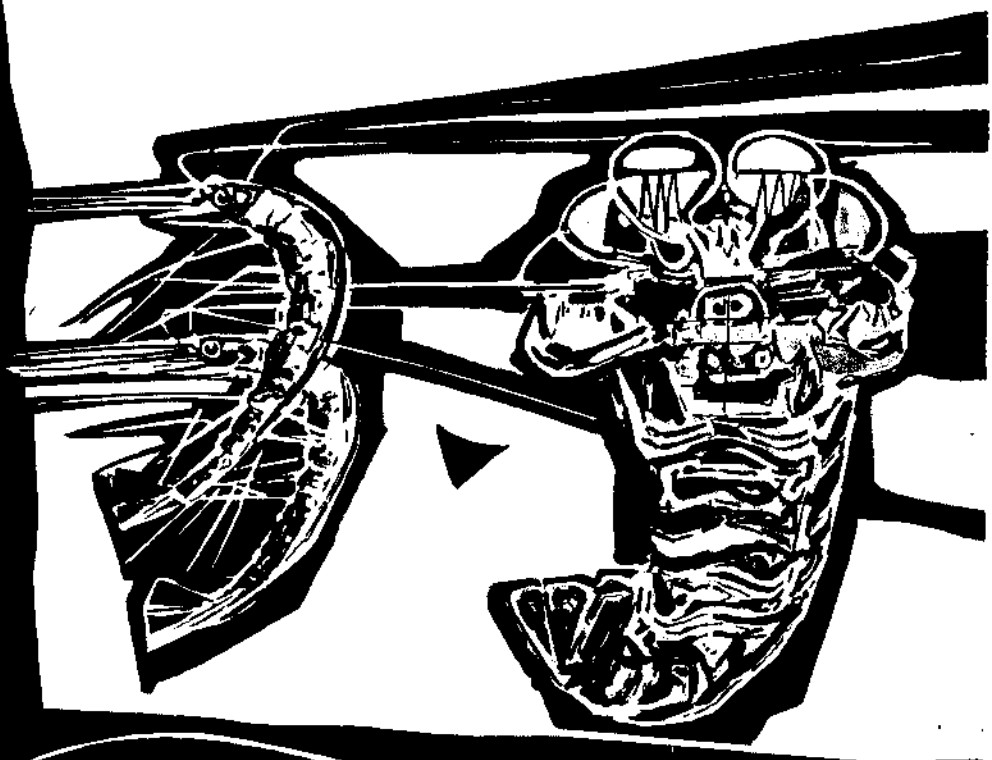
indian fisheries



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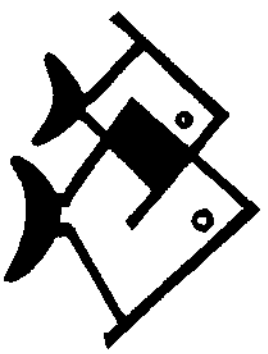
INDIAN FISHERIES

1947 – 1977



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foreword

Through an Act of Parliament, India declared in August 1976, an Exclusive Economic Zone of 200 miles to explore, exploit, manage and conserve the living and non-living resources of her seas. The measure was undertaken, taking note of the general consensus among nations and the emerging trends of the U.N. Conference on the Law of Seas. Several developing and developed nations have already taken similar steps to satisfy national aspirations for active involvement in full utilisation of marine resources close to their coasts.

The declaration of Exclusive Economic Zone is providing a great opportunity and a great challenge to the coastal nations. The resources hitherto exploited by other nations have come exclusively into the domain of national limits of jurisdiction of coastal nations increasing opportunities for them for obtaining raw material for food, better employment and for establishment of fishery based industries. The great challenge is for quick replacemnt, through national efforts, the efforts put in these waters by distant water fishing nations, so that the production trends are maintained and improved. This calls for massive measures by way of financial investment, vessel acquisition programmes, provision of infrastucture facilities at landing centres and use of modern technology in all aspects of fishing, processing and marketing. Training of technical manpower to meet requirements of prsonnel for duties at sea and ashore are also equally important. Fisheries research, particularly in resource assessemnt and for charting and mapping of seas to provide pre-investment information on availability of resources in time and space, is also assuming urgency.

A comparative study of the status of fishery development in the Indian Ocean countries indicates that the problems are more or less similar to all the countries in the Indian Ocean areas; only the degree of development differs in the different sectors in the various countries. While national efforts can alone ultimately solve national problems, this is an area where regional and global co-operation will quicken the phase of development and will bring together countries that have common resources and identical management problems.

It is hoped that this document on "Indian Fisheries" will serve as a base to facilitate discussions on problems and programmes facing developing countries in this area. In this context Indian fishery interests look forward with optimism and enthusiasm to the deliberations of the Fifth Session of the Indian Ocean Fisheries Commission as a forum of like-minded experts to eovle a new strategy for accelerated development of the living resources of the area under their special scrutiny and study.

P. C. GEORGE
Joint Commissioner (Fisheries),
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New Delhi.

preface

The development of fisheries of the Indian Ocean and of the countries bordering it received focussed attention only in recent years. The Food and Agriculture Organisation of the United Nations started evincing direct interest in the development of fisheries of this region with the formation of the 'Indian Ocean Fishery Commission' in 1967, under Article VI of the FAO Constitution. The objectives of this Commission are "to promote, assist and co-ordinate national programmes over the entire field of fishery development and conservation; to promote research and development activities in the area through international sources, and in particular international aid programmes; to examine management problems with particular reference, because of the need to take urgent action, to those relating to the management of offshore resources". Several subsidiary bodies of the Commission including the regional "Indian Ocean Programme" are operating at present to help the countries in different fields of fisheries and their development without either over-investment or over-exploitation.

Among the countries bordering the Indian Ocean, India is the largest. She contributes to about 45 per cent of the fish production from the region. The fisheries of the country is in the transitional phase from the traditional to the modern ways of exploitation. In this context, it is gratifying to note that India is selected as a venue to hold the Fifth Session of the Indian Ocean Fishery Commission, and it is hoped that the deliberations of this Session which is being held at Cochin from 19th to 26th October, 1977 would greatly benefit the country to finding solutions to the urgent problems encountered and the overall development of fisheries of the region.

The overall policy of India on fisheries is one of promoting growth with stability. The formulation of policies and priorities has been closely linked with the broad objectives of national developmental plans and the country's fisheries development programmes which have aimed at increasing fish production to meet the food requirement; to improve the socio-economic conditions of fishermen; and to tap on an increasing scale the potential for foreign exchange earnings through export of selected varieties. Such a developmental programme can succeed only with a strong infrastructure base involving resources assessment, research, education, extension, management, processing, marketing and distribution; and funding. The "Indian Fisheries 1947–77" brought out on this occasion deals with diverse aspects of fisheries research and development; extension and training, and the fishing industry of the country. It is not intended to be too technical nor delve deeply into specialisations, but aspires to provide an integrated picture of the development and progress of fisheries that have taken place during the last three decades. It is hoped that the volume would serve as an information base to assess the present status, to identify gaps and to evolve strategy and plans for future development of the fisheries of the country in particular and of the adjacent regions in general.

The preparation of this Volume has been made possible by the valuable contributions as well as active co-operation extended by the following scientists and experts and most grateful thanks are due to them.

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contents

1

introduction

Fish occupies an important place in the Indian mythology, history and tradition. According to mythology, one of the incarnations of God was in the form of fish ("Matsyavathara"). Profuse references to fish are found in the great epics of the country, in the stone carvings and paintings. Historically, reference to fish, its trade and fisher community are found in the Songs of the Sangam Age (1st to 4th Century A.D.) and in the diaries and records of travellers to India like Pliny and the anonymous author of the "Periplus of the Erythraen Sea" early in the first century A.D. Records also show that in the 18th century salt-fish trade flourished along the western coast of India. Traditionally, fishing has been the principal avocation for the livelihood of a segment of the population living in the coastal region, and on the banks of rivers, lakes and canals.

Despite its distinct tradition and significant trade, fisheries of the country received scant attention in the last century as well as in the first half of the current century, when the rest of the world marched ahead with its development. The important event that took place in the history of Fisheries of India in the 19th century was the enactment of "Indian Fisheries Act" in 1897. This Act delegated the States (erstwhile Provinces), the responsibility of development and conservation of fisheries in the inland and territorial waters of the respective States. It also empowered the States to formulate their own rules/laws for the safeguard of the fishery. Further, the Act provided certain conservational measures to prevent the destruction of the resources. Thus, the development, management and conservation of fisheries became principally a state subject. However, the fisheries of the country remained in a dormant state throughout this period.

Nevertheless, early naturalists like Hamilton-Buchannan, Sykes, Jerdon, Gunther, Day, Alcock, Anderson and others who worked on the Indian aquatic fauna made valuable contributions on the systematics, distribution and bionomics of the fresh water and marine fishes of the country. Subsequent works

by Hora, Misra, Trewaves, and others have added considerably to the knowledge of the ichthyofauna of the country. The fisheries research which was included as a subject in the concurrent list, was rather unorganised and diffused except for certain notable contributions by Day, Nicholson, Hornell, Hora, and Setna.

Concerted efforts for the development of the fisheries of the country were initiated only when we became independent in 1947. Immediately steps were taken for organised research and development with the establishment of the Central Fisheries Research Institutes for marine and inland fisheries, the Deep Sea Fishing Station, and subsequently, the Central Institute of Fisheries Technology. The Five Year Plans initiated to strengthen the foundation of economic and social structure, and to stimulate industrial, economic, scientific and technical advances, began to cater to specific needs of the development of fisheries of the country, and thereafter, the Indian Fisheries showed a progressive development.

During the first two Five Year Plans, emphasis on the marine fisheries sector was on the mechanisation of indigenous crafts, introduction of mechanised fishing boats, improvements of fishing gears, establishment of infrastructure facilities such as processing plants, ice plants, cold storages, and landing and berthing facilities. These programmes, backed by the discovery of rich fishing grounds in the inshore waters, paved the way for the establishment of a seafood export industry. In the inland fisheries sector, prospects of culture of freshwater fishes, spawn and fry production received greater attention.

In the subsequent Plan periods, the above programmes were continued with greater emphasis on introduction of mechanised fishing boats and adoption of synthetic materials for the fishing gears, establishment of facilities such as landing and berthing of boats, processing, transportation and marketing. Research on various aspects of marine fisheries and exploration of their resources were intensified. Increasing demand for fish and fishery products in the foreign markets gave a fillip for the export trade. During the Fourth Five Year Plan period a beginning was made in deep-sea fishing through import of trawlers as well as their indigenous construction. A breakthrough in inland fish culture was achieved by the successful development of induced breeding and rearing techniques as well as improved methods of spawn and fry collections.

