3.45
Eel	20.15	0.14	0.09	12.82	3.19
Perches	14.32	3.03	2.05	10.02	2.50
Sciaenids	16.36	0.02	0.11	10.40	2.58
Other varieties	37.99	3.90	12.41	48.82	6 97
Total	394.05	541.32	264.92	402.08	—

Horse mackerel, the predominant columnar species with a catch rate of 158.61 kg/hr formed 39.4% of total catch. Substantial yield rate of 474.15 kg/hr was obtained from the depth range 91–125 m. During the most productive season, viz. February-April, catch rates in the three depth ranges were in the order of 54, 1422 and 944 kg/hr. The ground north of okha in lat 22°N within 91 to 125 m depth proved to be the richest ground in this season. During the second quarter of the year good yield rate of this species was obtained along the Porbander, Veraval and Bombay regions.

Ribbonfish represented by *Trichiurus lepturus* and *T. savala* occurred over the entire area of investigation and formed 27.25% of catch with an average catch rate of 109.57 kg/hr. Significantly high yield rates were obtained in the Bombay-Dwaraka region mainly in 55-90 m stratum.

The silver pomfret, *Pampus argenteus*, gave an average catch rate of 7.68 kg/hr and accounted for 1.91% of pelagic catch. The depth range 55-90 m contributed to the major part of catch and the yield rate showed declining trend with increasing depth. The highest catch rate of this species occurred in the area bounded by latitude 22°20' - 23°00'N and longitude 67°00-68°30' E, from where catchup to one tonne per haul was obtained during January-February. The second region, where these species occurred in significant concentration, was between Dwaraka and Porbander. The black pomfret, *Parasromateus niger*, formed 4.74% of pelagic landings and was taken at a catch rate of 19.05 kg/hr. Highest concentration of the species was obtained during February-April from 55-90 m depth.

Apart from the species discussed above, catfish, eel, perches, sciaenids, sharks, rays, scombroids and carangids were the major components, contributing 1 to 4% of the pelagic catch. The general conclusion that could be drawn from the survey was that highly productive grounds of columnar resources are available over the north west region of Indian shelf. These resources are as yet unexploited and offer possibilities of developing a viable fishery by developing appropriate types of vessel and gear.

OCEANIC RESOURCES

Tunas, bill fishes and sharks constitute the exploitable large pelagic resources from high seas. The tuna fleets of non-Indian Ocean countries viz, Japan, Republic of Korea and Taiwan, were known to operate in Indian Ocean since 1950's. Potential yield estimates of tuna and related species in Indian Ocean range from 0.51 to 0.79 million tonnes whereas the landings are around 0.22 million tonnes only (FAO, 1980). Several authors (Gulland, 1971, Suda, 1974; Suzsuki, 1979; Silas, *et al*, 1979. Silas and Pillai 1982, Silas 1983; Dwivedi and Devaraj, 1983)have given detailed account of the stocksize and distribution of tuna resources in Indian Ocean and scope for increased production. The status of pervailing tuna fishery in the EEZ's of India,

Maldives and Sri Lanka has been discussed by and Sivasubramaniam (1985).

The average annual landings of tuna from Indian seas during the last decade was 11,500 tonnes and its share in all - India fish production ranged from 0.03 to 1.92%. There is no organised fishery in the country for tunas except the pole and line fishing in Lakshadweep Islands mainly for skipjack tuna. Eapen (1964) and Joseph (1972) have discussed on developmental prospects of tuna fishing in Indian waters based on the preliminary resource apprisal surveys conducted during the sixties. Fishery Survey of India during the last few years has been exploring the extent and magnitude of tuna resources in Indian seas deploying the longliner *Matsya Sugundhi*. The results obtained during October'83 to December '85 are discussed here, enabling a preliminary assessment of the resource position of tunas and related species. A fairly good coverage by operating about 2 lakh hooks was made in the Arabian Sea including Lakshadweep waters, Bay of Bengal including Andaman and Nicobar seas and the equatorial waters.

Four scombroid species viz. yellowfin tuna (*Thunnus albacares*), bigeye tuna (*T. obesus*), skipjack tuna (*Katsuwonus pelamis*) and albacore (*T. alalunga*) formed the major component of catch (46.07%). Billfishes consiting of striped marlin (*Tetrapturus audax*), blue marlin (*Makaira nigricans*), black marlin (*M. indica*), sail fish (*Istiophorus platypterus*) and broad bill sword fish (*Xiphias gladius*) accounted for 9.3% and pelagic sharks 41.2%. Dolfin fish, seer fish and other varieties made up the rest of catch. But the resource composition in different oceanic regions showed marked variations as given in table 12. Percentage of tuna in equatorial sea was 62.3% whereas in Andaman area tuna formed only 35.76% of catch. Joseph (1986) has analysed the percentage composition of tuna in squares of 5° lat. x 5° long. and found that the area lying between lat. 0°-5°N and long. 65°-70°E yields the highest proportion of tuna (87.2%).

Table-12 *Percentage composition of longline tuna catch in different oceanic regions*

Species/group	Arabian sea	Bay of Bengal	Andaman sea	Equatorial sea
Tuna	47.59	38.19	35.76	62.30
Bill fishes	8.13	19.10	10.60	6.28
Pelagic sharks	42.47	39.18	43.71	30.89
Other varieties	1.81	6.53	9 93	0 53

Among tunas, yellowfin was the most dominant species, contributing 91.7%, with wide distribution in the Indian seas and adjoining areas. Availability of bigeye tuna was significant in equatorial sea, whereas skipjack tuna was more frequently hooked from east coast. Albacore was observed to have rather limited distribution, confining to the Andaman and Nicobar seas.

The average number of fish obtained per 100 hooks was 2.67. The rate of hooking in general was observed to be the highest in Arabian sea (3.32%) followed by east coast (1.99%), equatorial waters (1.91%) and Andaman sea (1.51%). The highest hooking rate of 12.9% was recorded in area 14-72 followed by 11.3% in 13-73 and 8.2% in 14-71.

The hooking rate in respect of the four species of tuna together was 1.23%, west coast yielding comparatively high rate (1.58%) followed by equatorial sea (1.19%). The areas in lat. 13°N and 14°N off the Mangalore-Karwar coast were found to be the richest grounds from where average rates as high as 9.67%, 6.74%etc. were recorded. The distribution pattern of yellowfin tuna which formed about 92% of tuna catch essentially remained the same. Sulochann *et al* (1986) has worked out in detail spatial distribution pattern of this species in Arabian Sea. Bigeye tuna were hooked at higher rate (0.5%) in the area 3-77 south of equator followed by 5.68 and 7-91 (0.4% each) in the northern hemisphere. Hooking rate of marlins was high (0.38%) in east coast

and the minimum (0.12%) in equatorial sea. Pelagic sharks indicated high catch rate (1.41%) in Arabian Sea, the latitudes 13°N to 15°N giving the highest yield rate of 2.87%. The hooking rate of major species of tunas, billfishes and pelagic sharks in 1° squares have been documented by Varghese *et al* (1984).

As abundance pattern of the major species varied considerably in different months in different oceanic regions comprehensive information on the seasonal fluctuations in catch rate becomes imperative for planning any strategy of exploitation. The hooking rates of important groups worked out on a bimonthly basis in respect of Arabian sea is furnished in Table 13 The post-monsoon season commencing from September formed the productive season for tuna longline fishery.

Table 13. *Hooking rate (%) of major fish groups from Arabian Sea in different seasons.*

	Tuna	Billfishes	Pelagic sharks	others
Jan — Feb	0.56	0.17	0.14	0.19
Mar — April	3.16	0.39	1.84	0.39
May — June	0.31	0.31	0.89	0.05
July — Aug	0.77	0.10	0.01	0.19
Sept — Oct	1.48	0.21	1.56	0.02
Nov — Dec	2.74	0.34	1.67	0.04

Though the table shows 3.16% hooking of tuna during March-April, reliability of the information is rather low as it is based on a single sampling. From a highly productive ground (14-72) identifield off Mangalore-Karwar within 150 miles from the coast excellant hooking rate of 23.9% yellowfin tuna was recorded during October 1985, which further reached a phenomineal level 33.5% during January'86. In the least coast, in Andaman sea and equatorial waters only preliminary surveys have been completed and sampling was therefore confined to a few months. Observations in east coast indicate first quarter of the year as the best season for tuna fishing with 1.13 to 1.18% hooking, whereas in equatorial waters higher catch rates (1.22 to 2.19%) were obtained during October and November.

Bigeye tuna yielded higher catch rate in November and December whereas skipjack did not show any definite seasonal availability pattern. Marlins were caught more in east coast during February-March.

From the survey it emerged that some areas within Indian EEZ is highly productive with encouraging hooking rate for tuna. The average catch rate in thc surveyed area for all tuna together and separately for yellowfin tuna was 1.23% and 1.13% respectively. These indices are considerably higher and favourably compared with those hooking rates recorded from Indian Ocean by Japanese (8.23%), Korean (0.62%) and Taiwanese (0.17%) longliners during the late Saventies. Sivasubramaniam (1985), while analysing tuna longline catches from the seas boardering India, Maldives and Sri Lanka reported yellowfin tuna hooking rates as 0.07% between lat. 0°-5°N in long. 70°-75°E, 0.19% between lat. 0°-5°N in long. 75°-80°E and 1.50% between lat 5°-10°N in long 75°-80°E. The present study reveals much higher catch rate, ranging from 0.36% to 3.08% tunas when examined in squares of 5° lat x 5° long. Druzhinin (1973) reported catch rate of 16.7 kg. tuna per 100 hooks in the western Arabian sea in lat. 10°-15°N which roughly works out to 0.5% hooking by number. The share of tuna in longline catch from Arabian sea was only 15% as per earlier records (Anon, 1976 a) whereas the present survey indicates 49.59% of longline catch as tunas. All these suggest that with the release in fishing pressure consequent to withdrawal of alien fleets from Indian seas the cateh rates have considerably revived and resource availabillty is no more a constraint in tuna exploitation.

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APPENDIX I

Major Survey projects carried out by Fishery Survey of India during 1980-85 in the different regions of Indian coast and details of vessels deployed

Survey project	Region	Vessel	GRT	BHP
I Demersal resources survey	North-west coast	Matsya Nireek-shani	329.36	2030
		Matsya Varshini	268.88	1160
	South-west coast	Matsya Shakti	327.18	825
		Matsya Viswa	327.18	825
	Wadge Bank & Gulf of Manner	Matsya Nireek-shani	See above	
	Lower east coast	Matsya Jeevan	328.13	825
	Upper east coast	Matsya Shikari	352.47	1740
II Pelagic resources survey	West coast	Matsya Varshini	See above	
	East coast	Matsya Harini	257.95	750
III Tuna longline survey	Indian EEZ& equatorial sea	Matsya Sugundhi	243.45	650

POTENTIAL MARINE FISHERY RESOURCES OF INDIA

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INTRODUCTION

Marine Fisheries resources of our country, being dynamic and self renewing in nature, are subject to fluctuations due to fishery-dependent and fishery-independent factors. Therefore, it becomes necessary to riview periodically the status of exploited resources and make critical assessent of the fishery potential as more and more data are gathered and new knowledge based on exploratory surveys and researches emerges. Such vital information on the potential resources of the country is an essential prerequisite for proper planning of development strategies with regard to the marine fisheries sector.

The marine fish production of the country continues to be predominantly in the hands of the traditional and small-scale mechanized sectors, the efforts of which still concentrate in the narrow coastal belt. This situation has been continuing despite the developmental inputs such as strengthening mechanized fleet by increasing small trawlers to 20,000 and establishing infrastructural facilities such as fishing harbours.

With the declaration of the Exclusive Economic Zone, a vast area of 2.02 million sq.km., having rich marine fishery resources, is thrown open for rational exploitation, offering scope for increasing production.

PRESENT LEVEL OF EXPLOITATION

India's marine fish production, as estimated by the CMFRI, touched the 1 million tonne mark for the first time in 1970 and,

thereafter, for nearly 15 years, has remained stabilized around 1.4 million tonnes. Table 1 gives the current level of production based on the estimates for the years 1980 to 1984, During the previous 5-year period, the average production was 1.36 million tonnes.

Table 1: *Annual Marine Fish Production in India during 1980-1984*

Year	Landings (tonnes)
1980	1,249,837
1981	1,378,457
1982	1,420,624
1983	1,548,475
1984	1,630,678
Annual average	1,445,614

As could be seen from the table, the marine fish production has reached a plateau, which is because of the fishing effort being mainly concentrated in the 0-50 depth zone of the coastal belt. It is estimated that, on an average, the artisanal fisheries sector contributes 39% and the small-mechanized sector 61% of the annual production.

The exploited resources along our coasts are unevenly distributed, with the west coast, with its dominating major fisheries for oil sardine, anchovies, bombayduck, and penaeid prawns, contributing about 2/3 of the present yield. Table 2 givies the regionwise average production for the period of 1980-84.

Table 2: *Regionwise average production of marine fish during 1980-1984* (in million tonnes)

Northwest region (Gujarat & Maharashtra)	... 0.489
Southwest region (Goa, Karnataka & Kerala)	... 0.498
Southeast region (Tamil Nadu, Pondicherry & Andhra Prdesh)	0.386
Northeast region (Orissa & West Bengal)	... 0.065
Lakshadweep region	... 0.004
Andaman-Nicobar region	... 0.004

The all-India marine fish production is made up of pelagic and demersal stocks to the average extents of 51.9% and 48.1%, respectively. The major pelagic stocks are oil sardine (*Sardinella longiceps*), bomdayduck (*Harpodon nehereus*), anchovies *Stolephorus* sp, *Thryssa* sp, *Coilia* sp. and *Setipinna* sp) and 'other sardines' (*Sardinella gibbosa*, *S. albella* etc). The major demersal stocks comprise penaeid prawns *Penaeus* spp., *Metepenaeus* spp., *Parapenaeopsis* spp), sciaenids (*Sciaena* sp, *Pseudosciaena* sp, *Johnius* sp., *Penhania aneus*, *Otolithes* sp,) silverbellies (*Leiognathus* spp) and Elasmobranchs. The average productions of these major groups during 1980-84 are given in Table-3. They together contribute to 54% of the total production. Apart from this, the species of medium importance contributing to the fish production are ribbonfish (*Trichiurus* spp.), mackerel (*Rastrelligen kanagurta*), carangids, pomfrets, seerfish (*Scomberomorus* spp.) catfishes, perches and non-penaeid prawns.

Table-3: *Annual production trends of major species 1980-84 (thousand t)*

Year	Pelagic species				Demersal species			
	Oil sardine	Bombay duck	Anchovies	other sardines	Penaeid prawns	Sciaenids	Silver bellies	Elasmo branch
1980	116	96	63	67	112	89	54	58
1981	221	138	68	62	84	83	69	56
1982	205	86	80	55	111	87	73	64
1983	184	101	126	77	118	101	92	69
1984	189	118	120	68	130	110	57	58
Annual average	183	108	92	66	111	94	69	61

Table-4: *Average annual praduction from species of medium importance during 1980-84 (thousant 5)*

Pelagic species		Demersal species	
Ribbonfishes	50	Catfishes	58
Mackerel	41		
Carangids	44	Perches	48
Pomfrets	48	Non penaeid	
Seer fishes	32	prawns	57

The other groups of commercial importance are the clupeids, (30,000 t), tunas (20,000 t) and cephalopods (15,000 t).

The characteristic feature of most of the exploited stocks is a wide year-to-year fluctuation.

ASSESSMENT OF POTENTIAL RESOURCES

The foregoing paragraphs, showing the current levels of exploitation of the major and minor resources within the present intensively fished 0.50 m zone, point out the existing stagnation in yield and the lack of scope for further increase within the zone in respect of many species. Therefore, we should look to the waters beyond the 50m zone and the EEZ for additional resources. In this context, the assessment made on potential yield (PY) of resources assumes importance.

During the past two decades, many approaches were made for assessing the potential resources of the EEZ. Estimates of PY were made based on the primary production of seas and the exploratory surveys of various agencies, as well as by the approximation based on estimated production from exploited stocks. These estimates of PY ranged from 2 million tonnes to 8.5 million tonnes per annum for the Indian waters (Subranmanyan 1959; Panikkar 1966; Prasad *et al* 1970; Cushing 1971; Gulland 1971; Jones and Banerji 1973; Prasad and Nair 1973; Shomura 1976; and Silas *et al* 1976).

In the context of the declaration of Exclusive Economic Zone in 1977, George *et. al.* (1977) made a comprehensive review of the exploited resources in different regions and, taking into consideration the additional data from the exploratory surveys in the intervening period, gave an estimate of annual potential yield in EEZ as 4.47 million tonnes. Out of this projected potential, the estimates of PY of different regions and depth zones *vis a vis* present productions are presented in Table 5.

As could be seen from the regionwise potentials *vis a vis* present levels of production within the 0.50 m depth zone, there appears to be a scope for increased production only in the north-east region. Whereas, the potential from the 50-200 m depth

Table-5. *Estimated annual potential yield of marine fish in the EEZ of India (in thousand tonnes)*

Region	India's present production	Annual potential yield			
		0.50m	50–200m	beyond 200 m	Total
North-west	489	540	340		880
South-west	498	700	720		1420
South-east	386	480	200		680
North-east	65	540	200		740
Lakshadweep	4	–	90		90
Andaman&Nicober	4	–	160		190
Oceanic of all regions	–	–	–	500	500
Totals	1416	2260	1710	500	4470

zone and the oceanic waters, amounting to 2.2 million tonnes, offers vast scope for exploitation.