The programmes of the Fifth Five Year Plan gave further impetus to the development of the Indian fisheries, which stressed on an increased production of fish to meet the protein requirement in the Indian diet; improvement of socio-economic conditions of fishermen; and realisation of enhanced foreign exchange earnings through the export of selected marine products. Greater priority has been given for an integrated development aimed at a balanced progress of all the sectors of marine fisheries. With the declaration of an Exclusive Economic Zone of 200 miles in 1976, the programmes relating to deep-sea fishing and provision of necessary infrastructural facilities are intensified. Extension of fishing to under- and unexploited areas, diversification of fishing and fishry products, and improvement of traditional fisheries are the other core programmes of developmental strategy taken up during the period. Research and exploratory surveys on marine fishery resources are stepped up. Development of technologies of culture of selected varieties of fishes, prawns, shell fishes and seaweeds of commercial importance has formed an important activity of marine fishery research. In the inland fishery sector, projects on freshwater fish culture, composite fish culture, culture of air breathing fishes, frogs, etc. form the main activities. On the developmental side, intensive culture is being widely propagated through the formation of Fish Farmers Development Agencies and establishment of seed production centres. Simultaneously the fishing industry of the country backed by progressive increase of export of marine products has also shown considerable expansion. A number of ancillary industries such as boat building, net making, marine diesel engine manufacture, etc. are also established. The developmental measures taken up during 1947–77 thus helped the country to build up a modern fishing industry with a significant role to play in the country's economy.

India is ranked at present seventh among the fishing nations of the world as far as fish production is concerned. It is estimated that about fortyfive per cent of the total fish production in the Indian Ocean is by India. The country has a coastline of about 6500 km and an inland freshwater spread of 1.6 million hectares of impounded culturable area excluding

riverine sources. However, India is considerably behind in per capita production and consumption of fish. The current level of availability of fish for the entire population is only 4.13 kg per capita per annum, as compared to 14.9 kg in the United States of America and 20.9 kg for the United Kingdom. The national income from fisheries, as assessed by the Central Statistical Organisation is of the order of Rs. 3,610 million out of the total national income from Agriculture estimated at Rs. 2,74,760 million.

The achievements registered in the fish production from a level of 0.75 million tonnes to 2.3 million tonnes and the export earning through marine products from Rs. 25.6 million to Rs. 2,000 million during the last 25 years, is highly significant. However, when compared to the vast resources potential, it should be possible to raise substantially the level of production and export earnings. The National Commission on Agriculture has estimated that the fish production of the country could be stepped up to 8 million tonnes in the next twenty five years.

This document on "Indian Fisheries" endeavours to review briefly the progress of fisheries and cognate aspects during the last thirty years.

2

growth and present status

India's Five Year Plans are milestones in the country's economic progress for intensive and extensive use of the national resources, manpower and skill. The First Five Year Plan commenced in the fiscal year 1951–52 and at the beginning of this plan period the fish production was of the order of 0.75 million tonnes. The production increased in a phased manner culminating in the current level which is around 2.3 million tonnes. The production level at different stages of time *vis a vis* that of the financial outlays is given in Table 1.

Table 1. *Progress of fish production through the plan periods* vis a vis *financial outlays*

Financial year of plan period	Financial Outlay (Rs. in million)	Fish production (in million tonnes)
Ist Plan	51.33	0.86
IInd Plan	122.6	0.96
IIIrd Plan	282.7	1.34
IVth Plan	826.8	2.28
Vth Plan	1500.0	2.61 (estimated)

It will be interesting to compare the production level at different stages of time with that of the total World Production (Table 2).

Table 2. *Comparative statement of fish production of India* vis a vis *the world production (in million tonnes)*

	1951	1961	1971	1975
India	0.75	0.96	1.84	2.27
World	25.90	43.60	70.89	69.73

The annual growth rate in production during the ten year period ending 1961 was 2.5% only, whereas in the subsequent ten year block ending 1971, the annual growth rate has been of the order of 6.8%. However, the growth rate is only 6.1% for the period 1971-75. It may also be noted that the world fish production has increased during the corresponding first two periods at the annual growth rate of 2.2% and 5.8% whereas during 1971–75, a minus growth rate was evident. The above comparison indicates that the progress of fish production in India compares well with that of

the world as a whole. For better appreciation of the production trend in India the break-up of marine and inland fish production from 1951 to 1975 as ten-year blocks is given in Table 3.

Table 3. *Marine and Inland fish production (in million tonnes)*

Year	Marine	Inland	Total
1951	0.55	0.20	0.75
1961	0.68	0.28	0.96
1971	1.15	0.69	1.84
1975	1.42	0.85	2.27
1976	1.39	0.87	2.26

The fish availability pattern in India is typical of tropical waters. Indian fishery resource is constituted by a large variety of species of fish and shell fish. Important varieties contributing to the marine fishery are sardines, mackerel, Bombay duck, sharks and rays, perches, sciaenids, carangids, soles, ribbonfishes, white-baits, silver bellies, prawns, cuttle fishes and a variety of other fishes generally grouped as miscellaneous species. Certain other varieties of fishes such as pomfrets, seerfishes, polynemids, flying fish and the tunas and tuna-like fishes also rank as important table fishes although their quantities are not appreciable. Indian marine prawns have become important in the world market as an item of import and contribute substantially to the export earnings from marine products which have shot up to nearly Rs. 2,000 million during the current year. It is this thrust in the unit value that is becoming almost a guiding factor for bringing the Indian marine fishery programmes to the level of an organised industry.

The production of fish from inland waters has been stepped up considerably during the last decade. This was mainly due to the progress achieved in State fishery development programmes and the breakthrough in fish culture techniques and extension programmes and services. It has been projected that the current level of inland fish production of 0.85 million tonnes would be stepped upto 5.0 million tonnes in a period of 25 years through adoption of intensive fish culture in small inland water areas and planned management programmes in the natural and man-made lakes. Although the technology for augmenting fish production through culture is indigenously available, the bottle-necks preventing a real break-through are many. A far-sighted leasing policy for making available water areas to pisciculturists on a long term basis and adoption of modern technology through intensive training for fish breeding, nursery management and conservation of brood fish have been identified as areas which require immediate attention. Although fish seed is produced under natural conditions at very significant levels in the upper Indian rivers their timely utilisation to meet the country's requirements continue to call for improvements particularly in organisation of collection and distribution. A strategy for achieving self-sufficiency in fish seed availability using induced breeding techniques, and with adequate investment is being programmed, as lack of required quantities of fish seed is the most important constraint in achieving high production levels in inland fisheries. Taking the country as a whole, carps constitute 40% and cat fishes 35% of the total inland fish catch, and the rest is contributed by prawns, mullets and other miscellaneous fishes. As regards predominant States in Inland fish production, West Bengal is followed by Tamil Nadu, Andhra Pradesh, Karnataka and Bihar The cold water fisheries of trout, mirror carps, Schizothoracinae and related species form sizable fishery only in Jammu and Kashmir and Himachal Pradesh followed by the North-eastern hill States. Fresh water fishery resource potential is not fully tapped and is an area that attracted attention in the last two plan periods. The maximum inland fish catch is obtained from Asia and India ranks third in production, next only to China and the Soviet Union. The common varieties of inland fish that are cultured are catla, rohu, mrigal and other species of major carps and culture of exotic varieties and air-breathing fishes are also proving to be popular. The migratory species, *Hilsa,* forms an important fishery in the North-eastern rivers (while supporting a minor fishery at other places) and is considered no longer to be a truly anadromous variety like the European salmon.

Brackish water fish culture has shown good promise. It is hoped that extensive culture programmes would be taken by the industry in coastal areas towards the end of the current plan period availing of the technology evolved by national organisations and pilot projects and the excellent market demand for prawns and related species in domestic and export markets.

Most of the inland species, although fast growing, have problems in breeding in confined waters. Marine shoaling fishes of the Indian Seas mostly support zero–year class fisheries. The sharp fluctuations in the

environmental conditions contributed by the monsoons and unique oceanographic features of upwelling and related phenomenon have added to the burden of annual forecasts of availability of fish. This has also kept the industry shy of investing heavily on fishery projects. In addition, the traditional fishing gear being shore-based, limits fishing operations to near shore areas. The introduction of purse seines and similar types of fishing gear from crafts which could go after the fish shoals in offshore areas and employment of modern techniques for detection and estimation of availability of fish have to some extent overcome the difficulties of production means. It is only during the current Five Year Plan that India ventured on a serious attempt for offshore and deep sea fishing with the introduction of large trawlers and the creation of infrastructure facilities. A programme of training of technical manpower is under implementation by the concerned institutions, to synchronise with the fishing vessel acquisition programme so that trained manpower and fishing harbours are available when deep sea fishing vessels are procured for introduction in Indian waters. Mapping and charting of fishing grounds through exploratory surveys are being stepped up to facilitate pre-investment decisions and economic evaluation of deep sea fishing ventures which are capital-intensive. Financial assistance through Shipping Development Fund is being widely availed of by those handicapped by financial constraints and international funding and financing agencies have also shown active interest to support integrated programmes of fishery development. It may also be remembered that joint ventures in selected areas of deep sea fishing have been accepted by the Government as a guideline for the accelerated programme of exploitation of deep sea fishery resources in the Indian Economic Zone, particularly in areas where Indian expertise is inadequate. Research and survey organisations received considerable fillip in the current plan period and project oriented approach to problems have brought results more quickly and made research and training more action packed and directly aimed to meet the "users requirements". The marine products exports reached an all time high level and an integrated programme of fishing, processing and marketing has been accepted as the pattern of commmercial ventures, by the fishing industry.

3

fisheries research

The fishery research activities in the country were modest prior to 1947. It was mostly species-oriented and centred around the studies on the taxonomy of fish and descriptive natural history carried out by individual scientists working in isolated places. With the realisation of the importance of research for quicker development and rational management of fisheries, specialised research institutions were set up, and organised research activities on multiple aspects of fisheries got gradually established.

Fishery Research Institutes

Premier Institutes concerned with fisheries Research and Survey in the country are:

1. Central Marine Fisheries Research Institute (CMFRI), Cochin
2. Central Institute of Fisheries Technology (CIFT), Cochin
3. Central Inland Fisheries Research Institute (CIFRI), Barrackpore
4. Pelagic Fishery Project (PFP), Cochin
5. Integrated Fisheries Project (IFP), Cochin
6. Exploratory Fisheries Project (EFP), Bombay
7. National Institute of Oceanography (NIO), Panaji
8. Zoological Survey of India (ZSI), Calcutta

Besides these, several conventional Universities as well as the Departments of Fisheries of State Governments and recently certain Agricultural Universities also carry out research on topical or regional interest.

MARINE FISHERIES RESEARCH

Marine fisheries research in any organised scale in India was first carried out in the Madras Presidency

with the establishment of Marine Biological Stations at Krusadi, West Hill and Ennore. The studies carried out between 1908 and 1946 was mainly on the fishery and biology of mackerel, sardine, anchovies, sharks, soles; on the causes of fluctuations in pearl and chank fisheries and on marine biological aspects such as inshore plankton and hydrography.

After the establishment of the Central Marine Fisheries Research Institute in 1947, marine fisheries research was put on a sound footing. The basic objectives of the Institute have been to collect and consolidate all available marine fisheries resource data which provide the vital information for all development programmes of the Centre and States; to understand the biology of most of the commercially important species and to monitor their stock for proper management, judicious exploitation and conservation; to conduct exploratory surveys and map out the productive fishing grounds and locate new areas and resources; to carry out environmental studies in relation to fisheries and recently to evolve methods of augmenting natural resources through mariculture of suitable marine organisms.

CAPTURE FISHERIES

Marine fishery resources of the country comprise chiefly of:—

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

ii) Demersal fishery resources such as perches, sciaenids, catfishes, polynemids, flatfishes, pomfrets, eels, sharks, skates, rays, and fishes which are mainly caught by trawls;

iii) Mid water fishery resources constituted by Bombay duck, silverbellies and horse mackerel;

iv) Crustacean fishery resources consisting of prawns, shrimps, lobsters and crabs;

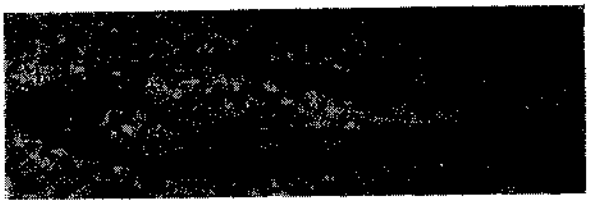
v) Molluscan fishery resources such as chank, oysters, mussels, clams, squids and cuttlefishes and

vi) Sea weed resources.

PELAGIC FISHERY RESOURCES

Oil sardine (*Sardinella longiceps*)

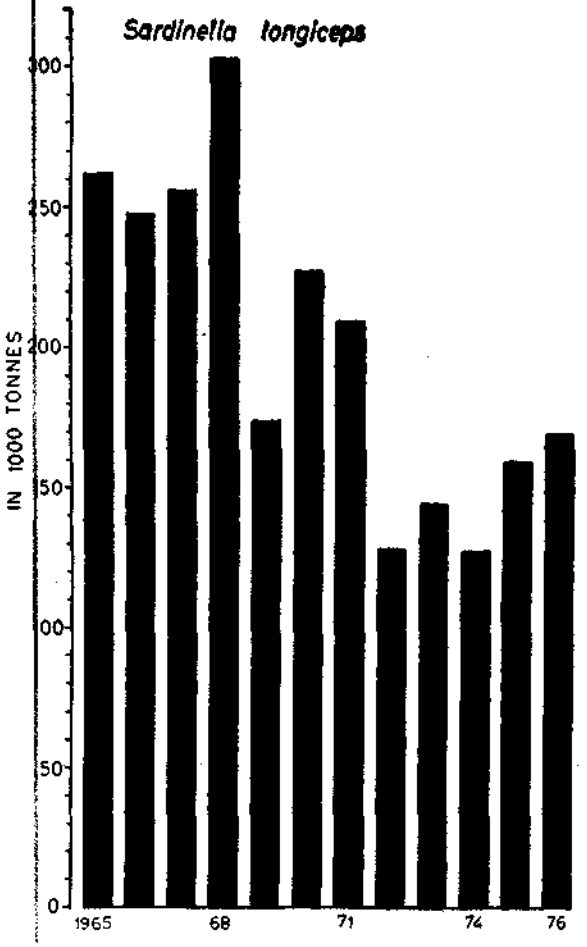
Oil sardine is the most important resource in the neritic pelagic zone off the west coast of India. The coastal areas between Quilon in Kerala and Ratnagiri in Maharashtra are the rich and traditional fishing grounds for the oil sardine; although in certain years its commercial abundance extends to other sections of the west and east coasts.



Oil Sardine *(Sardinella longiceps)*

Scientific studies made during the past three decades on the oil sardine have collected valuable information on the ecology, biology, fisheries and population characteristics, and on the resource. It is fairly clear now that the species lives in the neritic pelagic habitat and completes its life history in the area of its commercial distribution mainly off the west coast of India. Oil sardine breeds in the shelf waters off the south west coast over an extended period and area. The species has a high fecundity. The eggs are ripened and released in several batches. The main spawning, however, takes place during June-September period. Once the spawning is completed, the adult fish moves away from the inshore grounds and later appears to migrate to the southern regions. The eggs and larvae are pelagic and the eggs hatch out into larvae within a day. The larvae get transported with the prevailing current to the southern areas which form the nursery grounds. The prevailing current system in the breeding grounds thus seems to play a vital role in the spatial and temporal distribution of the oil sardine larvae. The young sardines, when they have grown to a size of 10–12 cms form into small discrete schools just prior to their migration into the inshore belt for feeding on the abundant plankton produced during the southwest monsoon period following the coastal upwelling. The food of the young and adult oil sardine consists of plankton which is abundant in the grounds. It is indicated that the areas and

periods of upwelling favour intense schooling and aggregations of oil sardine. The distribution pattern of the species appears to be similar to mackerel but with a tendency to be distributed closer to the shore.



Annual catch of oil sardine

After the monsoon, when the upwelling ceases, the oil sardine schools which are no longer restricted in their vertical distribution start to disperse and the schools move closer to the coast and become available to the shore based traditional fishery. The distribution of the stock along the coast varies, but during recent years the bulk of the biomass has been observed between 10° and 13° N.

The oil sardine during its early life grows very fast and has a longevity of 4 years. The species breeds at a size of 14-15 cm when it has completed one year's growth.

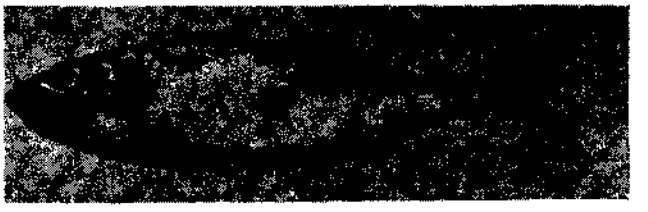
The traditional fishery is supported mainly by the fish of length range 10–16 cm comprising mostly 0-year and 1 year olds. The fishery starts immediately after the southwest monsoon and lasts from August to March with a peak during September - December period. Large shoals first appear in the southern area and strike the coast gradually in succession in the northern areas and disappear towards the end of the season in the reverse order. The fishery is restricted to a narrow coastal belt and is considered to be based on a unit stock.

The average standing stock of the oil sardine in the fishing grounds is estimated to be of the order of 400,000 tonnes. The mortality rate of the population in the fishing grounds is found to be about 80% (M = 1.12) per year, and the exploited resource forms only about 30% (F = 0.54) of the stock. Further, hardly a fraction of the spawning stock is taken by the traditional fishery. A part of the stock that is found beyond the present fishing grounds, is known to consist mainly of larger adult fish. These situations point out that considerable increase in the catches is possible by stepping up fishing pressure in the offshore grounds, employing efficient fishing methods such as pelagic trawl and purse-seining.

Large scale fluctuations in the fishery are due to fishery independent factors and the variations in the numerical strength of newly recruited year class to the fishery.

Mackerel (*Rastrelliger kanagurta*)

Rastrelliger kanagurta popularly known as the Indian mackerel, contribute to a fishery of very high magnitude in the country. Its average annual landing during 1950–76 was 69,818 tonnes varying largely

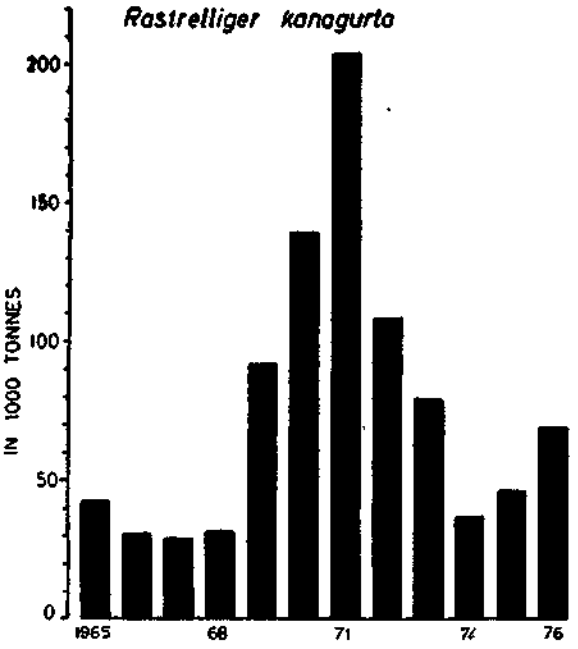


Indian Mackerel *(Rastrelliger kanagurta)*

from year to year from 16,431 tonnes in 1956 to 204,575 tonnes in 1971. On an average it accounts for about 8% of the country's marine fish landings.

Mackerel is widely distributed along the Indian coasts including Andamans. However, about 90% of the total catch is landed in the regions between Quilon and Ratnagiri along the west coast. The yield from Kerala is as high as 35%. But the fishery is of great importance in Karnataka and Goa, where it accounts for 28% and 50% respectively of the total marine fish production of these regions. The species supports a minor fishery in Tamil Nadu, Pondicherry and Andhra Pradesh along the east coast. The Indian mackerel along with the short-bodied *Rastrelliger brachysoma* forms a fishery of local importance in Andamans. A third species *Rastrelliger faughni*, is recently reported to occur off the Madras Coast.

The fish spawns in the shelf waters in the areas of its distribution, for extended periods. The individual fish releases eggs in batches. Major spawning is noticed around and during the southwest monsoon season in the west coast and during the northeast monsoon period along the east coast. Recently,



Annual catch of mackerel

the larval and post-larval stages of the mackerel have been identified and their distribution and relative abundance along the southwest coast have been charted out. The larvae and juveniles are most frequently observed between 9° and 13° N. around 30 metres depth zone. Information on the fecundity of the fish at present is very scanty.