The potential yield of 4.47 million tonnes in the EEZ comprises pelagic fishes (1.85 million), demersal fishes (1.1 million) and the rest, consisting of crustaceans, cephalopods, oceanic fishes and miscellaneous fishes. (Table 6).

Table - 6. *Groups of fishes and their potential annual yield in the EEZ of India* (in thousand tonnes)

Groups	present yield	Potential yield
Pelagic fishes	714	1850
Demersal fishes	336	1095
Crustaceans	214	325
Cephalopods	15	180
Miscellaneous	164	520
Oceanic fishes	3	500
Totals	1446	4470

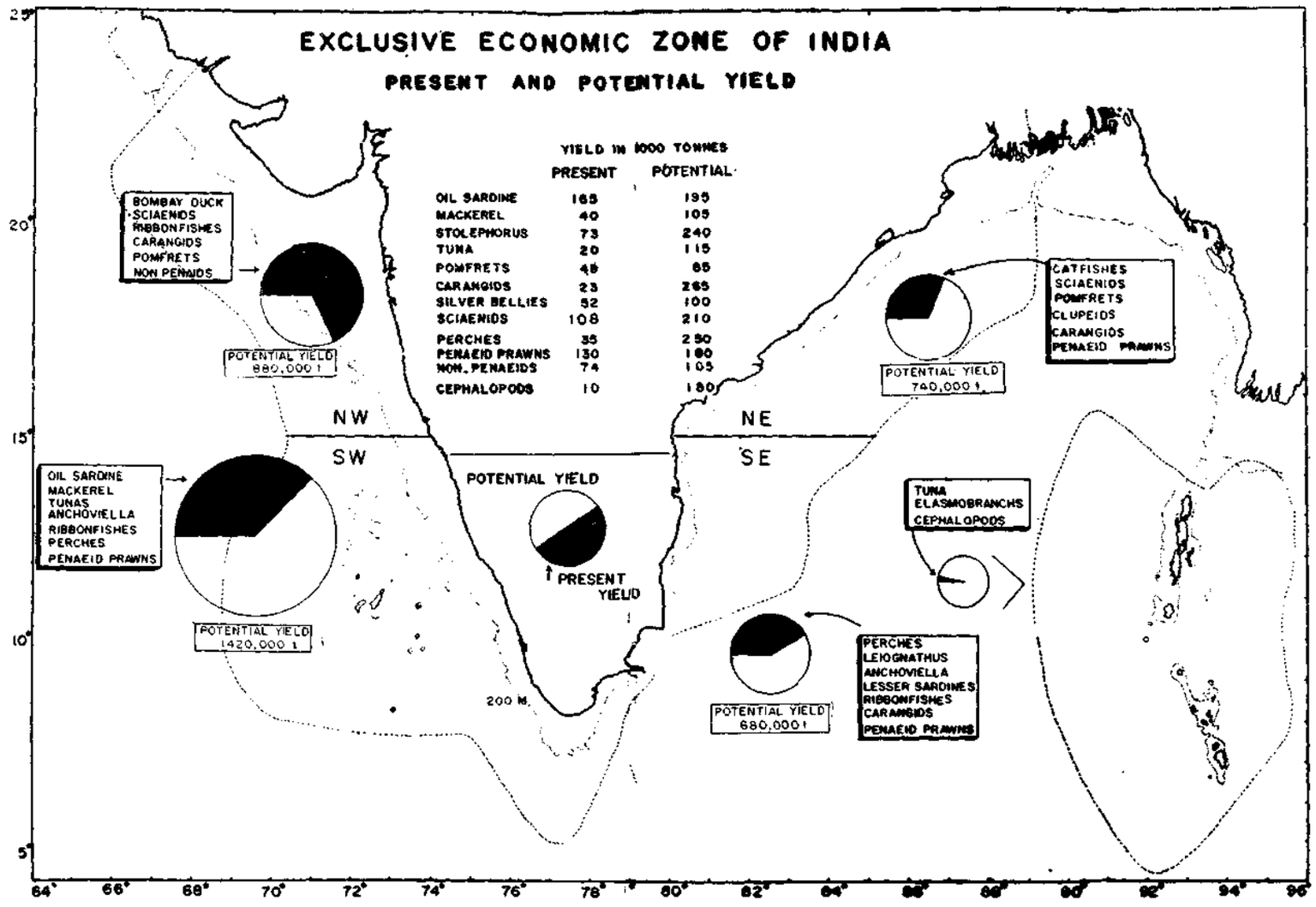

FIG. 1 Map of the EEZ of the India showing the area wise estimated potential yields of different groups.

Potential Pelagic Resources

The present levels of production of different groups and the potentials and scopes for increasing them can be examined in greater detail as follows.

It is estimated that the potential of pelagic stocks is 1.85 million tonnes as against the present yield of about 0.7 million tonnes. By the acoustic and aereal surveys conducted by the

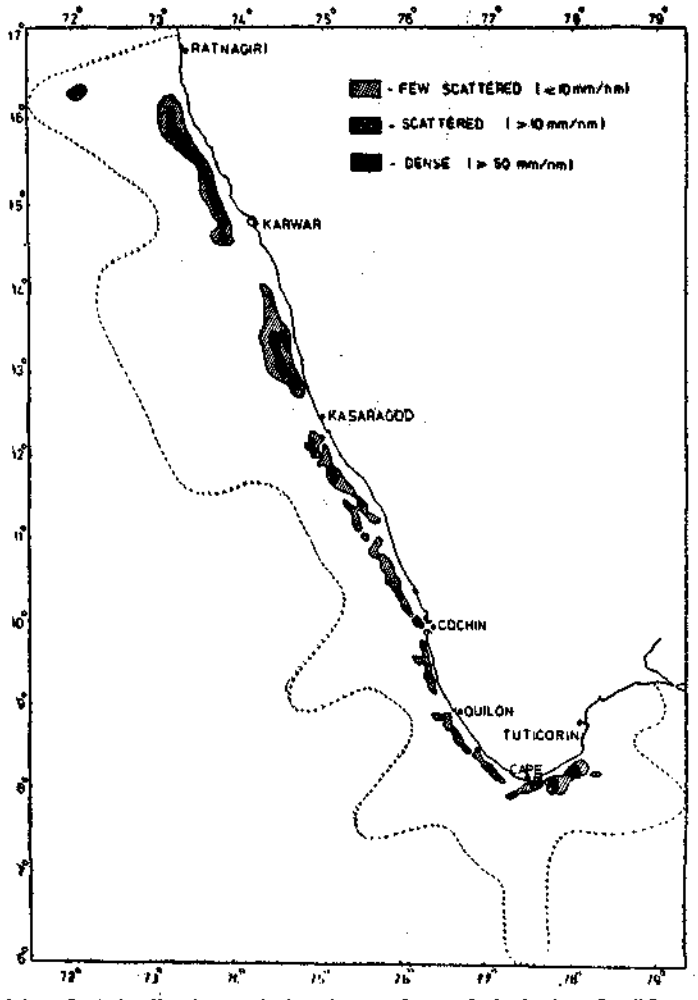

Fig. 2 Distribution and abundance of whitebait during Oct/Nov.

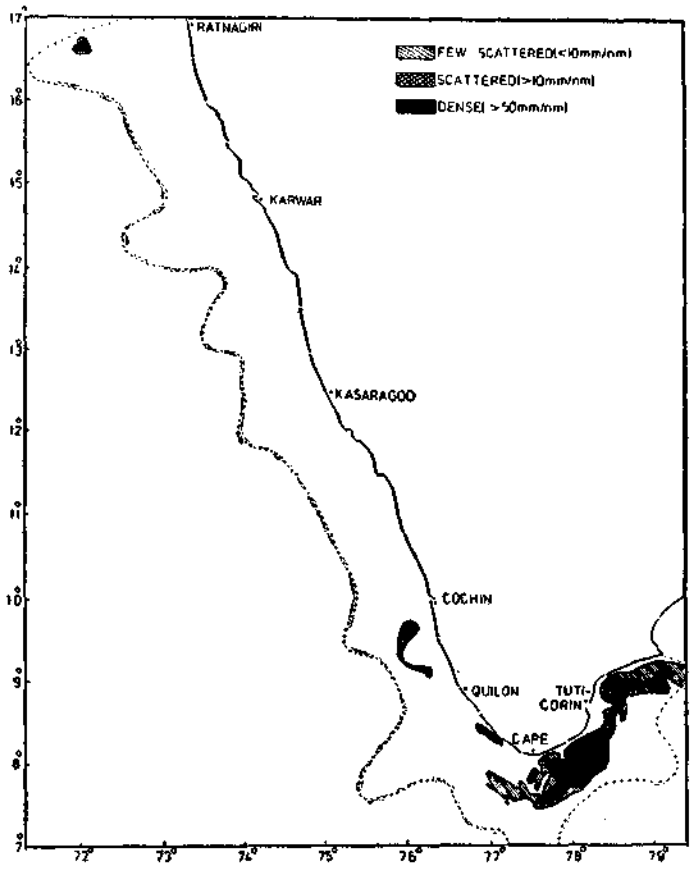

Fig. 3 Distribution and abundance of whitebait during August.

eirstwhile Pelagic Fisheries Project along the southwest coast and in the Gulf of Mannar, the average annual biomasses of white bait, horse mackerel, mackerel and oil sardine have been estimated respectively as 0.75, 0.13, 0.27, 0.55 million tonnes (Anon, 1980), A single-group resource that is reported to have a very high concentration in the 20-50 m zone is the anchovies, particularly in the southwest and Gulf of Mannar regions (figs 2-3) Besides, definite indications of large stocks of oil sardine, mackerel, pomfret. carangids, ribbonfish, lesser sardines and coastal tunas in depth zone 50-200 m have also come from some recent surveys along the east and west coasts of India (Bapat *et. al.* 1982; Silas and

Pillai, 1982; Joseph, 1984; Somavanshi and Bhar 1984 and Ninan *et. al.* 1984).

Stock assessment studies carried out by CMFRI on the exploited major pelagic stocks has indicated that increased production from the stocks in the presently exploited ground is possible by capturing them at increased size or by extending the fishing to unexploited areas.

Among the pelagic stocks, those which promise high production *vis a vis* current production are as follows:

Species	PY (x1000 t)	Av. current yield (x 1000 t)
Other sardines	1410	66
Anchovies	240	92
Other clupeids	165	30
Ribbonfishes	270	50
Carangids	265	44
Coastal tunas and Related species	240	20

By far the most important among pelagic resources, which offer the maximum potential for exploitation, are the oceanic tunas such as yellowfin (*Thunnus albacares*), skipjack (*Katsuwonus pelamis*), bigeye (*Thunnes obesus*), albacore (*T. alallunga*); marline (*Tetrapturus* sp and *Makaira* sp) and oceanic sharks (*Carcharinus melanopterus, C. longimanus etc*). These together have a potential of 0.5 million tonnes and we are exploiting only a fringe of the resources. Recent surveys of CIFNET and FSI vessals which conducted longline fishing in the southwest coast, Andaman sea, west of Maldives and eastern Arabian sea, have indicated rich grounds for these resources, especially in the area 12° to 16°N latitude and 70° to 74° E longitude off west coast of India, where catch rates as high as 8.1 to 25.0 nos/100 hooks have been obtained. (Varghese *et al.* 1684; Anon 1882). (fig. 4).

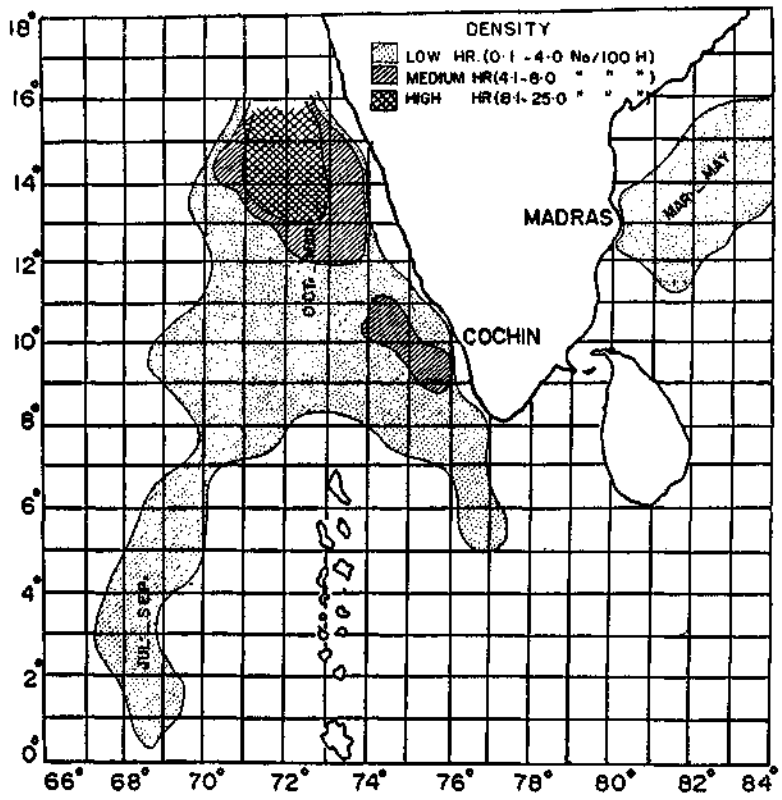

Fig 4. Distribution and abundance of oceanic tuna resources.

Potential Demersal Resources

The demersal fisheries of Indian seas, their component groups and fluctuations, have been well studied by various organizations including CMFRI (Rao, 1973). The estimated potential of demersal finfish resources of thr EEZ is around 1.1 million tonnes, as against the current total yield of 0.34 million tonnes. As has been already stated, the 0-50 m zone is intensively tished, and any increase in effort here is likely to affect the stocks. Enhanced production is possible only by allowing to increase the size of fish at capture of the presently exploited stocks, or by extending fishing to the unexploited grounds, where, too, good concentration of the species presently exploited are found to occur.

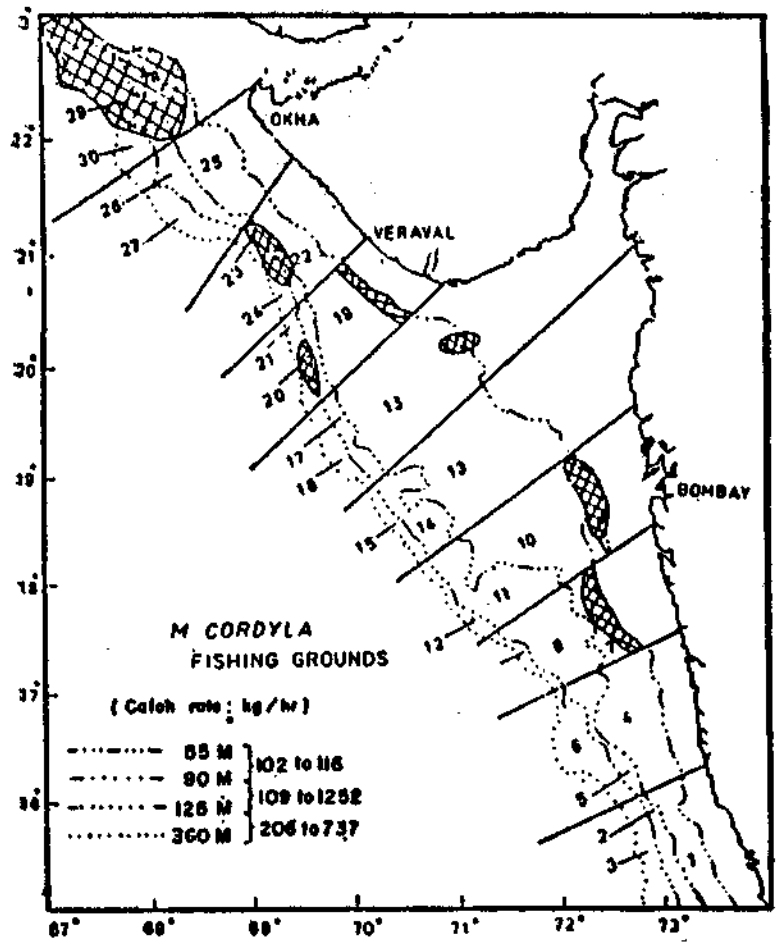

Fig. 5 Horsemackerel fishing grounds.

Based on the results of the exploratory surveys by M. T. *Murena*, the potential harvestable yield of three depth zones (55-90, 91-125 and 126-360 m) in the north western region were estimated to be 0.11, 0.03 and 0-01 million tonnes, respectively (Bapat, *et al.* 1982). The density was indicated to be the greatest in the 55-90 m zone (2. 31 t/km^2), where the resources comprised mainly pomfrets, catfish, clupeids, breams, ghol, koth, dhoma, elasmobranchs and eels. In depths beyond 90m lutianids, serranids, other perches and nemipterids were indicated

to have wide distribution, the catch rates increasing with increasing the depth.