The fish feeds mainly on zooplankton. Studies on the food and feeding habits have suggested a broad correlation between the abundance of food in the sea and availability of the shoals in the fishing grounds during the post-monsoon months.

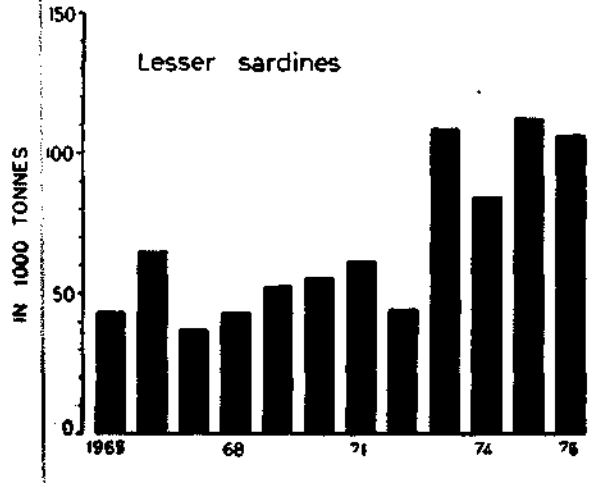
The fishing season on the west coast begins in July-August and ends by April, the peak season being November-December. It starts early in the south and lasts longer than in the north where it commences late and closes early. The fishery is sustained by immature fish, mostly 16 to 20 cm in size believed to be mostly of 0-year class fish. As the stock consists mainly of a single year class it is susceptible to large variations in recruitment and mortality. This explains to a great extent the wide annual fluctuations in the stock size.

The aerial and acoustic surveys carried out along the southwest coast have indicated an average stock size of about 280,000 tonnes and confirmed their offshore occurrence particularly between 24 and 72 metres. A considerable portion of the stock, particularly the juveniles, migrate to inshore waters after the southwest monsoon while much of the adults remain offshore. The total mortality of the stock in the fishing grounds is found to be about 90%. Studies on the exploited fishery resources indicate that the scope for further increase of production in the coastal grounds employing traditional non-mechanised fishing operations during the conventional season is just marginal. But the offshore resource at present is almost unexploited. The stray catches of larger size mackerel from the deeper waters along the Maharashtra Coast points to the availability of mackerel resource in a wide area in the sea. Further, the mackerel resource in the Andamans also remains at present underexploited. Information on the resource potential of the oceanic species, *Rastrelliger faughni* is scanty. Thus, there is great scope for intensive research on resources aspects of mackerels and their exploitation in the offshore areas by employing suitable fishing techniques such as purse-seining.

Lesser sardines

Lesser sardine (*Sardinella* spp.) catches come almost entirely from Andhra Pradesh (20%), Tamil

Nadu (28%) and Kerala (36%). The annual yield varies between 50 and 90 thousand tonnes forming about 6% of the total marine fish catch. *Sardinella gibbosa, S. fimbriata, S. albella* and *S. sirm* are the commercially important species. The other species are *S. dayi, S. clupeoides, S. sindensis* and *S. melanura. S. gibbosa* occurs singly or along with *S. albella* or *S. fimbriata*. Similarly, *S. sirm* usually occurs along with *S. clupeoides*. The lesser sardine fishery, which is restricted to the inshore waters, within 25 km from the



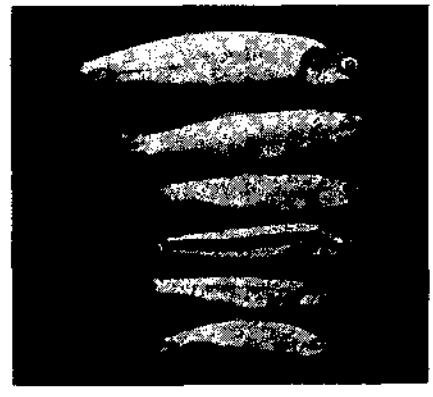
Annual catch of lesser sardines

shore, is mainly supported by o-year class fish. The fishery lasts from October to April. The catchs are usually heavy during the dark phase of the moon. *S. gibbosa, S. albella* and *S. fimbriata* have more or less the same rate of growth reaching about 120-130 mm total length at the end of one year of life, and also have a similar length of about 110 mm at the time of attaining sexual maturity. Though the overall spawning period of each species appears to extend from December to August, it is relatively brief in the different sections of the coast. March-June is the main spawning period for the foregoing three species. Each individual fish spawns once during a season. *S. sirm* on the other hand, attains 170 - 180 mm length at the end of first year of life and has the spawning season spread almost throughout the year. An individual fish seems to spawn more than once during a season in the nishore waters. Gulf of Mannar has been found to be a good spawning ground. Early life history of *S. gibbosa* and *S. sirm* has been described. The lesser sardines have similar food preferences, zooplankton (copepods) being the most dominant food item.

Some aspects of the biology of the sardine, *Herklotsichthys punctatus*, an important clupeoid around Andamans and of the white sardine, *Escaulosa thoracata* have also been investigated.

Anchovies

Species of *Stolephorus, Thryssa, Thryssina, Setipinna* and *Coilia* constitute the anchovy fisheries of the country. The average annual catch of anchovies is about 48,000 tonnes. *Stolephorus* spp. popularly known as white-baits, are the most important among them with annual average catch of 34,000 tonnes and accounts for 70% of the total anchovy catch. At present, the catch of this fish is obtained almost entirely from Andhra Pradesh (18%) Tamil Nadu (32%) and Kerala (44%). *Stolephorus heterolobus, S. devisi* and *S. bataviensis* form the bulk of white-bait catch. They occur in the catches either singly or together. *S. buccaneeri* and *S. indicus* are the two next important species occasionally contributing to very good catches. *S. andhraensis, S. macrops, S. commersonii* and *S. tri* are also recorded in the catches.

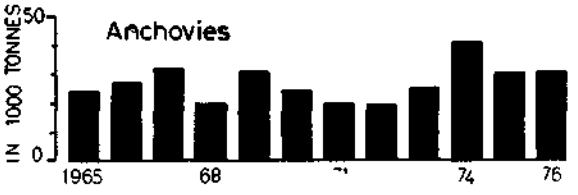


Anchovies

The present trend of exploitation indicates that over 70% of the white-bait catch along the southern half of the west coast comes from the region between Cape Comorin and Quilon. The white-bait stock north of Quilon is usually located between 8 - 32 km from the shore, while in the south, they are frequently found quite near the coast. White-baits exhibit typical diurnal vertical migrations, and occur mostly in areas with bottom depths between 20 and 50 m. They also exhibit seasonal movements along the west coast. Moving southward around April/May, they accumulate in the Gulf of Mannar during August/

September, after which they disperse along the southwest coast. Highest proportion of their stock is found in the area between Quilon and Mangalore during November/December.

The fishery seasons are during June-July and October-November along the southwest coast, from May to November along Tamil Nadu and November to April along the Andhra Coast.



Annual catch of anchovies

The fishery is constituted mainly by 0-year class fish, the mean age being 0.5 year. They also spawn at this age. White-baits are multiple spawners and have an extended period of spawning lasting from November to July. They spawn over a wide area on the inner continental shelf. White-baits feed mainly on zooplankton. The distribution of the white-baits schools generally coincide with the high density areas of plankton.

The average annual standing stock of anchovies may be around 376,000 tonnes. Estimates as high as 809,000 tonnes are also on record. In fact, white bait stock has been estimated to contribute to about 35% of the total fish biomass along the southwest coast extending upto Ratnagiri.

The bionomics of other anchovies such as *Thrissina baelama, Thryssa hamiltonii, T. purava, T. mystax, Coilia dussumieri, C. ramacarti, Setipinna phasa*, and *S. taty* which account for about 1% of the annual marine fish catch have also been studied.

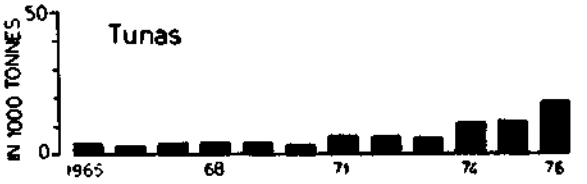
Other clupeoids

Among the other clupeoid fishes, the bionomics of *Hilsa ilisha* have been studied in great detail. Recently, success has been achieved in the artificial fecundation of this species. Hatchings thus produced and reared in tanks lived for more than 2 years exhibiting normal growth.

The bionomics of the rainbow sardine, (*Dussumieria acuta*) and of the two species of wolf-herrings of the Palk Bay and the Gulf of Mannar have been studied. Contrary to what has been believed earlier, the wolf herring fishery of the Palk Bay and the Gulf of Mannar is supported mainly by *Chirocentrus nudus* Swainson; the other well-known species *C. dorab* (Forskal) accounting for only 20% of the catches. The gulf of Mannar area has been found to be the spawning ground for both the species.

Tunas and billfishes

The average annual catch of tunas in India has been 4,000 tonnes during 1960's, but in the recent past the catches have shown signs of improvement. In 1976, the tuna landing of the country has been estimated at 20,000 tonnes. Excepting in Lakshadweep islands where the oceanic skipjack (*Katsuwonus pelamis*) and the yellowfin tuna, *Thunnus albacares* are fished in considerable quantities, there is no organised tuna fishery in India. The species such as the frigate mackerel (*Auxis thazard* and *A. rochei*), the bonito (*Sarda orientalis*), the little tunny (*Euthynnus affinis*), and the northern bluefin (*Thunnus tonggol*) are obtained from coastal waters in gears operated for other species. Kerala accounts for about 50% of tuna catches in India.



Annual catch of tunas

The tuna and tuna live bait fishery in the Minicoy, have been surveyed. Accounts of eggs, larvae and juveniles of tunas and related groups from Indian Seas have been given. The food and feeding and other aspects of biology of *E. affinis* have been studied. A comprehensive review of the helminth and copepod parasites of scombroid fishes has been carried out. Oceanographic parameters such as thermocline, areas of seasonal upwelling, convergence and divergence zones of the southwest coast and the southeast of Minicoy, primary and secondary production relating to tuna ecology have been studied.

Seerfishes

The average annual catch of seer fishes is about 15,000 tonnes which represent about 1% of the total marine fish landings of the country. Three species, namely, *Scomberomorus commerson, S. guttatus* and

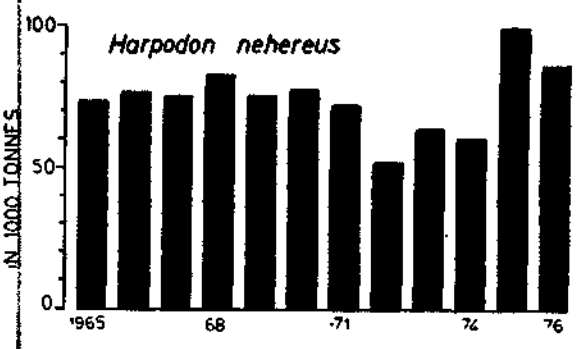
Annual catch of Seerfishes

S. lineolatus contribute to the fishery. The fishing season extends from October to March. The seer fishes are mainly caught in drift nets and by hooks and lines. *S. commerson* attains a length of one metre or more.

Mid Water Fishery Resources

Bombay duck

The Bombay duck, popularly known as "Bombil" is supported by a single species, *Harpodon nehereus* (Ham). It has a wide but discontinuous distribution along the east coast of Africa, the Indian subcontinent, Malaya, Indonesia and China. Saurashtra Coast in Gujarat and the Konkan Coast of Maharashtra, account for about 90% of the Bombay duck landings. The remaining 10% is caught in Andhra, Orissa and Bengal.



Annual catch of Bombay duck

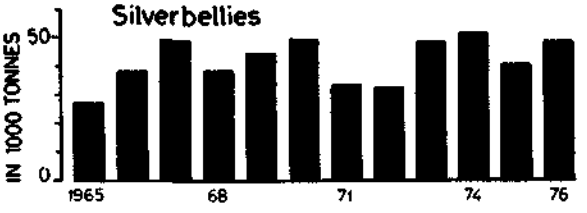
The fishing methods are as varied as its distribution. On the Maharashtra and Saurashtra Coasts it is exclusively caught in the bag net ("Dol"). The fishing operations are carried up to a depth of 40 m. In Bengal and Orissa also bag nets are in vogue, while in Andhra, seines are the principal gears.

The catch of the Bombay duck fluctuated from about 15,000 tonnes in 1950 to about 100,000 tonnes in 1955. The catch touched a new high in 1960 with a landing of about 108,000 tonnes. It is showing a declining trend since then.

H. nehereus attains maturity at about 210 mm when it is at the end of the first year of its life. It spawns almost throughout the year with two peaks in October-November and March-April. The commercial fishery is mainly supported by the 0-year class. The declining trend of catch, catch per unit of effort, average size of the fish and capture of high percentage of juveniles during the last fifteen years indicate overfishing of the Bombay duck along the north-west coast.

Silverbellies

Silver bellies belonging to the genera *Leiognathus* and *Gazza* contribute to 4 to 5% of the total annual marine fish catches. These small fishes form good

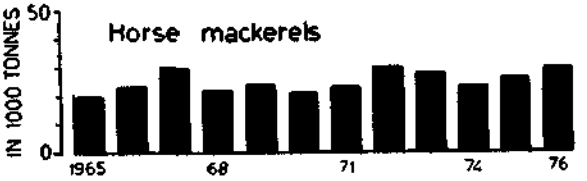


Annual catch of Silverbellies

raw material for the fish meal plants, fish protein concentrate and other fish products. They are generally included in the category of 'trash fish'. The catches comprise mostly of fish less than one year old (0-group); their life span seems to be less than two years.

Horse mackerels

This group of fishes include mainly *Megalaspis cordyla* and few other carangids and they occur all

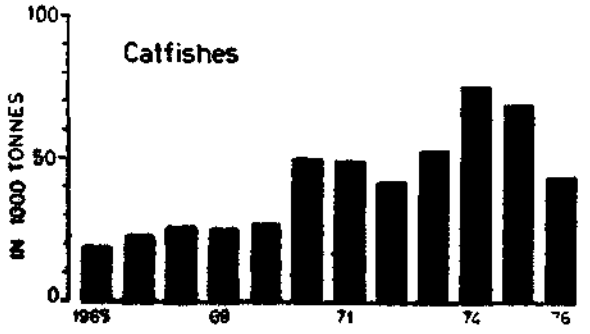


Annual catch of Horse mackerels

along the Indian Coast, forming annually about 2% of the total marine fish landings. They seem to breed almost throughout the year.

Demersal Fisheries

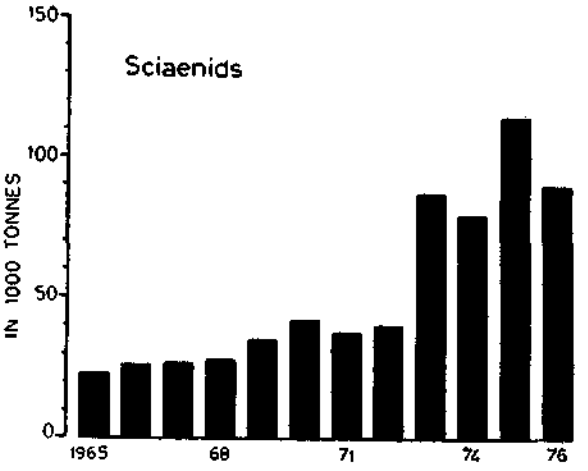
Though the traditional fishing in the country employed some indigenous gear that took in coastal demersal fishes, exploitation of demersal resources in a significant way is relatively recent. Attempts at trawling the offshore regions were first made by the turn of the century with fishing vessels like 'Golden Crown' (1908–11) in the northern Bay of Bengal, 'William Carrick' (1921–22) in Bombay waters, 'Violet' (1907), 'Lilla' (1920–23) and 'Nautilus' (1924–30) in the Wadge Bank area, and 'Lady Goschen' (1927–30) along the southwest and southeast coasts. The operation of these, and a few other vessels in the early decades were intermittant and systematic trawling of offshore grounds started only by the late forties by the exploratory fishing vessels belonging to the Government of India Organisations.



Annual catch of Catfishes

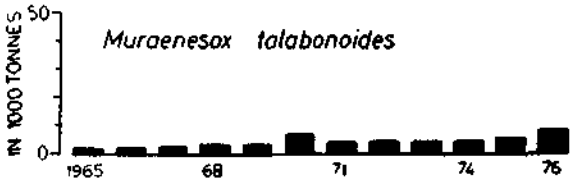
As a result of the above surveys, the demersal fishes and their resource in the grounds upto about 50 m depth have been fairly well studied and documented. The northwest region, consisting of the Bombay, Cambay, Veraval, Porbunder,Dwaraka and Kutch areas, has the most extensive shelf area (about 200,000 km²) and an abundance of such quality fish as Ghol, (*Pseudosciaena diacanthus*), Dara (*Polydactylus indicus*), Koth (*Otolithoides brunneus*), Karkara (*Pomadaysis hasta*) and a fair abundance of prawns in some areas. The yield and catch rates are high almost throughout the year, except for the third quarter when effort is low on account of the monsoon. Generally, better ghol grounds were found off Kutch, Porbunder, and Dwaraka; Dara and Koth off Dwaraka and Kutch; Karkara off Kutch, Dwaraka and Porbunder; eel in Cambay and off Veraval; garfish off Kutch and Porbunder and Prawns in Cambay and off Bombay.

In the southwest region the narrowness of shelf (about 43,000 km²) restricts trawling operations as compared to the north-west region. The existence of good fishing grounds in the Wadge Bank area is traditionally known to the fishermen of Kerala, Tamil



Annual catch of Sciaenids

Nadu and Sri Lanka. Rich prawn grounds are also located in this area in the inshore region. Recent exploratory surveys have indicated potentially rich fishing grounds for deep-sea prawns and deep-sea lobsters beyond the continental shelf edge, and for

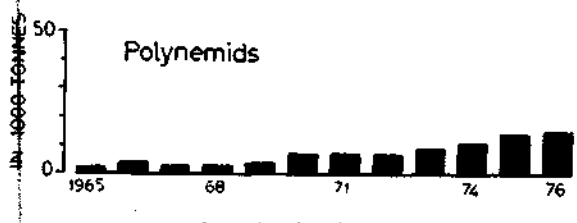


Annual catch of eel 'wam'

'Kalava' (*Epinephelus spp.* and *Pristipomoides* spp.) in the rocky areas of the shelf at 70–100 m depth off Kerala. Depth-wise, the littoral prawns occur mainly upto 30 m and decline thereafter, while fish are least upto about 15 m and increase beyond. Nemipterids form a significant resource in the 40–100 m areas.

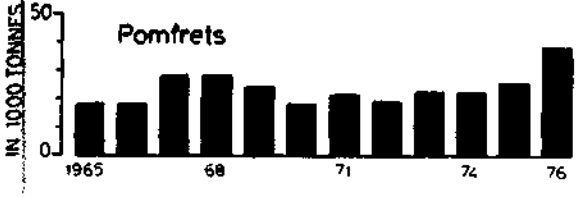
On the east coast, the trawling grounds are in general less extensive and quality fish too are less abundant. In the southeast region (about 64000 km²) the Pedro Bank area in the Palk Bay has been the traditional fishing grounds for fishermen from the

Tanjore Coast. Good trawling grounds have been indicated at Point Calimere, Nagapatnam, Tranquebar, Porto Novo, Cuddalore, Pondicherry and Madras; potentially good shark fishing grounds off Point



Annual catch of Polynemids

Calimere to Cuddalore: perch grounds from Point Calimere to Pondicherry and horse-mackerel from Pondicherry to Madras. The Palk Bay - Gulf of Manpar region has been found to be very productive for low quality fish like silver bellies which are dried



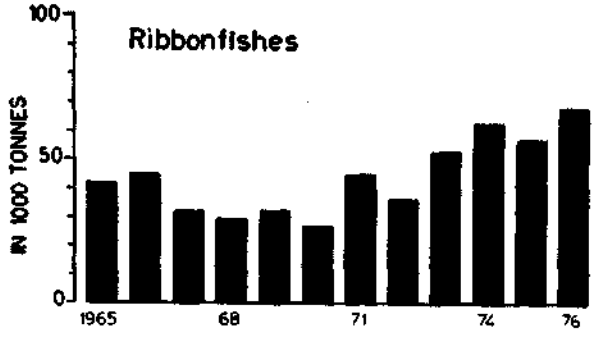
Annual catch of Pomfrets

or utilised for manufacture of fish meal. Recent explorations off Andhra Coast have given encouraging results particularly for the exploitation of prawns. In this region generally, fish catches give higher yield

Ribbon fish

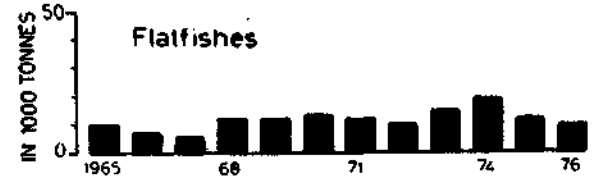
rates from the shallow (less than 50 m) areas in April-June and October-December, and from deeper areas in July-September.