The resource potential of the 'Kalava' grounds off southwest coast of India was estimated by Silas (1969) and Menon and Joseph (1969). The catch rates in these grouds ranged from 125 to 229 kg per 100 hooks per hour, indicating a rich potential for

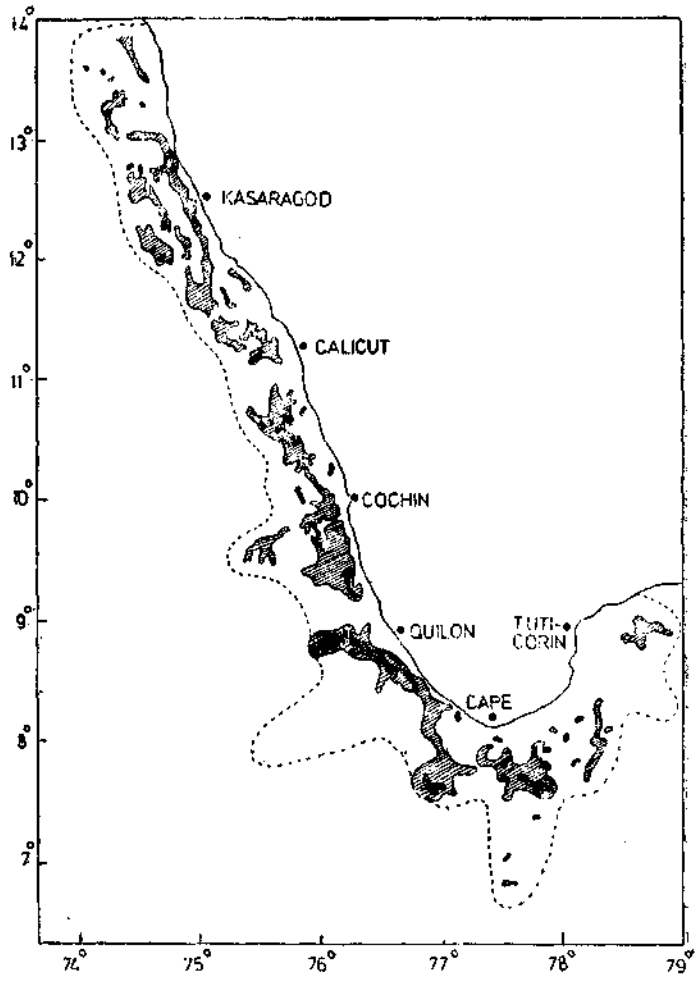

Fig. 6 Distribution and abundance of horse mackerel during September-October

commercial fishery. The main species were *Epinephelus chlorostigma* and *Pristipomoides typus*. Based on trawl surveys conducted in the same region in depth range 75-400 m, Silas (1969) estimated the sustainable yield of demersal resources to be around 60,000 tonnes, with nearly 60% of it in the 100-400 m. The predominant resource in 180-220 mdepth zone was that of the threadfin bream, *Nemipterus* sp.

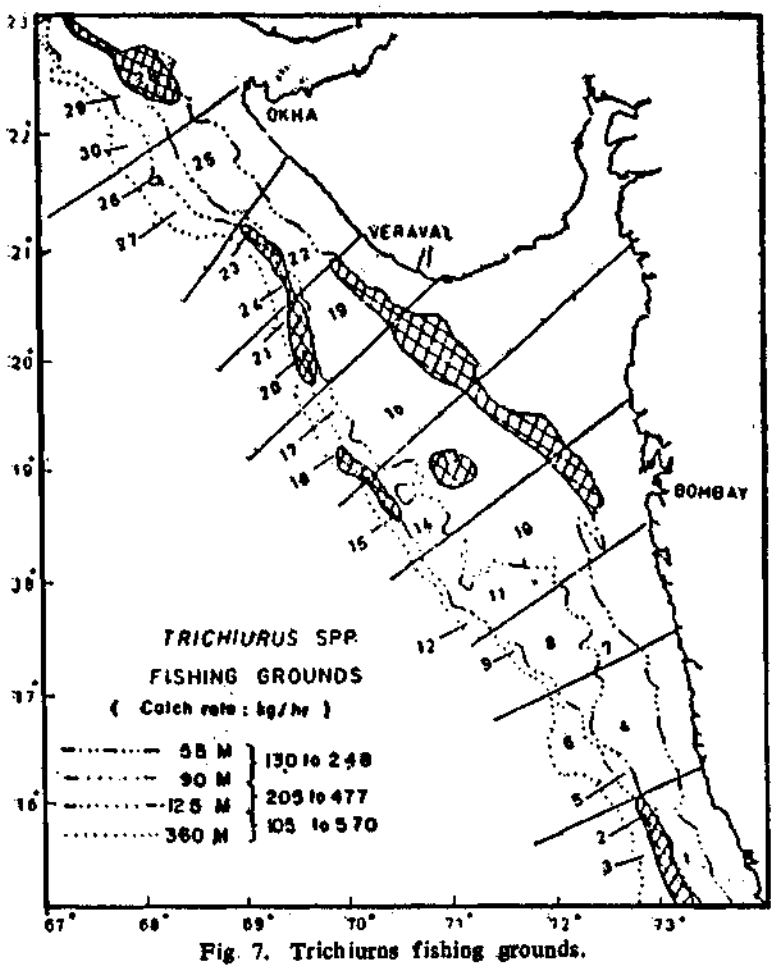

Fig. 7. Trichiurus fishing grounds.

The unexploited and underexploited stocks of catfishes along the southwest coast based on acoustic surveys were estimated to

be 80,000 tonnes (Rao et al 1977). The biomass has been observed to be greater during the monsoon months, but the exploitation has been inadequate due to limitations posed by adverse weather conditions. In general, catfishes are available in greated concentrations over long periods (May to September) off Kerala and Karnataka, where larger size groups occur in deeper waters.

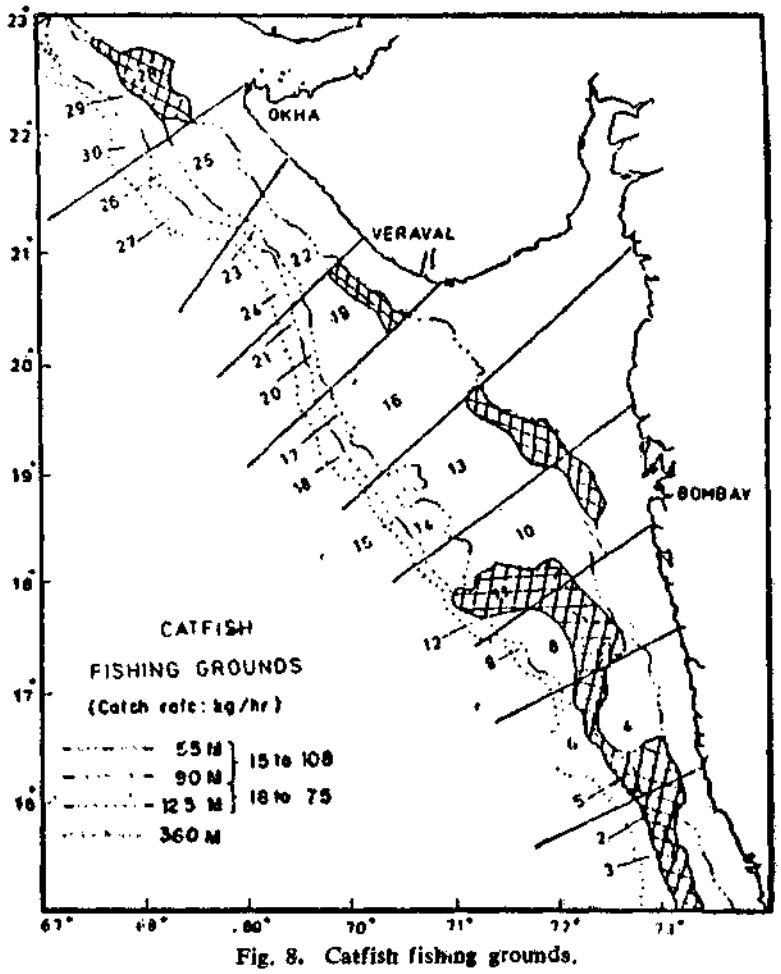

Fig. 8. Catfish fishing grounds.

Among the currently exploited demersal finfish resources, the groups that have greater potential for further exploitation and offer scope for increased production, are as follows:

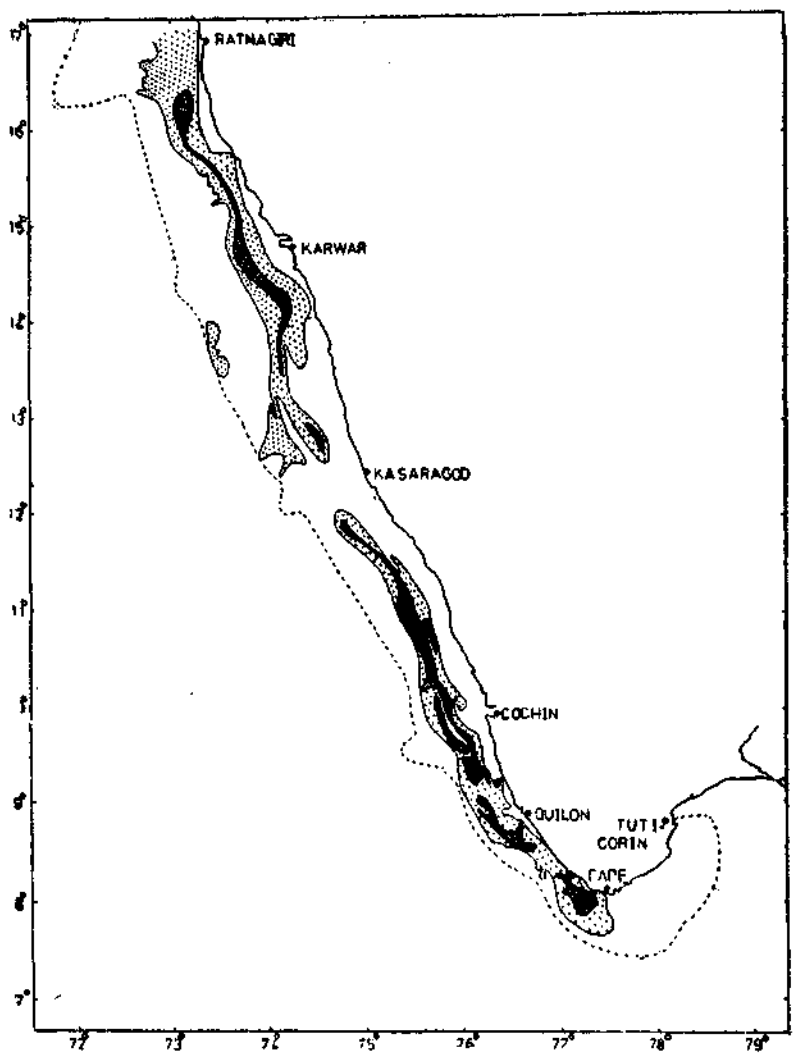

Fig. 9. Distribution and abundance of catfish/ribbonfish during July. August.

Species	P. Y. (x 1000 t)	Av. current yield (x 1000 t)
Elasmobranchs	185	61
Catfishes	310	58
Perches	250	48
Sciaenids	210	94
Leiognathids	100	69

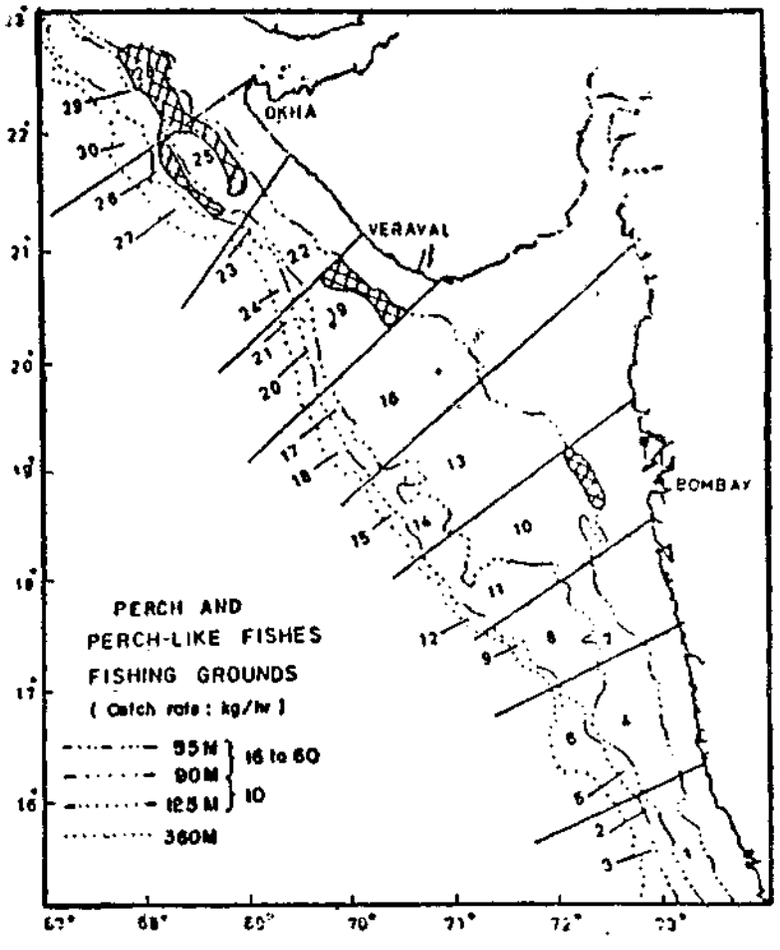

Fig. 10. Perch fishing grounds.

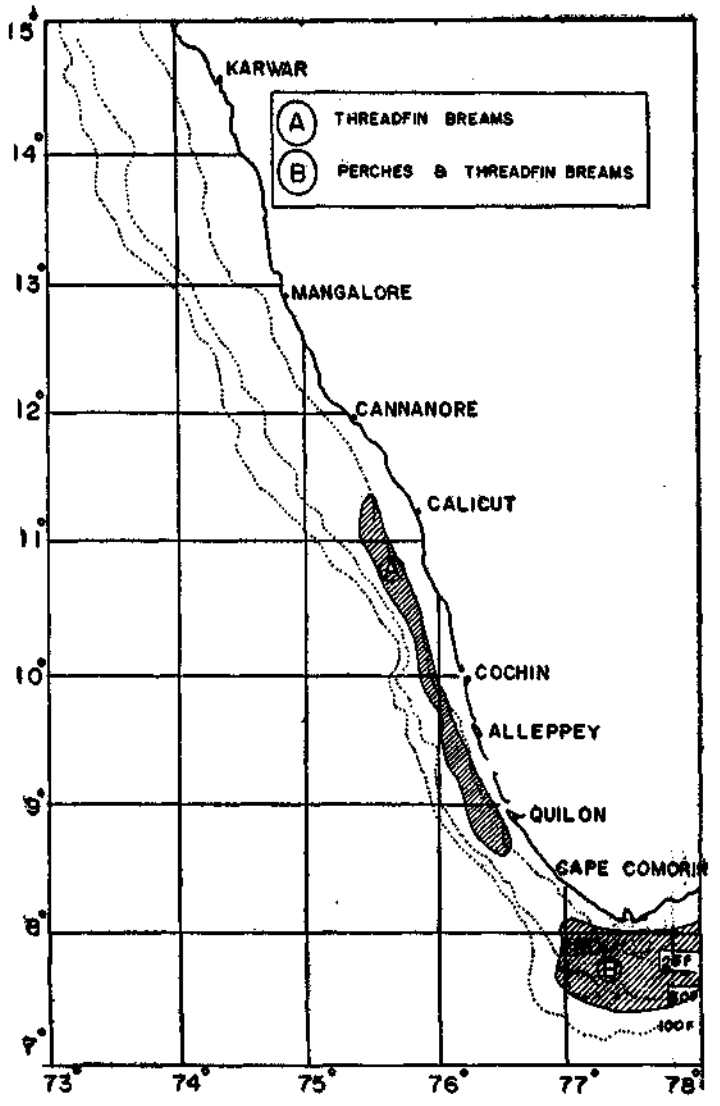

Fig. 11. Depthwise distribution of threadfin breams and perches.

Past and recent surveys by Govt. of India vessels and research vessels of other organization have indicated the availability of non-conventional resources in the deeper waters of the

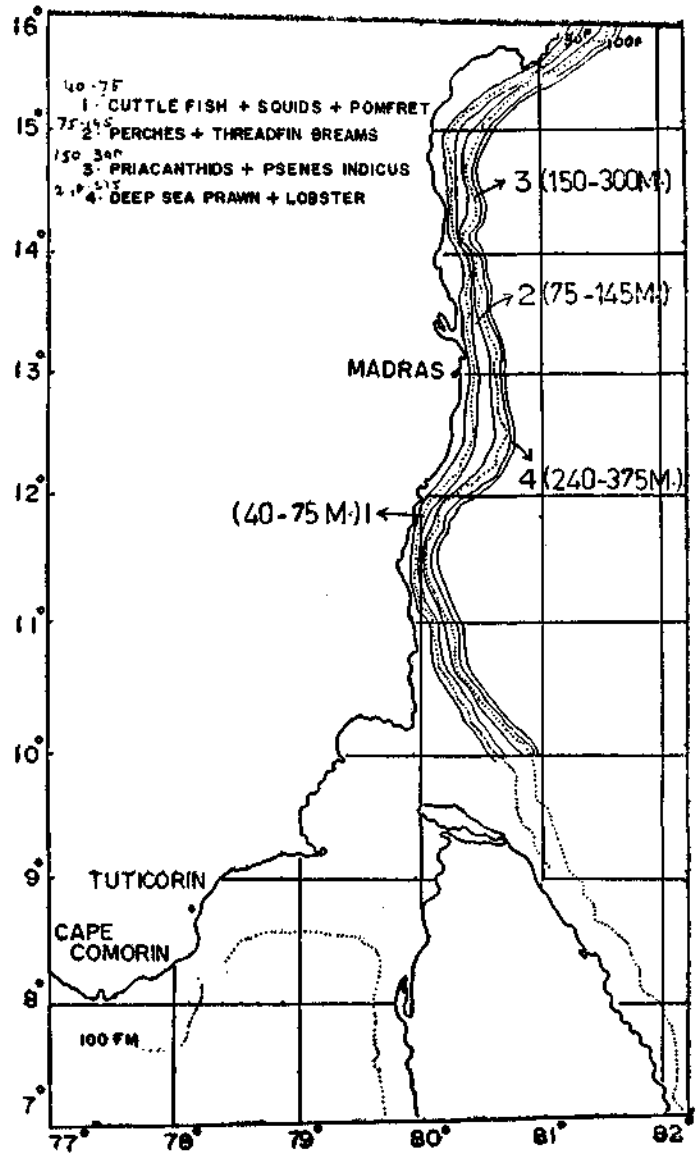

Fig. 12. Depthwise distribution of the potenital resources along lower east coast.