In the northeast region off Orissa and West Bengal (46,000 sq. km) fishing was traditionally done in areas of tidal influence and the shelf was mostly unexploited.



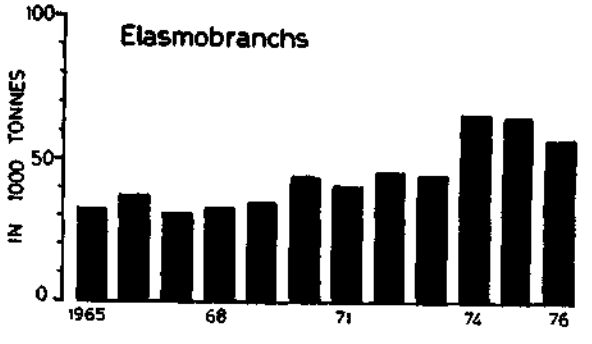
Annual catch of Ribbonfishes

The exploratory surveys have, however, revealed important grounds located off western and eastern channels, Sand Heads, Tiger Point, Baitarani, Debi, and Prachi River mouths, Black Pogada, Puri, Chilka



Annual catch of flatfishes

and Gopalpur. The "Swatch of no grounds" has been found to be good for quality fish. Areas off Chilka Lake and Kalingapatnam and some areas in the north Bay of Bengal have been found to be relatively rich grounds for commercial trawling. Quality fish

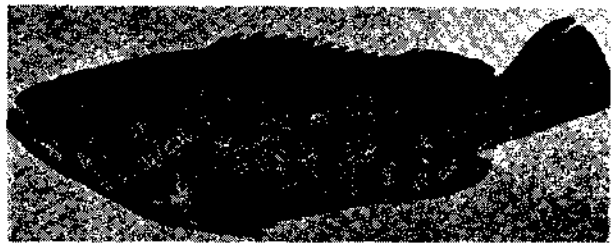


Annual catch of Elasmobranchs

like pomfrets, pomadasyds and prawns occur mainly in 10–30 m depth, others like sciaenids, clupeids,

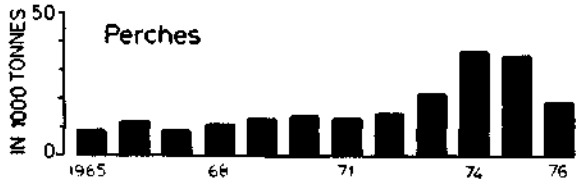
silverbellies, nemipterids, and carangids at 30–50 m and elasmobranchs, catfishes, etc. at 50 to 70 m depth.

Among the demersal fishes, perches contribute to 1.5 - 2%, sciaenids 4%, polynemids 0.7%, flatfishes



Perch

2%, catfishes 5%, and elasmobranchs 4% of the total marine fish catch of the country. Fishery and biology



Annual catch of perches

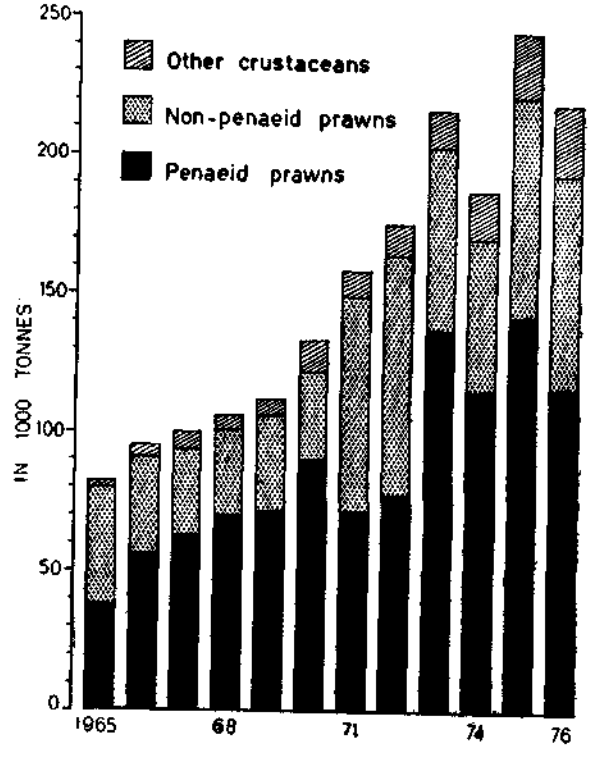
of the more important species such as *Nemipterus japonicus, Lactarius lactarius, Pomadyasis hasta, Pseudosciaena diacanthus, Polydactylus indicus, Cynoglossus macrostomus, Tachysurus thalassinus, T. tenuipinis, Pampus chinensis, P. argentius, Parastromateus niger, Muraenesox talabonoides, Scoliodon sorrakowah, Loxodon macrorhinus, Rhizoprionodon oligolinx, R. acutus* and *Himantura alcokii* have been investigated.

Crustacean Fisheries

Several species of prawns, shrimps, lobsters and crabs inhabiting different ecosystems such as seas, estuaries brackish-waters, creeks, lakes, rivers and canals contribute to the Crustacean fisheries of India.

Prawns and shrimps

Among the crustaceans, prawns and shrimps are the more important as they command a high price and have a great demand in the export market. About 52 species of prawns and shrimps that are either commercially exploited at present or have great commercial potentialities occur in the Indian waters. These belong to the families Sergestidae, Penaeidae, Palaemonidae, Oplophoridae Hippolytidae, Pandalidae and Atyidae. By intensive taxonomic studies, the identity and synonyms of these species have been well established and adequate background information for future studies has been made available. Most of the species exhibit wide geographical distribution in our waters as well as in the entire Indo-Pacific region. Bathymetrically, most of the prawns supporting the commercial fishery in the marine region are largely confined to the inner half of the continental shelf. However, depending on the productivity of the fishing grounds, physico-chemical changes in the ecosystem and movement of prawns, the abundance within this depth zone is found to vary in space and time.



Annual catch of crustaceans

The biological investigations carried out so far relate to age and growth, food and feeding habits, maturation and spawning, larval biology, mortality rate and some aspects of movements of the important commercial penaeid prawns (*Penaeus indicus*, H. Milne Edwards, *P. monodon* Fabricius, *P. semisulcatus* de Haan, *P. merguiensis* de Man, *Metapenaeus dobsoni*

(Miers), *M. monoceros* (Fabricius), *M. affinis* (H. Milne Edwards), *M. brevicornis* (H. Milne Edwards), *M. kutchensis* George, George and Rao, *Parapenaeopsis stylifera* (H. Milne Edwards), *P. sculptilis* (Heller), *P. hardwickii* (Miers) and *Solenocera crassicornis* (H. Milne Edwards) and some palaemonid prawns *Palaemon styliferus* (H. Milne Edwards), *P. tenuipes* (Henderson), *Hippolysmata ensirostris* Kemp, *Macrobrachium rosenbergii* (de Man), and *M. malcolmsonii* (H. Milne Edwards). A review of these studies shows that the littoral penaeid prawns of the Indian Coast have many similarities in their life history. This is particularly evident in species like *M. dobsoni, M. monoceros, M. affinis* and *P. indicus* that breed and spend their adulthood in the sea and juvenile stages in the coastal estuarine regions. *P. stylifera,* however, spends its entire life cycle in the marine habitat. All these prawns usually breed at some distance from the shore, but the peak spawning seasons vary from place to place. The early larval development also takes place in the sea. The distribution of larval stages in the inshore waters normally depends on the prevailing coastal currents to which they are subjected in the open seas. The location of spawning of adults and their inshore and offshore movements also affect the larval distribution. As the larvae develop they start moving towards the shore and on attaining the postlarval stage they reach the shallow coastal waters and estuarine nursery grounds where they assume a demersal existence.

After settling down to the bottom habitat, they grow fast feeding on plant materials, small animals and detritus available in the nursery grounds. They remain in this ecosystem for some time which varies from species to species. During this period of growth, they attain all the adult features including the secondary sexual characters, but do not breed there. This biological trait explains the return migration of prawns into the sea. In the sea, the prawns grow at a relatively slower rate and this retardation of growth rate is due to reproductive stress. From the observed growth rate, it is estimated that the species like *M. dobsoni, P. stylifera* and *P. indicus* live for two years, while the other species, *M. monoceros* and *M. affinis* have a slightly longer life span. Thus, while each of the species has its own biological characteristics, features such as their capacity to produce large number of eggs, protracted breeding season, spawning in the less exploited offshore areas, faster growth, short life span and the ability to withstand wide variations in the environmental conditions play an important role in maintaining their population and in the continued success of the prawn fishery of the country.

Some aspects of the physiology of the penaeid prawns, such as the rate of metabolism of *P. indicus;* osmoregulatory ability and food conversion efficiency of *M. monoceros* have been studied.

As regards the biology of the fresh water prawns, information on breeding grounds and seasons, nursery grounds, age and growth, food and feeding habits, reproduction and larval development is available in some detail, particularly for *M. rosenbergii* and *M. malcolmsonii.*

In India, prawns and shrimps are commercially exploited from all the three major aquatic environments, namely sea, estuary and fresh water. In the marine realm, they are caught all along the coast from the inshore waters by the indigenous as well as mechanised fishing vessels. The extensive estuarine systems of rivers like the Ganga, Mahanadi, Godavary, Krishna and Cauvery, and the brackish water areas like Chilka, Pulicat and the Vembanad lake support rich fishery for juvenile prawns. Fresh water prawn fisheries exist mainly in the peninsular rivers flowing into the Bay of Bengal, rivers of Maharashtra and the Pampa river system in Kerala.

The average annual marine prawn production of the country during the past ten year period (1966-1975) has been of the order of 1,35,242 tonnes, forming 13% of the total marine fish production. Penaeid prawns contribute to about 62% of the total prawn landings. The fishery is supported by multiple species that co-exist in the fishing grounds and is characterised by wide seasonal and annual fluctuations in abundance. Most of the commercial penaeid prawns are subjected to exploitation in the juvenile phase in the sea. The State of Maharashtra ranks first (47.5%) in prawn production followed by Kerala (30.7%), Andhra Pradesh (5.5%), Tamil Nadu (4.6%), Gujarat (4.1%), Karnataka (3.8%), West Bengal and Orissa (3.1%). However, the prawn catch of Maharashtra is chiefly composed of non-penaeid prawns. The highest catch of penaeid prawns is obtained from Kerala. In recent years, there has been significant increase in the penaeid prawn landings in all the east coast States.

In the All-India prawn landings, *P. indicus* contributes to about 8%, *P. monodon* 1%, *M. dobsoni* 28%, *M. affinis* 11%, *M. monoceros* 3%, *M. brevicornis* 2.5%, *P. stylifera* 28%, *P. sculptilis* 1.3%, *P. hardwickii* 2.5%, *S. crassicornis* 0.9%, *P. tenuipes* 3%, *P. styliferus* 0.6%, *H. ensirostris* 0.9%, *Acetes* spp. 3% and other miscellaneous prawns 6.3%.

Recent exploratory surveys carried out along the continental shelf edge and slope of the southwest and southeast coasts have located potentially rich fishing grounds for deepwater prawns. These grounds on the southwest coast are about 5000 km² in extent and the potential prawn resources of the area is estimated to be about 5300 tonnes per year. The average catch rate recorded is 120.3 kg/hr. Commercially important species encountered in the catches are *Aristeus semidentatus, Solenocera hextii, Penaeopsis rectacuta, Metapenaeopsis andamanensis, M. philippi, Parapandalus spinipes, Plesionika martia, Heterocarpus woodmasoni* and *H. gibbosus.* Certain aspects of the biology and fishery of these prawns have been studied.

Prawn and prawn products form the most important commodity in the export trade of marine products from the country. With progressive increase over the years, the export of this commodity in 1976 reached a figure of 48,090 tonnes valued at 1610.8 millions rupees which represent 77% of the total export of marine products in weight and 89.6% in terms of value. A variety of products like frozen prawns, canned prawns, dried prawns, prawn powder, prawn pickle, etc are exported to over 50 countries in the world.

Lobsters

The lobster fauna of India includes species belonging to the families Eryonidae, Nephropsidae, Scyllaridae and Palinuridae. Eighteen species representing nine genera in family Palinuridae have been reported from the Indian Ocean region. Among Scyllaridae 20 species comprising five genera also occur in the same region. The families of Nephropsidae and Eryonidae are represented by about 7 and 10 species respectively.

The lobster fishery of India is supported by 6 specie of shallow water spiny rock lobsters belonging to the genus *Panulirus,* namely, *P. homarus, P. polyphagus, P. ornatus, P. penicillatus, P. versicolor* and *P. longipes,* and one species, *Thenus orientalis,* belonging to the family scyllaridae. Of these, three species (*P. homarus, P. polyphagus* and *P. ornatus*) are commercially exploited. The annual catch of lobsters in 1976 was 6,233 tonnes realised mainly from Gujarat, Maharashtra and Tamil Nadu. The export of frozen lobster tails during the same year was of the order of 513 tonnes valued at 31.8 million rupees.

Some aspects of the biology and fishery of *P. homarus* have been studied. The species breeds during November-December in Kanyakumari District where the fishery for the species is most prevalent. Tagging experiments conducted with suture tags have shown that the movement of the species in the fishing grounds is of a restricted nature and it grows very fast attaining the commercial size by the end of first year after the puerulus stage settles down in the fishing grounds. The size attained at successive ages has been estimated and the commercial fishery is largely supported by one and two years old lobsters.

Extensive studies on the phyllosoma larvae occurring in the Indian Ocean region and their distribution pattern have been carried out. Detailed description of the anatomy and the organ systems and information on chemical constituents, ash content, trace elements, natural radio active nucleids and amino-acids of *P. polyphagus* are available. Some data on the prephenolosidase properties of *P. homarus* are also available.

Recently, the exploratory trawling conducted along the continental shelf edge and slope off the southwest coast and Gulf of Mannar has revealed large concentrations of the deep-sea spiny lobster, *Puerulus sewelli,* at depths between 160–360 m. Another deep-sea lobster, *Palinustus mossambicus* was also caught in fairly good numbers from certain localities along the southwest coast. Distribution and seasonal abundance of *P. sewelli* in the fishing grounds on the continental slope of the southwest coast have been studied. From 1969 onwards the species is regularly exploited by the trawlers belonging to the Government of India.

Crabs

Faunistic investigations carried out from 1890 have revealed that about 560 species of crabs occur

in the Indian region. Of these, only 8 species, namely *Portunus pelagicus, P. sanguinolentus, Scylla serrata, Charybdis (Charybdis) feriatus, C. (C). annulata, C. (C). natator, Matuta lunaris* and *Varuna littorata* support localised fishery of some importance in the marine and brackish water regions. Insignificant quantities of the fresh water crab, *Paratelphusa* spp. are also captured in some of the Inland States where it forms the food of local inhabitants.

Studies on the biology of edible crabs are restricteg to certain aspects of the growth, food and feedind, reproduction and effect of parasites, but many of the observations are inconclusive. The morphology and anatomy of *P. sanguinolentus* are well documented. Recently investigations on the physiology relating to endocrine control of pigmentation, reproduction, histological and histo-chemical aspects of reproductive organs of certain crabs have been undertaken.

Available information on various aspects of the fishery shows that the fishing is restricted to the inshore areas mostly by the operation of indigenous crafts and gears. In most of the places crabs form an ancillary catch along with other crustaceans and fishes. The annual catch which amounted to 18,177 tonnes in 1976, is subject to marked fluctuations. The catches are largely obtained from the central Maharashtra, Karnataka and southern Tamil Nadu Coasts. Estimated potential resources of crabs in the inshore waters up to 40 metres depth and in the brackish water areas is found to be about 44,000 tonnes. In addition to this, recent exploratory surveys conducted in the Indian Ocean have brought to light the existence of deep water crab, *Charybdis (Goniohellenus) edwardsi* in large quantities.

Molluscan Fisheries

The molluscs form one of the less exploited resources of our waters. Researches carried out on this group mainly relate to the study of the specific identity of commercially important molluscs and identification of the areas of abundance; investigations on the fish and fisheries in selected centres; observations on the biology, reproduction and development of some important species and preliminary observations on the potentialities of certain areas and water masses. The species involved in detailed biological and fisheries studies are *Meretrix casta, M. meretrix, M. casta ovum, Villorita cyprinoides, Paphia malabarica, Katelysia opima, Donax cuneatus, D. faba, Solen kempi,* (all clams); *Crassostrea madrasensis, C. gryphoides, C. discoidea, C. cucullata* (all edible oysters); and *Perna viridis P.* sp. (green and brown mussel); *Sepia aculeata, Sepioteuthi sarctipinnis, Loligo duvauceli* (all cephalopods) and *Pinctada fucata* (pearl oyster), *Xancus pyrum* (chank). Extensive explorations of the molluscan grounds in the Gulf of Mannar have been carried out by aqua lung diving operations. Considerable information on the wood boring molluscs which are of industrial significance is also collected. The shell fisheries of Andaman and the Lakshadweep have been investigated. Although reliable statistics on the landings of molluscs from the country are not available.

Ecology of mangrove swamps

In India extensive mangrove forests and swamps occur in deltas of various rivers, estuaries, bays, islands and other sheltered areas. Virtually unexplored mangrove forests occur among Coromandel Coast, Sunderbans, Gulf of Cambay, north Kanara and Kerala Coasts. In recent years ecology of mangrove swamps in selected areas have been studied. Mangrove vegetation, resident and migratory fauna have been surveyed. Mangrove areas are very productive and offer shelter to juveniles of many species of fishes, prawns, crabs and other fauna. Investigations on mangrove swamps are of importance as they could be utilised for culture of edible oysters, prawns and certain fishes. Mangrove areas serve also as barriers against coastal erosion.

Ancillary Resources

Sponges

About 305 species of marine sponges have been recorded from India. Of these, the species *Spongia officianalis* var *ceylonensis* Dendy is commercially important. It is widely distributed in the shallow waters of the Gulf of Mannar, Palk Bay and the Arabian Sea and grows to a size of 30 cm in diametre generally a hemispherical shape. Its size, shape, colour, resistence, absorptiveness, durability, etc. are similar to those of other commercial species of sponges. Preliminary experiments conducted on the culture of this species have indicated the possibility of their culture on a large scale. A detailed study on the taxonomy and distribution of sponges has been undertaken.

Corals

Corals form one of the important organisms of considerable commercial value. In the seas around India, coral formations are found in the Gulf of Kutch, in Andaman Nicobar islands, Palk Bay and Gulf of Mannar (fringing reefs) in the Laccadive Archipelago (atolls) and in scattered areas along the continental shelf. Extensive investigations on the corals of the Palk Bay and Gulf of Mannar have been undertaken. Studies are also carried out on the ecosystem of the coral reef and productivity of the coral reefs and atolls.

The most important commercially valuable corals of the Indian Coasts are the Scleractinias. They form a major source of calcium carbonate and are used in the preparation of Calcium carbide, lime and cement, besides as building blocks and in the constructions of roads. Other economically important corals belong to *Heliopora, Tubipora,* gorgonids and *Antipatharia.*

Large scale quarrying of corals is undertaken at present in the Gulf of Mannar and Palk Bay region. Unrestricted destruction of the coral beds is adversely affecting the general fishery of the area as well as the reef dewelling animals. In order to protect the coral reefs of the Gulf of Mannar from human interference and to save some of the endangered marine species such as dugong (*Dugon dugon*), green turtles and other marine turtles which nest in the sandy beaches, it is proposed to establish a National Marine Park in the area. The proposal when implemented would not only help to conserve the marine ecosystem of the area, but also to utilise the experience gained to extend the concept to other areas such as Andaman-Nicobar Islands and the Lakshadweep.