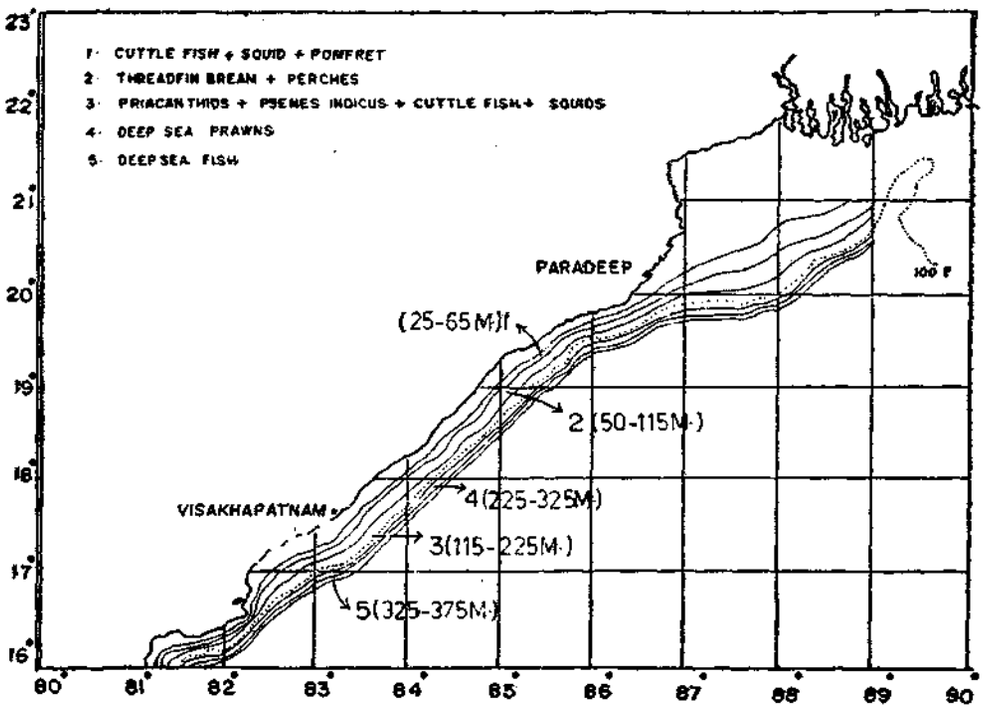

Fig. 13. Depthwise distribution of the potential resources of the upper eastcoast

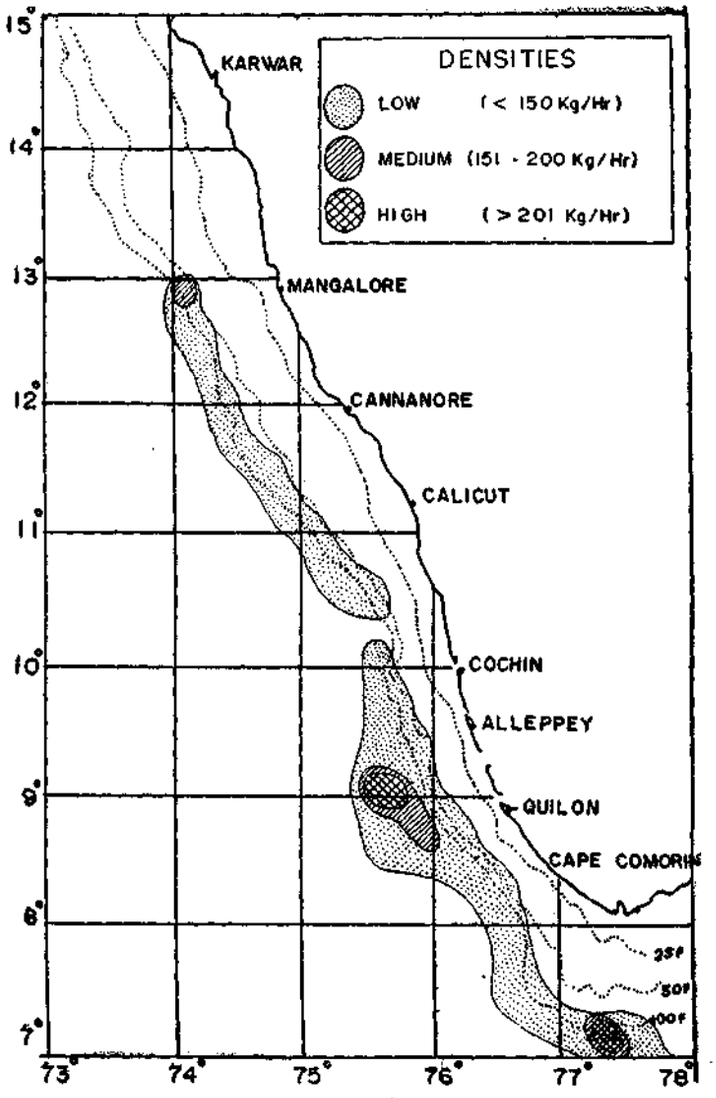

Fig. 14 Distribution and abundance of deep sea lobsters, shrimps and fish.

shelf and slope along the south west coast that are mainly consisting of fishes such as *Chlorophthalmus*, *Cubiceps natalensis* and *Pseneopsis*. Their potential yields have been estimated at 33,000 tonnes. Their maximum abundance is reported to occur in 300-400 m depth in July-January period. (Silas 1969; Mohamed and Suseelan 1973; Tholasilingam *et al.* 1973 and Oomen 1980, 1985)

Surveys by the larger vessels of the FSI in recent years have revealed that in different sections of east and west coasts there exist new and rich resources like Bull's eye (*Priacanthus* spp) black ruff (*Centrolopus niger*) and Indian driftfish (*Psenes indicus*) in depths ranging from 100 to 500 m, with catch rates as high as 600 kg/h, 2000 kg/h and 1400 kg/h, respectively, indicating their commercial potentialities (Somvanshi and Joseph 1983).

Potential Crustacean Resources

Ever since the export market for shrimp got established in the 60s, commercial trawling for this resource rapidly increased in the close-shore areas within 0-50 m depth zone, resulting in economic overfishing in certain regions such as the southwest coast. Studies conducted by CMFRI have shown that, since the stocks have been heavily exploited, very little scope exists for increasing production from the traditional shrimp grounds, Therefore, the potential crustacean resources that are available for further exploitation are those inhabiting the outer shelf and continental slope. Intensive exploratory fishing conducted in the past and in recent years have indicated potentialities for deep-water shrimp, lobsters and crabs off southwest and southeast coasts and in the Gulf of Mannar.

The sustainable potential for deep-sea shrimp along the southwest coast has been estimated at 3,000 tonnes and that for deep-sea lobster *Puerulus sewelli* at 8,000 tonnes for southwest coast and 1,200 tonnes for southeast coast. The maximum abundance of deep-sea shrimp was observed in 300-400 m depth zone, during the months October-January, and for deep-sea lobster in 180-270 m depth, during February-June (Mohammed and Suseelan 1973, Oommen 1980, 1985).

Among the deep-water crab resources, the most promising is that of *Charybdis edwardsii*, which gave a catch rate of 3500 kg/h in try net hauls carried out off Mangalore and Ponnani (Silas 1969). Recent surveys of FORV SAGAR SAMPADA have indicated the occurrence of largesized (23-25 cm) aristaeid prawns *Plasiopenaeus edwardsianus* in 800-900 m depth off Trivandrum. The surveys have also indicated the existence of good concentration of pelagic shrimps widely distributed in the EEZ, forming the major component of Deep Scattering Layer. The species in the main are of the genera *Gennadas*, *Funchalia*, *Acanthephyra* and *Oploohorus*. These appear to have good potentialities for commercial exploitation in future.

Vis a vis the exploited crustacean resources, the potential resources offering scope for increased production marginally are as follows:

Species	P. Y. (x 1000t)	Av. Current) yield (x 1000 t)
Penaeid prawns	180	111
Non-panaeid prawns	105	57
Deep water shrimp & lobster	12	0.5

Potential Cephalopod Resources

Cephalopods, comprising squids, cuttlefishes and octopuses are caught from inshore waters along both the coasts, Lakshadweep and Andaman-Nicobar Islands. The present landings of this group are mainly of shrimp trawlers as by-catch, of which 70% comes from the west coast. Maharashtra, Kerala, Gujarat and Tamil Nadu are the leading States in cephalopod production. Four species of squids, viz. *Loliqo duvaucelii*, *Septotoutis lessoniana*, *Doryteuthis sibogae* and *D. singhalensis*, and six species of cuttlefishes, viz. *Sepia pharaonis*, *S. aculcate*, *S. elliptica*, *S. brevimane*, *S: prashadi* and *Sepiella inermis*, from the commercial catches. Stock assessment of two species of cuttlefishes and one species of squid made by CMFRI indicated that the average annual stocks of these three species in the 0-50

m depth zone along the coastline were *L. duvaucelii*-18203 t; *S. aculeata*-23536 t; and *S. pharaonis*- 15245 t; against the presently exploited figures 5142t, 4483 t and 2397 t, respectively, indicating great scope for increasing production from the exploited stocks.

Besides the above study based on the surveys carried out by the FSI, the MPEDA has given a projection of potential resources of cephalopods in the shelf area of the west coast between lat. 07°30'N and 12°00'N up to 75 m depth as 12000 t (Anon, 1985). The survey by M. T. *Mutena* in 1977 indicated the availability of cephalopods in the area lat. 15°N-24°N in the depth range 55 to 360 m. Moderate catch rates (13.3 kg/hr) were obtained in the Gujarat coast in the depth range 91-125 m, and the catches mainly consisted of *S. pharaonis*, *S. aculeata* and *L. duvaucelii* (Bapat *et al. 1982*).

Silas (1969) drew attention to the fairly abundant resources of oceanic squid, *symplectoteuthis oualaniensis*. occurring in the shelf edge and slope off the west coast of India at depths beyond 180 m in lat. 7°- 14°N and long. 72°-77°E. The occurrence of dense concentrations of this species from October to December in the northern Arabian Sea (lat. 20°N-25°N; long. 62°E-67°E), mostly in depth range 120 to 200 m, during day time, was reported by R. V. *Shoyo Maru* (Anon, 1976 & 1977). Recent surveys by R. V. *Skipjack* and FORV Sagar Sampada brought to light the occurence of juvenile oceanic squids in the Bay of Bengal and the Arabian Sea.

The production potential of Indian Ocean was estimated at 500,000 t by Voss (1973); and George *et al.* (1977) estimated the potential for the shelf waters of India at 180,000 t, of which 55% is in the upper east coast, 11% each in the lower east coast and northwest coast and 20% in the southwest coast.

Thus the oceanic squids form one of the major potential resources of the EEZ.

PROSPECTS FOR INCREASING PRODUCTION

The present level of exploitation and the potential for

additional exploitation in the case of major groups indicated, thus the questions that might be asked by Govt. departments and industry would be about (i) the type and magnitude of the most promising resources that are capable of yielding additional production in the presently exploited inshore regions; (ii) the potential fishing grounds and abundance of resources in the depth zones immediately beyond the 0-50 metres; and (iii) the potential nonconventional and oceanic resources in the deeper water of the EEZ. The answers lie in delineating the levels of underexploited and unexploited resources and identifying the ways and means of exploiting them.

Among the pelagic resources the most important one, promising additional yield, is that of anchovies, especially during July-September in the Gulf of Mannar and during October-December on the south-west coast. The magnitude of additional yield would be 100-150 thousand tonnes within 20-50 m depth, where more than 60% of the anchovy stock is usually concentrated. The efficient means of tapping this resource would be by phased introduction of small purse seines and midwater trawls (Fig. 1 and 2).

Carangids, comprising horse mackerel, scads and trevallys, have a potential for giving additional yields to the tune of 200-000 tonnes from the inshore regions and immediately deeper waters of 50-125 m depth. Rich grounds for horsemackerel and scads have been located along the southwest coast, Gujarat coast and northeast coast. These resources can be efficiently harvested by purse seines and drift gill nets, the latter for larger speces (Fig. 5 and 6).

Ribbonfishes, with a potential of 270 thousand tonnes as already indicated, would yield considerable additional quantities from the depth zones 20-50 m (69%) and 50-80 m (29%) when the stocks are concentrated along the southwest, southeast and northwest coast. Ribbonfish catches can be harvested by improvised boatseines and trawl nets (Fig. 7 and 8).

As against meagre catches of about 20,000 tonnes of

coastal tunas and related species, there is a potential of about 100,000 t in Andaman waters, 50,000 t in Lakshadweep sea and 50,000 tonnes along the mainland coasts. The introduction of large purse seiners and suitably designed drift gill nets would help in tapping this resource.

Catfishes promise the maximum additional resource among the demersal group, with a potential of about 310,000 tonnes against the present yield of 58,000 tonnes. Very productive fishing grounds have been located along the upper east coast, northwest coast and southwest coast, where in depth ranges 20-50 m and 50-100 m 43% and 15% respectively of the stocks are found distributed. Productive grounds have also been located in still deeper waters in the northwest coast (Fig. 7 and 8).

The next important demersal resource is that of perches, which has a potential of 250,000 t against the present yield of 48,000 t. The existence of rich 'Kalava' grounds off southwest coast, wadge bank and northerneast coast is well known. Among the perches, one of the most promising resource, existing along both the coasts and having good potential for exploitation, is that of threadfin bream (*Nemipterus* sp). Large concentrations of this have been located between 75-225 m during February-May and in comparatively shallower waters during July-September (Figs. 10-13).

Among the crustaceans, deepsea prawns and lobsters offer scope for additional exploitation. They occuron the shelf edge and slope regions of southwest coast and Gulf of Mannar and can be exploited by deploying larger shrimp trawlers. (Fig. 14).

The cephalopod resources, which are at present not exploited by direct methods, are expected to give an additonal yield of about 50,000 t from the 0-50 m depth zone if appropriate fishing techniques such as squid trawling and jigging are introduced. Similarly, modern fishing methods when employed in the outer continental shelf would yield about 130,000 tonnes. Of oceanic squids, considerable potential has already been indicated to be in existence in the open ocean (Fig. 12 and 13).

Table 7. *Major Resources Indicating Prospects for Increased Production*

Sl. No.	Species/Group	Present Yield 000 t	Potential Yield 000 t	Area	Depth Range m	Method of Capture
1.	Anchovies	92	240	S. W. coast Gulf of Mannar	20–50	Small purseseiners, mid-water trawls.
2.	Carangids	44	265	S. W. coast, off Gujarat N. E. coast	0-50 & 50-125	Purse seines, drift gillnets
3.	Ribbonfishes	50	270	S. W., S. E. & N. W. coasts	20-50 50–80	Improvised boat seines and trawl nets.
4.	Coastal tunas	20	100+ 50+ 50	Andaman & Nicobar waters. Lakshadweep seas. along mainland coasts.	>100 m >100 m > 50 m	Purse seines and improved drift gill nets.

5.	Catfishes	58	310	N. E., N. W. & S. W. coasts	20-50m & 50-100m > 100	Bottom fish trawl, drift gill nets.
6.	Perches	48	250	S. W. coast, Wadge Bank, N. E. coast	0-50 & 75-225	Fish trawls, handline, traps
7.	Deepsea prawns and lobsters	5	12	S. W. coast (Gulf of Mannar)	300-400 180-270	Large shrimp trawlers.
8.	Cephalopods	15	180	N. W., S. W. & S.E. coast	0-50 50-200	Squid jigging, Fish trawl
9.	Oceanic tunas	—	500	Oceanic waters of EEZ	—	Longlining, purse seining
10.	Deepsea nonconventional resources			S. W. & E coasts	200-500m	

Except for a marginal production of skipjack in the Lakshadweep, there is at present no fishery in India exploiting oceanic resources. The total oceanic fish potential in the EEZ is estimated at 500,000 t, consisting mainly of yellowfin, big eye, oceanic skipjack, sail fish, marlin and oceanic sharks. These rich resources could be profitably exploited by introduction of long-lining and purse seining on a commercial scale (Fig. 4). Besides, there are potential non-conventional deepsea resourees on the upper continental slopes (200-500 m depth) of the southwest and east coasts which offer considerable scope for exploitation. These potential resources consist of bull's eye, Indian drift fish, black ruff and a host of other deep sea fishes (Figs 12-14).

(The above projections are summerised in Table-7).

GENERAL CONSIDERATIONS

For rational exploitation and management of the presently exploited resources and to utilize the potential resources of the EEZ the following aspects merit consideration.

1. Motorization of the country craft engaged in fishing in traditional grounds and beyond to help in augmenting the catches of large pelagic species such as coastal tunas, seer-fish, pomfrets, trevellys, sharks etc.

2. Regulations on purse seining such as restricting their fishing to areas beyond 30 m depth to help in reducing conflicts between purse seining and traditional fishing and to result in exploitation of resources that are now beyond the scope of traditional sector.

3. Exploitation of rich anchovy resources by phased deployment of purse seines and midwater trawls in depth zone between 30 and 50 m.

4. The demersal fishery, being primarily shrimp oriented, uses small-meshed gear, resulting in wasteful exploitation of young fish resources. Specific fish trawls for finfishes have to be introduced for increasing their production.

5. Strict regulation of mesh size, fishing seasons and areas of fishing to be enforced in order to avoid indiscriminate destruction of spawners and young fish.

6. The inshore shrimp catches to be stabilized and managed properly for sustaining the present level of production.

7. For exploiting the potential resources avilable in deeper waters of the shelf and beyond, considerable additional inputs are required. This could be compensated by bulk capture. This measure will require the designing and development of suitable boat and gear combination along with adequate storage facilities for long periods in the vessel. This point merits immediate consideration.

8. It is necessary that the Govt. of India organizations who posses different types of vessels conduct simulated commercial fishing for identified potential resources to work out the economic viability of these operations.

9. Creation of adequate infrastructure facilities such as for berthing, handling, storage, ice production and marketing at fishing harbours is an essential prerequisite to ensure remunerative price to the producer, which alone could be an incentive for additional production. This will also help in diversification of the industry.

CONCLUSION

As the marine fish production of our country from the presently exploited grounds has remained rather stagnant for more than a decade now, it is imperative that the potential resources of various species and areas as indicated in this account should be properly tapped by extending our fishing effort to middle and outer shelf, continental slope and oceanic region of the EEZ with concurrent development of infrastructure facilities. This would hopefully help in bridging the gap between the potential resources and present production.

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POTENTIAL FISHERY RESOURCES, THEIR EXPLOITATION AND UTILISATION

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Over the years various estimates have been made of the maximum sustainable yield of the total fish resources in the Indian waters. These estimates are by fisheries experts, exploratory teams, trial fishings conducted by independent agencies and Fisheries Survey of India. While the estimates vary from 2.4 to 6 million tonnes annually, there is a near unanimity in the projection of an annual yield of 4.5 million tonnes from our EEZ, which remains largely unexploited. It is well-known that the marine resources exploitation in the Indian Ocean have stagnated at the level of 1.5 million tonnes for more than a decade. While there has been some increase in the value of exports, and this has been largely due to the better international prices and greater quality control, the annual quantitative catch has remained almost the same, and there is also not much diversification achieved. Our fishing attitudes remain shrimp oriented only and we have made no tangible headway in increasing the production of various other varieties as has been the case in other countries. Hence, the attention of the planners should be focussed to tap this additional resource potential of the EEZ, which is 3.0 million tonnes over the psesent annual catch of 1.6 million tonnes.

In the opinion of the industry, it is possible to achieve a target of at least half of this potential almost immediately by increasing the present catch from inshore waters and by organising more effective efforts to exploit the off-shore and deep sea areas. This calls for a new, bold, imaginative and multi-dimensional approach through application of an innovative action plan. The industry looks forward to more specific data of resources assessment areawise and specieswise. It is hoped, Fisheries Survey of India will undertake further research in this direction. Within the limitations of present information and according to the resource position known to the Industry, Gunas,

tuna-like fishes and sharks are mostly available on the north-east coast, squids cuttlefishes and swimming crabs on the south-east coast, deep water prawns and lobsters on the south-west coast, Lakshdeep & Andaman group of islands and the anchovies are mostly available around the Cape Comorin bank.

For the exploitation of the above varieties of marine resource, the following type of fishing will have to be undertaken:-

1) Long lining/pole and line fishing/purse seining/trolling, drift netting for tuna, tuna-like fishes and sharks.

2) Jigging and midwater trawling with light attractions for cephalopods.

3) Purse seining/midwater trawling for anchovies and cat-fishes.

4) Trawling, trolling, lining and trap fishing for Cape Comorin bank resources.

5) Trawling for deepwater prawn/lobsters/perches, pom-frets, catfishes and sciaenids.

We would suggest that, in view of the present state of fisheries, we must undertake commercially oriented surveys by the highly trained and experienced crew, for, if, done otherwise, a potentially valuable fishery may appear erroneously uneconomical for exploitation. This will go a long way in regulating our efforts in the right direction. Once the economic feasibility is established, the training objective can take precedence because, if the fishery is not economically feasible, there is no meaning in training personnel for the chosen type of fishing. It is therefore very essential to demarcate areas, identify resources and new markets of commercial significance for the economic viability of the fishery venture.

We must also organise in a much better manner the system of information transfer on fisheries so that the industry gets timely information intelligibly desseminated, avoiding scientific jargons. There must not be much time lag between collection of valuable information and data and its transmission to the

industry. If this is done in a methodical manner, the industry can play an effective role in reaping the fruits of research efforts put in by FSI and other organisations. There must be better co-ordination of research, exploratory survey, experimental fishing and commercial operation in EEZ.

For exploitation of the resources, the industry has to determine the economy of the scales and to identify the right type of vessels required to carry out fishing operations. However, it is considered prudent for the present to think of only three sizes of vessels, of the size ranges of 20-25 m, 26-30 m and 31-35m. Larger sizes may be considered for resources like tunas, for purse seining and long lining methods, which would undoubtedly give a good rate of return on investment capital. In the estimation of the industry at least 250 fishing vessels must be inducted in the EEZ over and above the persent fleet of 86 vessels already in operation in the Indian waters.

This alone would enable us to achieve optimum results, EEZ holds out great promise of marine resources which can be harvested only by modern fishing vessels of adequate endurance. Any delay in their procurement, from whatever source by import charater, joint venture or indigenous production, would mean delay in the fishery development programme and letting the inexhaustible resources to go waste.

Looking into the present resources position, it is imperative today, more than ever before, to think seriously in terms of joint venture for diversifed fishery, which will not only result in acquisition of permanent national assets but also pave the way for appropriate transfer and absorption of modern technology. This would also simultaneously provide ready export market. There is vast scope of improvement in our fish handling and marketing, including export. The basic infrastructure required for proper handling and utilisation of fish resources consists of facilities in harbours for berthing space, for fuel, water, ice, provision, shipways, workshops, auction, cold storages, and transporation, etc. Though much progress in this direction has been made, particularly with the initiative of Ministry of Agriculture and MPEDA, the facilities are not adequate and require

further improvement. With the materialisation of more deep-sea fishing vessels in the near furture, there will be further strain on these services. Therefore, advance planning in this direction is called for. It will be in the ultimate interest of our country if a National Fishery Infrastructure Development Programme is undertaken on a war footing to match the forthcoming fleet being acquired. Programmes may also be formulated accelerating internal consumption and also generating demand for varied species available in the EEZ.

The two most powerful forces in reducing poverty in the developing countries are increasing food production and declining food prices. As is well known, fishery is a rich source for protein food. The utilisation of fish resources harvested from nearshore areas may be reserved for the domestic market, except the high priced varieties which may be exported to earn foreign exchange. The deepsea fishes may be exported totally to the international market. However, in case some of the varieties from these operations are not acceptable in foreign markets, these will automatically get diverted for domestic consumption. The local processing industry can also thereby find a very promising raw material rich in protein for commercial exploitation to benefit the weaker sections of society. In the estimation of the industry, if the potential fishery resources as known in EEZ are fully exploited, it will easily attain the target of export of Rs. 700 crores per annum by the turn of the seventh plan period besides substantially raising the growth rate in domestic consumption of this protein-rich diet.

It is well known fact that several fish species are either not exploited at all or lightly because of consumer taste. Therefore, in order to utilise fully the harvested fishery there is a need for a consumer promotional programme in the domestic market.

As regards management of fisheries, there are various educational and training institutes in the country to cater to the requirements of qualified manpower, who obviously form the

backbone of this sophisticated industry. With the bulk acquisition of trawlers, trawling activity will considerably expand. This will mean more trained personnel, such as skippers, engineers, fishing 2nd hand radio operators etc. Recently, the Central Government have taken a stock of the trained manpower requirements during the next five years, and it is hoped the prevailing situation of shortages in this respect will considerably improve. Besides this, we must also encourage employment of more and more scientists and biologists in key posts in fish processing plants with some subsidy from MPEDA, which we understand is being done now in a number of cases. Needless to say that this is an encouraging trend and would yield very positive results.

To bring about the 'Blue Revolution', we must augment fishery operations in every sector for fuller and optimum utilisation of our resources. To achieve, we have to move away from the regime of control and regulation towards major thrust for technological upgradation through a series of administrative measures for attaining the fastest growth in marine fishery production.

I would like to conclude by suggesting that Govt. of India may establish a Fisheries Guidance Bureau or a Control Board for transfer of innovative technology, at a most central location, preferably in a coastal area, for rendering valuable advice to the industry, individual enterpreneurs and the fishing community on all vital fishery matters such as suitable training programmes, sophisticated fishing techniques, processing methods and the best plants therefor, latest quality control techniques, most advantageous marketing arrangements and promotion of acquaculture etc. In short, the Guidance Bureau will assist us not only in all the field of fishery but also in the nature of a human encyclopedia by providing us the much needed exposure to modern technology.

NEW DIMENSIONS IN FISHERY MANAGEMENT

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Food resources remain under pressure for the rising Indian population. Our need to provide adequate and nutritious food is becoming much greater. Fish as a food and protein suppliant is universally accepted.

The future of economic stability and prosperity of India could be sought along our God bestowed generous coastline. Adequately surveyed and fully exploited ocean resources could produce earnings much more than any other resource this country may have ever known.

Knowledgeable people, who include scientists, politicians, senior Government officials, consultants and managers in fishing industry, feel that growth rate in general has been very disappointing, There have been many seminars, speeches, recommendations, and still there has not been optimum exploitation of marine resources which could have been achieved if the problem had been tackled more imaginatively and known facts had been analysed in proper perspective.

This is evident from the fact that till now we do not have a national fishery policy, which could have formed the backbone of growth to initiate decisive action plan.

The capital has remined shied away from fishing industry for fear of day to day changes in implementing so called rules and regulations. The policies have been basically made on ad-hoc basis. Many times the interpretations were based on ignorant whims by the people who had nothing to do with framing of the policy itself.

Any policy should be judged only to the extent it has been executed. If we review our developmental Five Year plans, we are to realise that most of the time paltry sums which were san-

ctioned for development of fishery resources remained unutilised. When there were plans for purchase of fishing trawlers there was paucity of resources.

The main objectives of the plans were:

a) Increase in fish production by increasing the number of mechanised boats

b) Improvement of the social economic conditions of fishermen, who were primary producers.

Between 1951-1985, our efforts on fishery development programmes and achievements in marine sectors are as follows:

a) As stated, marine fish production increased from 5.34 lakh tonnes in 1951 to 1.45 million tonnes in 1973. By itself it may not be poor, but when compared to other developing countries of S. E. Asia it is too slow. Moreover, since 1973, the production has virtually stabilised around 1.45 million tonnes. For comparison, other countries have registered the following growth pattern:

Phillipines - 400 times
Sri Lanka - 500 times
Thailand - 800 times
S. Korea - 900 times
Taiwan - 1000 times

b) The number of mechanised boats [between 8 and 14 m. length] rose from almost nil in 1951 to over 20,000 in 1984, and the non-mechanised boats from 75,000 in 1951 to 135,000 in 1982. The range of fishing operation increased from 20-22 miles in 1951 to 30 miles in some regions. Depthwise, our fishermen increased their fishing zone from 20 fathoms in 1951 to 40-45 fathoms in 1984. In the meantime, the cost of fuel alone has risen phenomenally. It has become natural for fishermen to go for selective fishing, prefering high unit value species to larger catches of uneconomical varieties.

c) In the year 1976, charter scheme was introduced by Government, with considerable foresight, to stimulate and galvanise the fishing industry by providing opportunities to them to experience something not known to the Industry, and for greater coordination of efforts for harvesting. The scheme was further revised with more stringent laws in the year 1980:

i) to get factual data

ii) to train Indian personnel

iii) to develop indigenous fleet

iv) to locate foreign untapped markets

The advantages of charter policy have been as follows:

i) New experience of Indian crew to work on long voyages, sometimes as long as four months.

ii) Leadership coordination for organising fishing on board.

iii) The concept of team work to be ensured on fishing trawlers for optimum utilisation of plant and equipment

iv) To work hard and in purposeful manner on board vessels.

v) To coordinate navigational skills with harvesting of fish even during rough seasons.

vi) Companies have gained experience and confidence to operate fishing trawlers on ownership basis.

vii) Adoption of bull trawl fishery by more than 500 Indian boats mostly in Tuticorin area.

d) There has been tendency in recent times for large number of fishing boats to remain idle because of non-availability of fish storage facilities. This could be considered the most improtant factor for th e stagnation in growth.

These are known facts to be taken into account for the formulation of new fishery policy.

The policies, objectives and strategies incorporated in various plans remained unchanged in all these years. Even in the latest plan there is no mention of stagnation of fishery development or its causes. Fishing Industry is important to Indian Economy as a source of nutritious food, employment and earning of foreign exchange. It should never be forgotten that even with meagre investment fishing industry earns more than Rs. 375 crores of valuable foreign exchange per annum.

The Industry has not registered anticipated growth. For development, it should have sound technological and economic base with proper plans and motivated desire for implementing the same, and above all, it will have to look for new concepts of fishery management.

Time has come to broaden our thinking. We are a big nation, and have no other choice than to think big.

Naturally, the present process of talking big and thinking small has to be changed completely. We have resources in our E. E. Z. There exists great stock of Krill in the Antarctic Ocean. We must also include the exploitation of Krill as part of our National Fishery Policy.

The implementing strategy should take into account national objectives on one side and national talent and availability of financial resources on the other to become the instrument of much needed positive change. We could at this stage identify the target which could be achieved in say next 10 to 12 years. Using various results, M. Visvaraya Industrial Research and Development Centre, Bombay, worked out the following resource potential in 1980:

Depth zones (in m.)	Area as% of Indian E.E.Z.	Potential Yield (in thousand tonnes)	Adjusted fig. (in thousand tonnes)
0 to 50	9.0	2,260(50.56%)	3,000(66.6%)
51 to 200	11.6	1,170(38.25)	1,000 (22.2%)
201 and over	79 4	500(11.19%)	500(11 1%)
	100.0	4,470	4,500

From this we can safely state that India has harvestable fish resources of at least 4.5 million tonnes per annum in the E E.Z. From the various studies it has also emerged that it would be more profitable to fish further in 20-40 fathoms depth because that would give most economical returns. It would also be less expensive, since existing boats can exploit this area without any further investment. This area can be fished by smaller and medium fishermen with their existing technology and equipment.

The data presented show very clearly that another one million tonnes of fish can be harvested by exploiting to the optimum level, the depth zone of 0 to 50 m. Question arises, how to achieve this ambitious target? The assets which we possess are at the moment 7500 km long Indian coastline, where more than 300.000 artisinal fishermen live in about 2500 villages. The traditional fishermen operate 15 feet non-mechanised boats, whose number is at the moment about 135,000. We also have mechanised boats up to 50 feet length, numbering about 20,000 and deep sea fishing boats numbering about 90.

Studies indicate that there is scope for addition of 200 more shrimp trawlers. whose economical viability has already been established. There is also need for the introduction of intermediate crafts in near future, which will be owned primarily by the members of fishing communities.

The immediate gains for us can only be achieved by round the clock utilisation of traditional and mechanised boats, which

in itself can exploit another one million tonnes ot fish by involving smaller capital investment, for renovation and upgrading of craft and fishing equipment. Continuous use of boats can be motivated by creation of cooperatives for their management and incentive orientation.

It is a known fact that most of the boats remain idle as the fish prices crash, the moment these fishermen improve their efforts and start landing more fish. Because of this, the fishermen, who fish for four days in a week, would earn the same amount as there are no facilities for them to store the surplus fish.

The investment which could be made in near future, should be made for the establishment of fish centres all over the coastline, to provide:

a) Fish storage facilities at low temperatures

b) Loading and unloading equipment

c) Transportation to refrigerated cargo vessels or other consumer centres by road.

d) Supply of ship stores, fuel oil, lub oil, fresh water, ice, provisions etc.

e) Ship maintenance and management facilities, workshops' slipways, suitable space for inspecting and repairing of nets etc.

I am now convinced that only by this approach it would be possible for us to exploit our resources further in near future. Once fish storage centres have been established, Indian fishermen would automatically increase their fishing efforts, and shall remain operative for the maximum possible period. Indian traders, who are one of the most skilled and talented in the world, will find ways and means to process, market and export the stored fish catch. International market will respond to the quotes of Indian Exporters of marine products in much better way. This will permit industry to go for the export of fish

properly by ensuring quality and delivery schedule. It will be possible for Indian entrepreneurs to create new thrust in the international market, as the world is witnessing resurgence in consumer use of fish after years of stagnation. The change is the result of low cholesterol fat content in fish and consumer resistance to red meats.

This will also help create bigger consumer base in the country itself as on one hand fishermen will get better price and on the other the Indian consumer will get better quality fish at very much cheaper prices. With supplies assured, fish will become part of regular diet in Indian household.

Fishery policy planning should be based on the basis of exploitation of species like Anchovies, Carangids, Tunas, Cat fishes, Perches, Deepsea Prawns, Cephalopods, Squids, Cuttlefish etc.

This way, having set out a target of exploitation of one million tonnes of harvestable resources in 10-12 years time frame, we can go about creating a system approach to gain specialised knowledge for exploitation, storage and marketing. For development, fishery policy may consider:

a) The declaration of fish harvesting as agricultural activity, having the same incentives as other agricultural outputs.

b) Establishment of fish centres with strong capital base to be able to buy and store all possible catch to be purchased at minimum support price.

c) The purchase at declared support price should be through cooperatives to enable round the clock utilisation of boats by changing the crew after every voyage if required.

d) Pollution hazard will emerge as the greatest enemy of the traditional fishermen. It could be countered by declaration of pollution—free zones and diverting the attention of small fishermen to more lucrative, less capital intensive methods of fish-farming, which will yield more fish at less cost and effort.

e) Motorisation of country craft.

f) Creation of franchised marketing outlets.

To achieve these targets, we may plan:

a) Survey of specific resources

b) Design improvement for fishing craft and gear

c) Identification of financial inputs

d) Creation of storage, processing, marketing and transporation arrangements.

e) Utilisation of all landed fish.

f) The manpower planning must take into account the national talent rather than theoretical achievements of passing out-dated examinations.

g) The role of various agencies, such as banks, Export Development Authority, and other financial institutions.

h) The objectives of various Governmnet departments must be very clearly defined and understood for their flexible interpretation.

i) Coordination of efforts of all the Fishery Institutes by appointment of a Director General and Institutes Management Board, having overall decision making powers.

j) To improve living conditions of fishing communities and to create educational Institutions for them to orient their thinking towards modern fishing trends.

k) Investment, keeping in view that per rupee invested direct and indirect employment potential in fishery is only next best to textile industry.

l) Adopt any other measure and systems approach for the optimal utilisation of our fishery resources.

I feel, that the time has come to frame a target oriented time bound National Fishery Policy. To start with, we may plan to harvest additional one million tonnes of marine resources. I feel certain that it can be done.

To achieve this target, let us dare and fix the date 31st as December, 1999.

UTILIZATION OF THE POTENTIAL MARINE FISHERY RESOURCES OF INDIA

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ABSTRACT

India's potential marine fishery resources, which have been projected at 4.5 million tonnes per annum, is thrice the current average production. The most important methods of utilization of fish in the country at present are in fresh condition and by salt-curing and drying, which together use up 87% of the catches. Of the remaining, 5% each is utilized frozen for export and for reduction into fishmeal. The rest is utilized for canning and for miscellaneous purposes like extraction of oil, manure etc. With the introduction of more efficient craft and gear and modern methods of harvesting worked out by our research institutions, a major portion of our potential resources, if not all, is likely to be netted in the near future. It then becomes binding on our part to make the best use of this natural bounty without any wastage whatsoever. This latter aspect has been fully tackled and solved by recent researches carried out on post-harvest technology, the more salient points of which are discussed in this paper.

INTRODUCTION

The average annual marine fish production in India at present is 1.5 million tonnes as against a projected potential of 4.5 million tonnes, which means that there is scope for a trebling of the catches from the marine sector alone. The country has made considerable progress in the matter of utilization of her fish catches from the not-so-satisfactory conditions that existed two/three decades back when fresh oil sardine, mackerel and even prawn had to be buried in coconut gardens as manure during glut seasons, though very infrequently, memories of which still linger in our minds. But developments in subsequent years both in the matters of scientific research towards better utilization of the fish catches and in promotional activities in fish trade

have given us the confidence and capacity to make full utilization of our potential marine fishery resources.

Drastic changes have occurred in the pattern of utilization of fish catches in India in the 1970s compared to that in the 1950s. The figures presented below bring out the glaring differences of this aspect.

Mode of utilization	1950s	1970s
Annual average catch (million tonnes)	0.93	1.95
Marketing fresh (%)	43.36	66.50
Salt curing and drying(%)	49.82	20.33
Reduction (%)	6.83	4.89
Freezing (%)	N.A	5.18
Canning (%)	N.A	0.47
Miscellaneous(%)	N.A	2.63

N. A.: data not available.

While there has been a doubling of the annual catch, the percentage utilized in fresh condition increased from 43.36% in the earlier period to 66.5% in the latter, and that by salt curing and drying showed a drastic fall from 49.82% to 20.33%. Another noteworthy feature is that 5.18% of the catch has been utilized by freezing and 0.47% by canning during the latter period. These figures include both marine and inland fishes of the country, as the breakup figures are not available.

A gist of the modern trends in utilization of marine fishes in the country is presented in the following paragraphs.

UTILIZATION OF FRESH FISH

Two-thirds of the country's fish catches are at present utilized in fresh condition. Approach roads to the fishing villages, quick means of transporation and the cheapest and most widely employed preservative for fresh fish, viz. ice, were conspicuously lacking in the earlier years. All the maritime State

Governments have taken commendable measures to provide the above facilities especially during the past two decades. Motorable approach roads wers laid to almost all important fishlanding centres, large number of ice plants were commissioned in both public and private sectors, and quick means of transport like trucks, vans etc were employed in large numbers for the expeditious movement of fresh fish to the potential interior markets. It is a fact that the *per capita* consumption of fresh fish declines drastically as the distance from the coast increases, obviously because of the difficulties involved in transporting the fish to the interior markets and the escalation in its cost contributed by the expenditure incurred in transporation

We have to gear up the above facilities to cope up with the increased landings of our potential resources still remaining untapped. More ice plants have to be set up, preferably in the public sector and ice supplied in plenty at subsidised rates so that the landed fish is maintained in the freshest condition possible until it is delivered to the consumer. Refrigerated/ insulated trucks must be made available for the efficient transporation of the landed fish to the interior markets. A limited number of refrigerated rail wagons had been in operation for some time in selected routes of the Indian Railways for lifting iced fish to distant places. They have to be revived and that too on a much wider scale in order to facilitate better distribution of our marine fishery resources in the fresh/iced condition. Freezing plants and frozen storages have to be set up at or around important fish landing centres so as to preserve the fish over longer periods in glut seasons. Chilled and frozen storage facilities will have to be provided in important interior cities where iced/frozen fish could be stored safely until marketed. In short, a 'cold chain' has to be built up embracing the entire country for efficient utilization of our fresh fish. This becomes all the more important in view of the increased landings expected out of the potential resources of both marine and inland waters and taking into consideration the fact that consumption of fish in the fresh condition deserves all encouragement as all their nutrients are retained unlike in the case of processed fish where heavy losses invariably occur of many of the vitamins, minerals, proteins and overall eating qualities.

Technical know-how has already been worked out for such long distance transportation of iced/frozen fish. Liquid nitrogen or solid carbondioxide can be successfully employed for supplementary cooling while transporting iced/frozen fish in insulated trucks over long distances. Since the private entrepreneurs dealing in this commodity may not be in a position to invest the huge capital required, these facilities will have to be provided by the public sector and leased out at concessional rates to the private sector on the lines on which the Marine Products Export Development Authority undertakes such services for the seafood export industry.

UTILIZATION OF FISH BY CURING

The second largest method of utilization of fish in India is by salt curing and drying which takes up one-fifth of her total landings. Though this was the only method employed for long term preservation of fish in the pre-independence era, utilizing one-half of the landings, it has receded to the background afterwards, with the advent of the modern methods of processing like freezing and canning and utilization of more fish in the fresh condition Still being the easiest and cheapest method of long-term preservation, it is bound to remain for a long time to come not only in India but in all developing countries as an important avenue of fish utilization.

Even though cured fish was the mainstay of India's export trade in processed seafoods in the period prior to the Second World War, it declined drastically afterwards, touching the lowest ever level of 1022 tonnes in 1981-82. However, it is slowly picking up afterwards recording a figure of 6492 tonnes worth Rs. 5.35 crores in 1983-84, the important markets being Srilanka, Singapore, Japan, Saudi Arabia and U. K.

One cause for the sharp decline of industry after the Second World War was the ban imposed on inport of cured fish products by our neighbouring countries which were our important markets due to reasons economic or otherwise of their own. We could not exploit the sophisticated markets in the developed

countries due to the primitive and unsatisfactory processing methods employed by us, rendering the products substandard according to the norms laid down by them. Research work carried out in the country in recent years has evolved methods which can turn out high quality, extra hygienic cured fishery products which can satisfy the quality requirements of even the most sophisticated of the countries.

The curing operations have to be carried out exclusively in processing halls specially constructed for the purpose. Preliminary steps of removing the guts and gills and filleting should be done over table tops of metallic or cement concrete make, and the dressed fish thoroughly cleaned in potable water until free from blood, bits of intestines and extraneous matter of any description. Salting has to be done in the correct proportion depending upon the size of the fish, and the salted fish stacked in cement tanks preferably lined inside with stainless steel or porcelain tiles. After the fish is properly 'struck through', which takes about 48 hours at our ambient temperature, they are lightly washed to remove adhering salt crystals and dried hygienically on raised platforms or in artificial dryers. Contamination from insects/ flies, birds, extraneous materials like sand etc. should be strictly avoided during the drying stage. Drying should be continued until the moisture content is reduced to sufficiently low levels as to prevent fungal and bacterial attack. The dried fish should be sealed in attractively printed synthetic film pouches for retail distribution and polythene lined gunny bags or dealwood/plywood/ cardboard boxes for bulk sales.

If the dried product is dusted superficially with calcium propionate powder before packing, it remains free from attack of red halophilic bacteria and fungi for quite long periods. In the case of fishes containing considerable proportions of fat, an antioxidant powder like butylated hydroxy anisole or butylated hydroxy toluene is also incorporated with the calcium propionate. This protects the fish from oxidative rancidity and discolouration for long durations. With the fuller exploitation of our potential marine fishery

resources, the quantity of fish available for curing is likely to increase several fold. If we modernise our curing techniques on the lines indicated above, we can advantageously exploit many a foreign market for cured fishery products, besides catering to the needs of our interior markets. Wet curing for fatty fishes where the salted fish is utilized as such without drying so as to exclude the possibility of development of rancidity during drying and Colombo curing where tho salted fish is held under saturated brine along with a natural preservative viz. *Garcinia cambogea* can also be applied for preservation of sardines, mackerel and some other varieties of fishes in seasons of glut. Being the cheapest of the processed fishery products, cured fish is sure to find ready acceptance not only in the urban areas in the hinterland but also among the tribals and labour classes inhabiting/working in high ranges in the plantation industry etc. Hence modernisation of our fish curing industry is an urgent need for the proper utilization of our potential marine fishery resources.

UTILIZATION BY FREEZING

As seen from the figures presented earlier, 5.18% of our total fish landings is utilized by freezing. This modern method of preservation of fish was introduced for the first time in the country only in the 1950s and even today it is applied mainly to export commodities like prawns, squid/cuttlefish and some of the costly varieties of fishes. A quantity of 54,444 tonnes of frozen shrimp valued at Rs. 314.81 crores was exported from India during the fiscal year 1983-84. This works out to 58.73% by quantity and 84.39% by value of the total exports, which proclaims the unique position that this single commodity occupies among our marine products. Making allowances for processing wastes like heads, shell etc, the quantity of prawns exported works out to about one lakh tonnes as landed against a total landings of 2.1 lakh tonnes of penaeid and nonpenaeid prawns together. Since this item is in the highest demand in the foreign markets, we can take it for granted that the remaining one-half of the landings belong to the nonexportable varieties. Our projected potential of these two varieties of prawns together exceeds the current yield by one-third and our freezing industry 70% of the

installed capacity of which is estimated to be lying Idle can very well take care of the increased landings.

Our exports of fresh and frozen fish in 1983-84 were 22,573 tonnes worth Rs. 29.1 crores - 24.35% by quility and 7.8% by value of the total exports. Of course, a major portion of it may have been exported in the fresh (iced) condition, though no separate figures are available for the two types. With our projected potential of marine fishes at three times the current yield, the increased catches of quality fishes can be frozen making use of our already installed idle freezing capacity and utilized for export as well as internal distribution making use of the 'cold chain' suggested earlier. We have already worked out the technical know-how for freezing preservation of all our important marine fishes Good demand exists for frezen fish in middle east countries like Bahrain, Kuwait, Saudi Arabia, U.A.E., Oman etc., fareastern countries like Taiwan, Singapore, Hongkong, Malaysia, Thailand and Japan, European countries like Federal Republic of Germany and U. K. and the United States of America.

Frozen cuttlefish and squid amounting to 3578 tonnes worth Rs. 6.47 crores (3.86% by quantity and 1.64% by value of the total exports) were exported from India in 1983-84. With the projected potential of 1.8 lakh tonnes of cephalopods against the current yield of 13,000 tonnes, the increased catches can be very well taken care of by our idle installed freezing capacity.

UTILIZATION BY CANNING

India had a flourishing shrimp canning industry in the 1960s and the earlier half of the next decade, the record export of 2199 tonnes of the product worth Rs. 5.2 crores taking place in 1973. Thereafter the exports dwindled down to a mere 41 tonnes valued at Rs. 2.4 million in 1983-84. We were also canning some of our food fishes like oil sardine, mackerel, tuna etc. mainly for supply to the Army Purchase Organisation and partly for catering to the internal and export markets The canning industry in India is at its lowest ebb today due to several causes like the high cost of the imported tin containers (the particular

quality of steel plate satisfying the requirements for fish containers is not manufactured indigenously at present) and filling media like edible oil and increasing labour costs. Substitution of tin cans with cheaper aluminum cans and synthetic film pouches and edible oil as filling medium with brine, tomato sauce etc. has been successfully tried out in the country; but the industry is yet to adopt them on a commercial scale. Technical know-how has been evolved by our research laboratories to can oil sardine in its own juice, brine, curry, tomato sauce etc., mackerel in curry, brine etc, tuna, seer, pomfret, lactarius, eel-smoked sardine, eel and dhoma, hilsa, tilapia, crab meat, clam, mussel and oyster meat etc. This can ensure full utilization of our increased catches with better exploitation of our projected potential resources of marine fishes.

DIVERSIFIED PRODUCTS FROM MARINE FISHES

Several of the less popular varieties of marine fishes which are at times referred to as 'trash fishes' are yet to find better utilization. Technology is now available for this by utilizing them as raw materials for many diversified products.

Meat picked from such miscellaneous fishes with the help of meat picking is frozen in small blocks. The product called 'kheema' finds good acceptability as a base for several products like fish cutlets, edible fish flour, fish hydrolysates, fish flakes, fish soup powder etc. Fish protein concentrate (FPC) is prepared as a colourless and odourless dry powder from such picked meat after cooking and extraction with solvents to remove fatty and odoriferous compounds. FPC can be incorporated with wheat flour to the extent of 10% for preparing popular dishes like 'chapathi' and 'puri' and baked products like bread and biscuit, increasing their nutritive value without imparting any fishy odour or flavour to the products.

The minced meat after cooking, pressing and hydrolysis with enzymes yields a hydrolysate which is dried to a powder to give bacteriological peptone useful for preparing culture media for microbial organisms. The cooked and pressed meat when homogenised with starch and flavouring ingredients and dried in

thin flakes, yields a product which swells to several times its original size when deep fried in oil. The fried product is quite crunchy and tasty. The hydrolysate can also be incorporated with malt, sugar, cocoa powder etc. and dried to yield a fine beverage similar to those available in the market and produced using vegetable proteins. The cooked kheema can be incorporated with the required amounts of starch, spices, emulsifying agent etc. dried and powdered to give an instant fish soup powder, which when dispersed in water at 5% level and boiled for a few minutes yields a fine soup.

Long term preservation by pickling, using venegar, oil and spices, can be applied to several types of our marine fishes and meat of bivalves like clam, mussel and oyster.

UTILIZATION OF BYPRODUCTS

Scientific utilization of the byproducts of the marine fish processing industry can go a long way in bringing better returns to the fishermen. Cheap miscellaneous fishes offal from the processing industry can be converted into fish meal either by wet rendering (cooking, pressing, drying and powering) or by dry rendering (drying as such and pulverising) processes. This product can be incorporated in poultry and cattle feeds. Any spoiled raw material of this sort can be similarly converted into a dry powder for purposes of manure. The above raw material can also be preserved by ensilaging, i. e., by mincing and keeping its pH low by addition of mineral acid or by producing the acid *in situ* microbial fermentation of added carbohydrates in the form of molasses. The ensilage can be fed either directly to cattle after neutralisation of the acid by chalk power or converted into a dry feed mix by neutralisation of the acid, addition of rice bran, tapioca powder, seaweed powder etc. drying and pulverising.

The oil sardine which are landed in huge amounts during certain seasons sometimes exceed the limits of utilization by ordinary methods. They are then used for extraction of oil. The fish is boiled up with water and the oil that floats to the surface

ladled off. cooked mass is pressed in canvas bags and the press liquor allowed to stand when all the oil floats to the surface, This is separated and added to the first lot. Several industrial products like faetice (artificial rubber), printing ink, lubricating oil, insecticidal soaps etc. have been developed out of the oil, besides its conventional use for tempering of steel, fat liquoring in leather industry and application on wooden boats as a protective. The press cake is dried and incorporated into fish meals from other sources.

As estimated, 50,000 tonnes of prawn shells and head wastes are thrown out of our processing factories every year. A high quality protein can be isolated from it in paste form by extraction with dilute alkali. Solvent extraction of the remaining portion yields pharmaceutically important compounds like cholesterol and glucosamine hydrochloride. The chitinous product left behind is deacetylated which finds several industrial applications like purification of water, clarification of wine, glazing of textiles and paper and as a general industrial flocculant.

Shark fin is another valuable product which is lightly salted, dried and exported fetching the highest average unit value among our seafoods of about Rs. 150/- per kg, 147 tonnes of the product being exported in the year 1983-84. A technique has now been developed for separating the rays (fibres) from the fins which are actually used in the preparation of shark fin soup, which is a highly esteemed dish in the countries which import the fins. The rays are valued above Rs. 1000/- per kg. in those countries. The skin of large varieties of sharks can be tanned scientifically to yield a high quality leather excelling even cow hide leather in strength properties. Similarly, fish maws, which are the air bladders found in some of our marine fishes, are cleaned, dried and exported, fetching more than Rs. 100/- per kg. On an average, the quantity exported during 1983-84 was 102 tonnes. The product is mainly used for clarification of wines beer etc.

CONCLUSION

With a projected potential of marine fishery resources of three times the current average yield and in view of the declaration of an EEZ of 200 nautical miles and the scientific methods

of harvesting already worked out, we have to gear ourselves up for the proper utilization of the landed catches so that wastage is avoided and the fishermen get remunerative returns for their efforts. With the improvements already achieved in the harvesting technology using the most modern fishing craft and gear, a major portion at least of our potential resources is sure to be exploited in the immediate future. The fish processing research laboratories in our country have risen up to the occasion and scientific methods are now available for the maximum utilization of any amount of landed fish. The foregoing account presents a brief description of the major developments that have taken place in this direction in India in a short span of the past two and a half decades.

EXPLOITATION AND UTILIZATION OF MARINE FISHERY RESOURCES

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With a coastline of over 6,000 km, India has a very rich marine fish potential. The potential yield from our Exclusive Economic Zone (EEZ) has been conservatively estimated at 4.5 million tonnes. The major marine fishery resources of India comprise :

a) Pelagic resources such as oil sardine, mackerel, seerfish, tuna;

b) Demersal fishery resources like perches, catfish, pomfrets, sharks;

c) Midwater fishery resources of bombayduck, silverbellies;

d) Crustaceans consisting of prawns, shrimps, lobsters and crabs; and molluscan resources such as oysters, mussels, clams, squids;

e) Seaweeds.

Our marine fish landings, which had been at 1.08 million tonnes in 1970, increased to about 1.24 million tonnes in 1980, registering an increase of about 15% over a decade. The current level of production is estimated to be about 1.5 million tonnes. Thus, we are exploiting only an insignificant part of our available resources in the sea.

According to estimates, the traditional non-mechanised sector, consisting of about 1,60,000 countrycraft, account for 67% of the total catches. Small mechanised craft, numbering about 16,000, are estimated to bring in 32% of the catches. Trawlers and other modern fishing vessels, numbering between 80 to 100, contribute about 8,000 to 10,000t of fish annually. Over five lakh fishermen out of an estimated population of twenty six lakhs are reportedly engaged in full-time fishing.

On the one hand marine fish production has been stagnating and on the other hand major part of our resources other than those in the inshore waters within 50 m depth remain unexploited. This paradoxical situation is obviously detrimental to the interests of the country. The average per capita consumption of fish and fishery products in India is extremely poor, being about 4 kg per annum. Our exports of marine products stagnate near 80,000 tonnes per annum on the average. We are neither able to make available fish and fishery products in large quantities for increasing internal consumption nor able to step up our exports. The adverse consequences on the nutritional levels of our people and on our foreign exchange earnings are too obvious to be stressed.

There is absolutely no doubt that for achieving any major break-through in our marine fish production, we have to expand and intensify fishing efforts beyond 50 m depth. But our technical know-how, infrastructure and experience in tapping even the identified resources of the deep sea are extremely limited. There is general consensus among experts that the major constraints in the exploitation of our deep sea resources are the following:

a) absence of reliable data on commercially exploitable resources in different areas of our EEZ

b) lack of specific information about the types of vessels, fishing gear and other equipments required

c) lack of know-how and technical skills required for different types of fishing

d) absence of basic infrastructure

e) lack of adequate finances and incentives

f) lack of adequate marketing outlets

Resource-surveys have for long been undertaken by the Exploratory Fisheries Project/Fishery Survey of India, the Integrated Fisheries Project, the Central Marine Fisheries Research Institute, the National Institute of Oceanography, etc. But un-

fortunately the periodical reports on resources published by them have not been found to be reliable/adequate enough for enabling the industry to undertake commercial fishing operations by making large capital investments. Therefore, a time-bound programme for completing the resource-survey of our EEZ within a period of say five years has to be effectively coordinated at Governmental level for this purpose.

Prospective entrepreneures have been reluctant to undertake deepsea fishing ventures for want of reliable data on resources and economics of operations. Therefore, till we properly survey, test fishing may be allowed and encouraged. A group of experts can be entrusted with the task of compiling and analysing the available data on resources and scrutinising and recommending proposals for test-fishing. Based on the recommendations of the group of experts, proposals for test-fishing may be cleared by the Ministry of Agriculture, on the merits of each proposal.

Based on the resource-data already available or which would become available as a result of test-fishing and completion of the proposed resources survey, the number, types and specifications of the fishing boats and gear required for commercial exploitation of fishery resources may be got assessed and prescribed. The Ministry of Agriculture may make use of the expertise available in institutions like the CIFT, the CMFRI and the IFP to make an immediate assessment of short-term requirements. Based on this exercise, the first stage can be completed within two-three months, and information on the number, types and specifications of boats and gear required can be made available to industry and State Governments.

With reference to the fishery resources available for exploitation and the types and specifications of vessels and gear sought to be introduced, fishing technology and skills have to be provided. There are many institutions already engaged in imparting know-how and skills, and the basic infrastructure for providing the requisite training already exists. But it is absolutely necessary to co-ordinate their activities and re-orient their curriculum and courses to meet the specific requirements.

This task, again, has to be undertaken by the Ministry of Agriculture with the involvement of the specialised institutions like CIFNET and CIFE and private parties, who have actual experience, though limited, in deep-sea fishing.

The large infrastructure requirements for the development of deepsea fishing like fishing harbours, boat repairing yards, cold storages, etc. would have to be provided by the Central and State Governments. The requirements of such facilities have been, by and large, identified, but necessary resources have to be provided for creating the facilities. Construction and management of such facilities that would come up in different parts of the country also deserves special attention. The present administrative systems and set-up are totally inadequate to cope with the work. Therefore, the Ministry of Agriculture has to take the initiative in setting up suitable machinery and in preparing specific action plans for each facility in consultation with the state Governments concerned.

Commercial fishing in the deepsea waters is capital intensive, technology-oriented and risk-prone. Therefore, it is unrealistic to expect the traditional sector to contribute significantly to the exploitation of the potential resources in the deep sea. Organised efforts with adequate financial, managerial and technological backing have to be made for tapping the available resources. Government has to consider making suitable institutional arrangements to provide funds for financing deepsea fishing activities. At the same time, keeping in view the large risk element in the operations, some kind of incentives would also have to be provided.

Exports have contributed very significantly to the development of marine fishery industry so far. Fortunately for us, it is possible to enlarge our share of the world market. Therefore, immediate steps are required to diversify our export products, particularly in view of the limited scope for larger shrimp landings. After clearly identifying the fishery items which can be exploited on commerical basis, strategies and specific plans aimed at finding suitable international markets for them would

have to be evolved. To some extent, this exercise would form part of the project planning for the successful economic exploitation of particular types of fishery. The MPEDA which has done considerable work in gathering market information and promoting our products abroad can be asked to intensify its efforts in this direction more systematically at the appropriate time and to involve itself suitably in the preparation of the export components of fishery projects.

Creation of a domestic marketing chain, either regionwise or Statewise, is another important requirement for sustaining the exploitation of deepsea resources. Total dependence on export markets for the deepsea marine products would not be prudent. Therefore, besides encouraging private initiative by providing infrastructure facilities and finance, the Central/ State Government may have to, in the initial stages at least, enter the field of domestic marketing directly or through co-operatives.

Development of marine fishery in India during the last one and a half decade seems to have been an export-led growth. Good demand for a high-value product, namely prawns and shrimps, in the expanding export markets has spurred and sustained the fishing and fish processing industry. Most of the fishing efforts and even the developmental and promotional measures were aimed at increasing the production and export processing of shrimps and prawns. Stagnating or declining catches of shrimps and prawns (during the year 1985, landings apparently declined by about 10,000 tonnes) must awaken us to the urgent need for evolving an integrated long-term strategy for the development of our marine fishery. Such a strategy should lay down clear policies and specific action plans for:

a) the judicious management of our resources in the inshore waters with due emphasis on conservation;
b) the exploitation and utilisation of our deepsea resources roughly on the lines indicated in this paper;
c) the integration of the large fishermen community with the development of the fishery sector in the context of emerging technological and socio-economic compulsions.

The views and suggestions expressed in this paper are those not of the MPEDA.

MANAGEMENT OF POTENTIAL FISHERY RESOURCES

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The prevailing situation in the fisheries sector in many countries of the world can be briefly stated as (1) insufficient information on fish resources, (2) diminishing stock and (3) conflicting uses of coastal areas and types of fishing. Since there is free accessibility to the exploitable resources in the sea, the natural tendency is to make more and more without regard to the real availability. The need for fishery management assumed importance in recent years on account of the uncontrolled, or rather reckless, exploitation of the resources in many countries leading to depletion of stock. Although according to available information the level of exploitation of the fishery resources in our country in general is far below the optimum level, there seems to be too much concentration in certain areas and in respect to certain species which perhaps is a reflection of the lack of fishery management policies or their implementation.

What is the ultimate aim of fishery management ? To make full use of the available fish resources without endangering their renewability. Fish in the sea is a self-generating resource. But, as nature would have it, the quantum of resources amenable for exploitation, otherwise called the maximum sustainable yield, appears to be more or less fixed. The primary task of management is to determine the effort needed to exploit the available level of resource. Fisheries management cannot, however, be seen as an isolated policy package. It must in fact be viewed as part of the overall policy measures needed for the most rational exploitation of the total natural resources of a country. In the matter of exploitation of resources, there is an implicit conflict of interests between the end uses. For example, in agriculture there

is a conflict between different crops for available land. In the fishery sector also the conflict is manifest between the inland and marine sector; within the marine sector between the modern sector and the tradional sector; and within the traditional sector between the motorised and non-motorised sectors. In the market, the conflict or disequilibrum is between the potential social demand and the potential supply as determined by the maximum sustainable yield. The function of fishery management is to resolve this conflict and ensure maximum social gain in terms of production, consumption and employment.

Within this broad theoretical framework, let us examine the real situation. The first thing to be examined is whether we have any policy with regard to the management of the potential fishery resources and how far we have succeeded in translating these policy measures into action. Before doing so, we must see what is our present knowledge regarding the fishery resources in the different regions falling within the EEZ of the country. Different estimates are available with regard to the potential resources of the Indian Ocean. As for the Indian waters, the potential is broadly indicated as 4 million tonnes. A break-up of this with respect to the southwest coast, northwest coast, upper east cost and lower east coast is also available. In spite of these macrolevel figures, which have been worked out nearly a decade ago, no accurate estimates regarding the resources falling within the different depth zones off the different maritime states are available. This is a major limiting factor in devicing appropriate management measures. It is not known whether a constant systematic effort is made to estimate accurately, at the microlevel, the available resources in each fishing zone on the basis of reliable yardsticks. From the practical point of view the resource estimates will become useful only when we are in a position to suggest the maximum sustainable yield of the important species in the different zones and, based on this, the permissible fishing effort within the modern and traditional sectors. This effort should then enable us to suggest the types and number of craft and gear needed for the effective and economic exploitation of the resources. As a matter of fact, the available information is rather sketchy and totally inadequate from the operational angle.

In this respect, special mention should be made about the attempt made by the Kalawar Committee to estimate—of course based on insufficient data—the maximum sustainable yield and the maximum effort required within the inshore area of Kerala State. The Committee has found that the maximum sustainable yield of the State's inshore waters (50m) is about 4,39,203 tonnes, comprising 3,19,317 tonnes of essentially pelagic and 1,19,886 tonnes of demersal stocks. Based on this the Committee could prescribe the maximum number of craft and gear needed in the traditional and mechanised sectors. Such an estimate, although it amounts to only a first approximation, is needed for the entire country. The responsibility of estimating the exploited resources has been shouldered by the C.M F.R.I. It should be possible for the Institute to generate more comprehensive data on the resource potential and to prescribe the effort required, and more specifically the ideal fishing methods needed for its optimum economic exploitation.

One thing that appears very relevant to me in this context is the lack of sufficient co-ordination between the research institutions and the state departments of fisheries. Whatever data are presently generated are not used properly. The efforts made to generate the empirical data would become fruitful only when such data get translated into policy measures and the actual fisherman and the country get the benefit of it. The situation calls for more efficient integration between the departments, which should definitely lead to mutual enrichment.

A second point that I want to stress in this context is that all of us who are directly or indirectly responsible for the management of the fishery resources must be aware of the complexities of the larger political and economic system to which the fishery sector is integrally linked. Two important realities of the prevailing situation are (1) the overall financial constraint and (2) the large scale unemployment and poverty among the fishermen. While deploying the resources at the command of the state, the immediate objective should be ensuring maximum social gain which in the present context does not mean optimum exploitation of the fishery resources but providing employment

to the fishermen whose main source of livelihood is fishing. It is common knowledge that further exploitation of the resources has scope only in the deeper areas. But, as it is, private enterprise, motivated by target fishing for deepsea shrimp, is unlikely to go in on a large scale for deepsea fishes because of their limited marketability, except in the case of selected species. As for the state, the future policy should therefore be diversification of fishing into deeper areas. This also is going to pose some problems. The craft and gear presently in use are not suited for the deeper areas. Introduction of the sophisticated deepsea trawlers does not, on the other hand, appears helpful in solving the problem of unemployment among the fishermen. Development of a new generation craft and suitable gear should therefore get the immediate attention of the fishery technologists. This will help to generate new employment opportunities without unduly raising the capital-labour ratio. The scale of investment required being less, unlike in the case of deepsea trawlers, it is also possible to make the fishermen group become owners of the craft and gear. I want to stress this point of ownership particulary because the social objective of the generation of wealth in fishery sector should be to enable the toiling fishermen to enjoy the benefit.

Another important aspect which is to be stressed while considering the management of potential fishery resources is the need for product development. It is a well-known fact that a good portion of the bycatches of the mechanised boats is now thrown away as trash. If these trash fishes are processed into products they become consumable. It has two benefits : (1) the increased availability of fish and (2) generation of additional employment and income. This support measure is also necessary when we start exploiting the resources in the deeper areas which in fresh form have only limited marketability. In other words, product development, which aims at demand building, must go hand in hand with increased effort for exploitation of the potential resources.

Before concluding these brief observations I wish to draw your attention to the limitations of capture fishery in meeting

the growing demand for fish on the one hand and providing gainful employment to the growing dependent workforce on the other. The imperatives of development appears to be such that increasing attention will have to be given in the coming years to the development of mariculture and inland culture fishery. This seems to be necessary to ensure proper management and rational exploitation of the resources in the sea also.

MANAGEMENT OF POTENTIAL FISHERY RESOURCES

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INTRODUCTION

The marine fishing industry of India, though capable of becoming an important sector in the national output, has been growing at a slow rate, at an annual average rate of 3.4% during the period 1970-1979.

The marine fish landings of India, which averages about 0.62 tonnes per sq. km and which is mostly from the inshore waters up to about 50 m depth, is low, as compared to the estimated total marine fisheries potential of about 4.5 million tonnes in the entire economic zone. The present relatively low production is mainly due to the marine fisheries being not fully exploited in the inshore waters up to about 50 m depth and practically unexploited in the economic zone beyond 50 m depth.

The zone up to 50 m is estimated to be capable of yielding a substantial quantity of fish additionally, while the deepsea fishery resources beyond 50 m depth are of such a potential that the distantly based fishing fleets from USSR, Japan, Taiwan, South Korea, Thailand etc. had found their exploitation economical.

With the introduction of "Territorial waters, Continental shelf, Exclusive Economic Zone and other Maritime Zone Act, 1976", which came into force on the 15 January 1977, India has assumed a great responsibility for the optimum exploitation of living and non-living resources from about 2 million sq. km area.

EXCLUSIVE ECONOMIC ZONE OF INDIA

The extent of the areas of EEZ of India is as follows:

Total area under EEZ off India	... 2 million sq. km.
Off west coast including Lakshadweep	... 8,60,000 sq km. (42%)
Off east coast	... 5,60,000 sq. km. (28%)
Andamans and Nicobar	... 6,00,000 sq. km. (30%)

The fisheries potential of the Indian Ocean is estimated at 14.4 million tonnes, which can be classified into:

(a)	Demersal fishes	... 7.4 million tonnes
(b)	Shoaling pelagic fishes	... 6.0 million tonnes
(c)	Large pelagic fishes	... 0.7 million tonnes
(d)	Crustaceans and squids	... 0.25 million tonnes

Detailed information on the actual fish stocks in the Economic Zone of India is not available; it is, however, estimated that the Economic Zone may support about 4.5 million tonnes of living resources, of which a sizable part could the be commerially exploitable fish stocks.

FISHERY RFSOURCES

The Marine fishery resources of India in the four main regions, in northwest, southwest, southeast and northeast, consist chiefly of:

(1) Major pelagic resources, such as oil sardine, mackerel, seerfish, tuna, and other pelagic resources of regional importance, such as lesser sardine, anchovies and ribbonfishes;

(2) Demersal fishery resources, such as perches, sciaenids, catfishes, polynemids, flatfishes, pomfrets, eels, sharks, rays;

(3) Midwater fishery resources consistituted by bombay duck, silverbellies and horse mackerel;

(4) Crustacean fishery resources, consting of prawns shrimps, lobsters and crabs;

(5) Molluscan fishery resources such as chank, oysters, mussels, clams, squids and cuttlefishes; and

(6) Seaweed resources.

K. M. Joseph (1986) in his observations on potential resources from Indian EEZ has analysed the data and indicated the catch/h in three sectors on the west coast and in three sectors on east coast, as also in Wadge Bank and Gulf of Manner for certain fisheries which are of significance and are abundant. These fisheries are thread fin bream, carangids, perches, catfish mackerel, squids, cuttlefish, big eye and black ruff. It may be, seen that threadfin bream, horse mackerel, catfish, squids and cuttlefish and black ruff are abudant on the west coast, horse mackerel, perches and mackerel on the east coast; thread fin bream and perches on the wadge bank and perches and horsemackerel in the Gulf of Mannar.

Besides, cuttlefish and squids are abundant on the northwest, southwest and southeast regions, including Wadge Bank. These are evident from the landings of the vessels which operated in charter. Unforunately, details of analysis of over 75 pairtrawlers which operated for about 3 years are not yet available. Deepsea lobsters and deepsea prawn are also in large quantities in the southwest and southeast regions.

The ocean resources of India and their estimated potentials are assessed to be as follows:

Tuna and skipjack	—	500,000 to 800,000 t.
Larger tunas	—	150,000 t.
Oceanic sharks	—	1,000,000 t.

The details of hooking rate of these forms, regionwise and specieswise, as gathered from November '83 to October 1985, are given below:

Species	West coast	East cost	Andaman sea	Equatorial sea
Yellow fin	0.72	0.61	0.49	1.05
Big-eye	0.05	—	0.02	0.12
Skipjack	0.07	0.13	0.02	0.12
Albacore	—	—	0.01	—
Marlin	0.13	0.22	0.18	0.70
Pelagic Sharks	1.28	0.75	0.68	0.57
Others	0.18	0.32	0.13	0.10
Total	2.13	2.03	1.53	2.66

Of the many unexploited and underexploited fish stocks in our deepsea and high sea areas, for which no economic assessment of the potential is available and which, as a consequence, have not been developed, such as tunas, squids, cuttlefish, deepsea prawns and lobsters, require attention on a priority basis. These are essentially export items with demand in world markets and are oceanic in distribution. They occur not only in EEZ but even beyond in the international waters. Fishing operations for such fisheries will be important not only for exploitation and protection of EEZ but also for extending the range of fishing into the international areas and to conserve, protect and manage the resources, taking note of the influence of basic ocean characteristics on these resources. The approach and strategy for the development of each of these fisheries will have to be worked at carefully.

TRADITIONAL FISHING

The production from the traditional fishing craft can be increased by improvement in efficiency of the traditional fishing craft and gear in the different regions, increasing the marketing system to provide an increase in the price for producers and incentive for increasing landings, provision of basic amenities and services at landing centres and by covering a group of fishing villages and landing centres by fishery industrial estates.

With timber becoming increasingly scarce and expensive, the introduction of craft with alternative raw materials like FRP, ferrocement, etc. for canoes and craft for surf-beaten coast will have to be taken up. It is necessary to provide craft acceptable to the fishermen at a reasonable cost. There should be promotional effort by waiving excise duty on raw material components and a grant of subsidy for a period of five years.

As the outboard motors will greatly benefit the traditional fishermen to reach the ground quickly and come back on time for the market with quality fish, increasing their productivity, it is necessary to allow import of OBMs freely with complete exemption from import duty. There is no manufacturer of OBMs in this country, though licence was given periodically for the last twenty years. It is necessary to provide an incentive of 50% subsidy for new areas and modernisation of craft.

MECHANISED FISHING

There are about 20,000 mechanised fishing boats in the country, Most of these mechanised vessels have been predominantly concentrating on catches of shrimps. There have been apprehensions that heavy mechanised fishing have caused over-exploitation of shrimp resources. It is considered necessary to control carefully and monitor the entry of additional mechanised boats, except for craft designed for diversified fishing operations and for exploring new areas for efforts other than shrimp trawling.

Immediate steps are required for conservation of shrimp resources in certain areas, both directly and indirectly.

It is necessary to standardise the designs of these new types of fishing craft and their number to rationalise the cost, especially when new raw materials are introduced for the different functions, and the designs should be restricted to the minimum. It is also desirable and necessary to consider development of alternative designs and with alternative raw materials like FRP and ferrocement from competent agencies.

Most of the mechanised boats are engaged essentially in shrimp trawling due to its high value. There should be an endeavour to introduce new technology in the inshore waters by constructing and distributing FRP/ferrocement boats of about 6-9 m size and motorising them for gill nets and about 14-15 m mechanised boats for bull trawling, gillnetting and longlining.

Designs of smaller size can perform the functions of larger size vessels now in operation for shrimp trawlers of 23 metres. A few such craft are operating in Vizag and Gujarat coasts. The economic assessment will bring out comparative saving in fuel. It is necessary to arrive at standardised designs of such craft for construction in different materials. The SDFC fund is only for steel craft and this may be extended to all fishing craft of different materials and for sizes above 15 metres.

APPROACH TO DEVELOPMENT OF DEEPSEA FISHERY AND TUNA FISHERY

The steps required to be taken to achieve immediate results and to streamline the procedures for accelerating the programme of deep sea fishing and tuna fishing are immediate and important, especially in the light of international competition both in exploitation, and in the export markets, in terms of quality, prices, and quantities honouring the commitments and contracts.

The guidelines issued early in 1981 for charter for fishing vessels have not accelerated the programme for commissioning of larger number of vessels difficulties in the procedures laid down for the acquisition of these vessels, frequent shifts in policy, rules and regulations and application of certain criteria on an adhoc basis for reasons not necessarily on merits,as well as certain delays in monitoring.

All the operators of chartered vessels have expressed difficulty in meeting with the procedures involved in obtaining the initial clearance and subsequently at intermediate clearance at ports from the D. G. (Shipping) and Coast Guard. Besides the procedural formalities, there has also been considerable delay in obtaining the clearance at ports for deck personnel causing con-

siderable loss of fishing time and consequent loss in catches and value. The operational phases are also beset with impractical restrictions. The use of telecommunication system from ship to ship and from ship to shore is restricted, especially when vessels of other nations are using satellite communication; it should be under the Fish Terminal Authority; it should be possible to draw up a clear set of guidelines and instructions to the regional and local officers of the D. G. Shipping, Coast Guard, Navy, Customs and Ports—decentralising and delegating powers. Such powers are exercised by them in the case of merchant shipping for national and international carriers and similar procedure may be adopted for the employment of crew, use of equipment and for clearance by customs, port and Coast Guard in the ports.

The objectives for charter of fishing vessels are for identifying the suitable craft and gear for different fisheries in the different areas, training of personnel and providing the experience, a clearer picture of the composition of the catches and the markets for them in export and domestic markets. The experience gained in the operation of these vessels will have to be built into joint venture arrangement and establishment of Indian companies.

The scheme of charter of fishing vessels have to be continued for another 5 years and the question of phasing out this facility for specific types of fishing vessels may be taken up after a period of 3 years and with proper monitoring, acquisition and transmission of the knowledge gained by this experience. It is necessary that charter arrangement be linked up with joint venture programme, especially because of the need for the continued market promotion and development, both for export and domestic markets. The charter policy should lead to joint venture operations.

Based on the status of each fishery, a proper approach and strategy will have to be planned covering technical, financial and administrative support for accelerating its development and taking into consideration the biological, economic, social and political problems posing each fishery.

Besides deepsea fishing for bottom fish, the importance of tuna and squids and cuttlefish has been recognised, but very little has been done so far in encouraging fishing for these fisheries, mainly because of the highly specialised types of fishing, involving heavy capital, organisation and management, It has also not been possible to achieve anything concrete because of the difficulties in securing clear guidelines and policies on tuna fishing and foreign collaboration and in identifying the craft and gear and personnel.

Tuna fishery is an international fishery and an export oriented industry. It is one of the important fisheries in the EEZ, which are contiguous in the international waters and cover the high sea fisheries. The Govt. of India have been taking up the issue of attracting joint venture on tuna fishing from 1965 onwards but with no result till date.

It will be evident that besides Japan and USA, S. Korea and Taiwan have the necessary experience and expertise on tuna fishing operations in the Indian Ocean area and India should take advantage of this situation. Tuna fishing can be carried on in the International waters beyond our EEZ. It is important to consider programmes from these countries having a better knowledge of the fishing grounds with ready experience and attracting them to exploit the tuna fisheries of EEZ and share part of this cost.

A study undertaken by CMFRI in 1982 indicates that India will certainly benefit from foreign expertise in specific areas like Tuna fishing, fleet management, purse seining, longlining, post harvest technology and product development for different export markets.

Tuna fishing, an essentially export oriented operation, requires very careful handling and freezing on board to meet the special markets of Japan and USA. In view of the highly sophisticated nature of operations, it is desirable to consider some more relief than what was extended to the trawler operations by charter, mainly with a view to identify the

economic size of tuna fishing boats. One or two applications for tuna on 100% export oriented basis are facing rough weather due to certain controversies.

The foreign collaborating firms specialised in selective fishing would like to undertake prefeasibility (test) fishing to be convinced of the commercial viability of such ventures and the cost of such test fishing is to be met by the Government and it should be treated as a development cost.

OUTLINE AND STRATEGY

The investigations and studies in EEZ on the living resources are yet to be directed in a systematic manner and the manpower required for collection of data, though available to a limited extent, will have to be increased after suitable training programmes.

Commercial exploitation of the important fisheries in the EEZ and Indian ocean are specialised and capital intensive, and can be effectively initiated only as joint ventures in collaboration with fishing company (s) from foreign country (s) who have the expertise, equipment, capital and market for the resources. Therefore, considerable effort in planning at the national level is needed to generate interest among the Indian entrepreneurs and the foreign firms in this field of development. The most important preparatory study required for this plan of development is an economic assessment of resources potential.

The varying nature of fisheries and fish resources complicates the adoption of a rigid system of economic zones, particularly in areas where resources are shared. The difficult task in such areas is to apportion the rights to resources.

Economics and other data are vital when considering the practicability of developing fisheries on stocks of fish that are at present lightly or not exploited, e. g. tuna, squids. It is not sufficient to know that there is a potential for taking out in hundreds of thousands annually. Development also requires the knowledge of how fish can be caught economically and how they are to be processed and marketed.

The demands for stock assessment advice are increasing. Many stocks especially in the near shore waters are heavily fished and need management. Advice is needed for national planning and management, as well as for increasing production from resources further offshore. The law of the sea places the responsibility on the coastal states to determine the potential of the resources in the EEZ and to manage them. Under the new regime of the sea, operations of foreign vessels under charter, joint venture or licence may be the most suitable way for finding out whether good offshore resources exist, and if so, their distribution and approximate magnitude. The coastal state should apply appropriate controls, e.g. placing observers on board each such vessel to ensure getting full information.

Some work has been done in the country on the economic assessment of a few of the exploited inshore resources, using the actual production and marketing arrangements. As regards the unexploited fish stocks in the deeper and high sea areas of the Indian Economic Zone and the Indian Ocean, no systematic study has been made to obtain the most valuable fishery resources information, which comes from actual fishing and advantageous disposal of catch and which would provide data not only on the quantity and the quality of the resources available in a particular area but also on the fishing cost and the comparative economic return. Economic assessment of the fishery resources potential is very important and requires to be considered on a priority basis in the development plan for establishing joint venture, so as to infuse adequate interest and confidence in the Indian entrepreneur and invite participation from the foreign collaborator towards the commercial exploitation of the deep sea and high sea fisheries and thus the management of these living resources.

A distinction has to be made between pre-exploration surveys, to provide an inital estimate of biomass and potential yield and regular monitoring surveys-carried out at regular intervals to determine changes in the abundance of fish stock and continuous understanding of the fisheries for proper conservation and management, maintaning a balance.

The National Research Institutes may be encouraged to augment their capabilities into the area of projectisation of the available technology from the point of view of fishermen, industry and trade. The commercial use of available technology would involve looking into the aspects of market organisation, financial and economic viability of projects based on the technology developed by such Institutes.

Deepsea fishing is highly capital-intensive industry. It requires sophisticated craft and equipment and high skills and support from the beginning. Efficiency of operation will depend to a great extent on the infrastructure for bunkering, maintenance and repairs and trained personnel for fishing. This calls for a Fishing Terminal Authority.

Deep sea fishing activity calls for efficient management skills with a strong organisational build up to take decisions for a quick turn round of fishing vessels at ports and ensure immediate repairs, proper handling of fish, marketing, efficient use of working capital and get the maximum number of days of fishing by vessels with full utilisation of the catches.

As for the infrastructural facilities required for berthing and handling fishing vessels, major and minor fishing harbours have to be brought to effective use by proper organisation, management and regulations through Fishing Terminal Authority.

The problems of fish marketing are basically related to a combination of certain factors, viz. production characteristics influencing supply and demand and consumption pattern of fish and processed fish of diverse products. The whole concept of marketing of fish is undergoing a change with the declaration of Exclusive Economic Zone by the coastal nations.

NATIONAL POLICY

It is important to evolve a national policy in clear terms and also ensure prompt and effective implementation policy in a practical manner. The policy for charter/joint venture/foreign collaboration for acquisition of fishing vessels, for engagement of foreign technicians and for attracting investments to accelerate the programmes of deepsea fishing should be practical and

realistic and the procedures laid down should be simple and cleared as at one time by one agency/committee representing all interests involving:

a) opportunity for Indian investor to negotiate with minimum risk, credit facilities, deferred payment, share of the catch etc,

b) collaboration for a minimum period of five years with a possible extension for improvement, diversification and expansion

c) investors to be given greater freedom in the choice of the size and type of boats from different countries

d) duty free imports of fishing vessels, gear, equipment– navigational electronic, communication, refrigeration and spare parts and to be spelt out clearly without giving any room for wrong interpretations for restrictive measures; and

e) proper monitoring of the operation for management and conservation.

The main objectives of the early phase of the project for deepsea fishing should cover:

1. Exploitation of deepsea demersal and midwater fishery through charter of fishing vessels to identify the extent of commercial feasibility, suitable types of fishing vessels and equipment and the additional infrastructure required for economically viable operations and subsequently on a fully commercial basis.
2. Developmenet of the processing technology suitable for adding value to fishes for domestic and export markets.

The fisheries resources potential in the EEZ is there, but there has been efforts to exploit these resources but not in a positive direction. It is essential to have a bold national policy for providing the necessary inputs, support and encouragement to this industry from Government for an accelerated development on the lines adopted in most of the countries in the Far East.

ORGANISATION OF FISHERY

The fisheries activities are closely associated with various other agencies and disciplines. The fisheries organisations, and

fisheries research and educational institutions, both Central and State, have direct bearing and involvement. The interplay of the various disciplines is so much that any delay or an impractical step will affect the fishing activity, due to the highly perishable nature of the commodity and the need for maintaining a high quality of the products for reasons of health and competitive nature in export markets.

It is important to evolve a national policy in clear terms and also ensure prompt and effective implementation policy for joint venture/foreign collaboration for the various activities.

The studies by IIM, Ahmedabad, on the survey of marine and inland fishery have stressed the importance of the formation of the National Fisheries Development Board; it has also drawn attention to the many interdependent issues regarding production, consumption and marketing of marine fish.

The National Fisheries Development Board will have wings for:

a) Policy formulation and planning;

b) Developmental activities and support services;

c) Commercial operations;

d) Research and training;

e) Financial support;

f) Legislative action and enforcement; and

g) Administration and accounts.

The various legislative measures are enforced by the different departments in their own ways, encroaching on other activities, rather than a coordinated and cooperative approach to achieve the national objectives. It should be possible to have effective approach coordinated for enforcement by these Departments. It is important and essential to see that any organisation built up does not lead to unhealthy practices, which will be more damaging to the cause than the intentions.

The Board will be represented by the Ministries, States, Industry and Trade. It will have an Executive Committee. There will be separate Committees in each wing.

Table 1 – *Details of the fishery potential in different depth ranges on the two coasts & present production*

Sl. No.	Regions	Fisheries potential of EEZ	Potential yield t/sq. km.			Production in Tonnes		Remarks
			upto 40m	40-160m	160-320m	Current production (1981)	Gap	
1.	Northwest region	1.0 million tonnes	5	4	1.90	500,000	47%	Deeper areas to be exploited - crustacean & cephaloped. 80% of present production is from inshore areas
2.	Southwest region	1.15 million tonnes	*K 8.4 G 5.2	4.4 4.3	2.0 1.9	462,242	50%	60% of the potential to come from deeper waters of EEZ, Pelagic mid water

3.	Southeast region	0.67 million tonnes	Not available	435,000 —	Mid water & demersal stocks, crustaceans & cephalopods
4.	Northeast region	0.74 million	Not available though shrimps trawlers and Fishery Survey vessels are operating		Crustaceans - mid water and demersal.
5.	Andamans & Nicobar	160,000 Tonnes			Tuna 100,000 t Pelagic Shoaling fish 40,000 t;
6.	Lakshadweep	90,000 Tonnes	Tuna – squids and cuttle fish		Demersal stock - 20,000 t.

Table 2 - *Availability of fishery resources in the different regions off the Indian coast*

Sl. No.	Region	Demersal high value %	Demersal low value %	Pelagic M.W. high value %	Pelagic M.W. low value %	Remarks
1.	N.W. region	51%	8%	21%	14%	53% to come from deeper waters.
2.	S. W. region	51%	18%	16%	15%	
3.	S. E. region	52%	—	40%	—	
4.	Andamans & Nicobars	12%	—	63%	25%	100,000 T Tuna and allied fish (25000 T yellow fin and 50,000 T of Skipjack)
5.	N. E. Coast	Though all Shrimps trawlers are based here; the data have not been analysed and made available, as also the results of fishing vessels on charter; which operated from Port Blair.				
6.	Lakshadweep	(Details not available)				

For undertaking all these functions, the NFDB must have a very sound organizational structure, managerial skills and leadership. The required structure, skill, leadership and financial resource needs should be carefully assessed.

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