Echinoderms

Comprehensive investigation on the taxonomy and distribution of echinoderms of India, particularly of the southeast coast have been undertaken. Although several echinoderms have economic importance, holothurians belonging to the families Holothuridae and Stichopodidae are commercially exploited, processed and exported as *Beche-de-mer.* At present over 68,000 kg of *Beche-de-mer* is exported from India to Hong-kong, Singapore and Sri Lanka. Holothurians occur in large numbers in the Gulf of Kutch and along the southwest coast. They are collected by divers in 3–12 m depth from February to September. They are also caught in appreciable numbers in trawls. *Holothuria scabra* is the species widely used in the country for the preparation of *Beche-de-mer.*

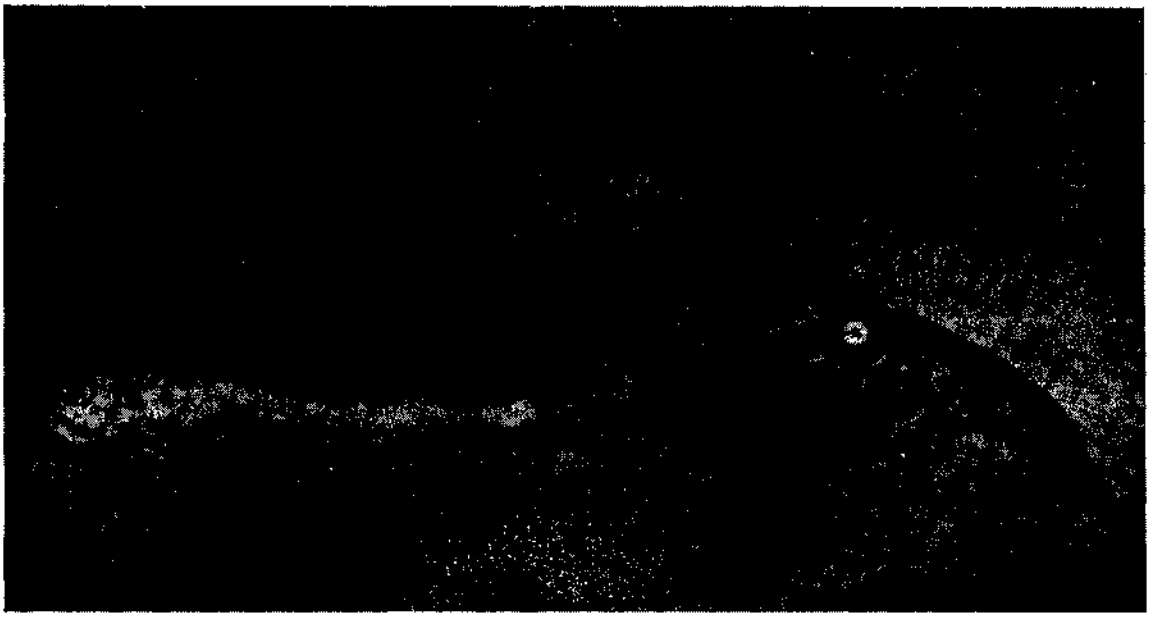
SEAWEEDS

Although there are no detailed systematic accounts for the identification of commercially valuable seaweeds, considerable work has been done on the taxonomy of the Indian marine algae during the last 40 years. Research on various aspects of commercially important seaweeds such as their identity, growth, reproduction and seasonal changes in chemical composition has been carried out in India. The distribution, rate of growth, life history, fruiting cycle, ecological conditions, mineral constituents, seasonal changes in mannitol, algin and agar contents of a number of commercially important green, brown and red algae like *Ulva* spp., *Dictyota* sp., *Padina* sp., *Sargassum* spp., *Turbinaria* spp., *Gracillaria edulis* and *Gelidiella acerosa* have been studied.

Recently as part of the programme on estimation and resources survey of the available sea weed resources in different regions, a comprehensive survey of the seaweeds of Tamil Nadu Coast has been conducted. The survey indicates that there are vast resources in the intertidal zone in the Gulf of Mannar, Palk Bay and the rocky regions between Rameswaram and Colachel. The density of distribution of the total algae is on an average 1 tonne per ha. Of these agarophytes form 10% of the total in the Gulf of Mannar and 40% in the Palk Bay. The alginophytes form the dominant component contributing 42% in the Gulf of Mannar, 51% in the islands and 34% in the Palk Bay. The most productive depth zones are between 0–1.25 m for agarophytes and 0–3 m for alginophytes. The total yield from an area of 15,000 ha has been found to be 6,000 tonnes of alginophytes and 1000 tonnes of agarophytes. Besides, rich beds are found in Gujarat (Okha, Dwaraka, etc.) Lakshadweep and Andaman and Nicobar Islands. Recent survey report from Gulf of Kutch indicates that about 4000 tonnes of fresh *Sargassum* can be harvested from this area.

A technique for the extraction of agar-agar from *Gracilaria edulis* without using either freezing or other costly equipments to purify the agar at the jel stage has

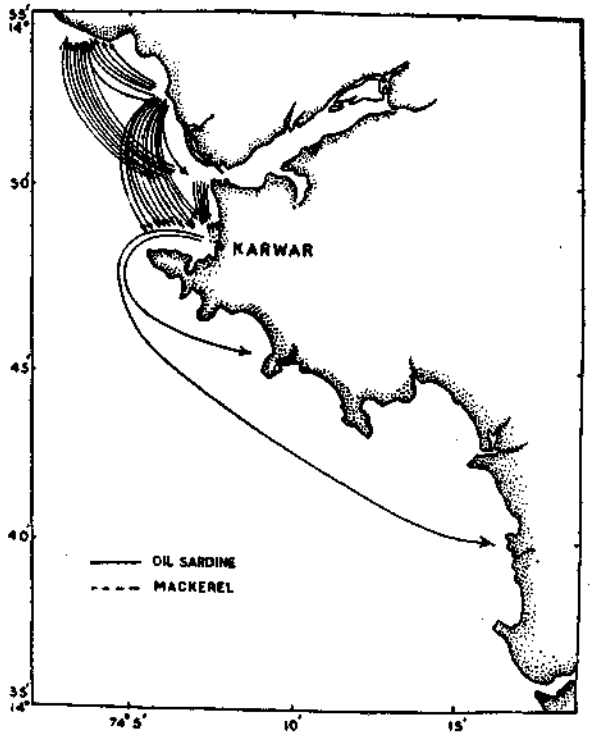
been developed. This technique can be advantageously used at the Cottage level. Large quantities of seaweeds and seagrasses such as species of *Cymodocea*, *Diplanthera* and *Halophila* can be utilised as manure directly or in the form of compost. The use of *Hypnea* compost as manure has resulted in higher yield of Bhendi, various beans, gourds, greens, lime, papaya, and drum stick and remarkable results have been obtained with protons and zinnias. Recently, a process has been worked out for the preparation of "seaweed meal" from *Gracilaria edulis*.



Tagged mackerel, oil sardine and prawn

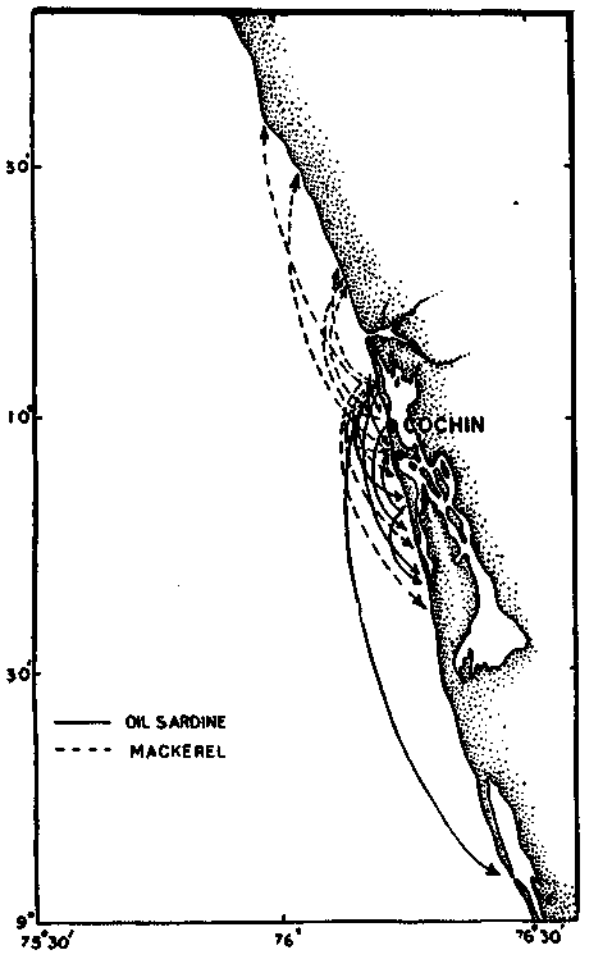
Tagging Experiments on Fishes

Tagging of fishes, despite its importance as a means to elucidate the important aspects of their biology such as migration, growth, recruitment, mortality, stock and racial composition, had not been attempted in India until the late 1950's. Mark release experiments were undertaken in the country for the first time by tagging of *Hilsa* in the Hoogly estuary and of the Gray mullets and certain other brackish water fishes in the Chilka lake. Tagging of marine fishes was undertaken for the first time in 1964 with the lobster, *Panulirus homarus*. Subsequently, tagging experiments on mackerel and oil sardine were commenced from Karwar, Mangalore and Goa. Realising the importance of tagging of commercially important marine fishes, a National Tagging Programme was initiated in 1975. This programme is progressing at present.



Recoveries of tagged oil sardine and mackerel (Karwar region)

The lobsters were tagged with suture tags and released at Muttom (Kanyakumari District) during 1965–1966. Of the total 134 lobsters released, 29% were recovered, the longest duration before recapture of the tagged lobster being 615 days after marking. The results of these investigations have shown that the lobsters do not stray far out of the fishing grounds; that their recruitment takes place at a very early stage; that the species grows very fast and attains commercial size at the end of the first year; that their growth rate slows down after the second year the maximum fishable size being attained by 5 years; that the males grow faster than females and that the fishery is supported mainly by the first and second year class lobsters.



Recoveries of tagged oil sardine and mackerel (Cochin region)

Tagging experiments on Indian mackerel and oil sardine were conducted during 1966–1969 using a variety of tags such as opercular, loop, dart, semi-internal and opercular button tags of different colours from Karwar, Mangalore, Kozhikode, Cochin and Vizhinjam on the west coast, and from Mandapam and Waltair on the east coast. During this period, a total of 4,599 mackerels and 22,439 oil sardines were tagged and released from different centres. This was followed by intensive and wide propaganda for the recovery of the tagged fish. The recovery rate for the mackerel was 0.61% and for oil sardine, 0.28%. Non reporting of recaptured specimens by the fishermen is believed to be the main reason for the poor rate of recovery, though high initial tagging mortality and mortality due to attrition from the shedding of tags and predators might have contributed for the low recovery rate. These preliminary investigations have indicated that the loop and opercular tags are not suitable for tagging mackerel and oil sardine as the other tags such as red and blue tags register higher recovery rate. It is also observed that the movement of mackerel and oil sardine is limited to the normal fishing grounds and that this movement is parallel to the coast. Large scale tagging of mackerel and oil sardine is in progress.

Tagging of commercially important penaeid prawns was started in 1972 from Cochin, Goa and Madras. Modified Peterson disc tag was used in these experiments. During 1972–74, 3053 prawns comprising *P. indicus*, *P. monodon*, *P. merguiensis*, *P. stylifera*, *M. dobsoni*, *M. affinis* and *M. monoceros* were tagged and released in the inshore and offshore waters and in the estuarine regions. The overall percentage rate of recovery was 2.1%. The results of these experiments indicated that the modified Peterson disc tag is suitable for prawns measuring over 40–45 mm size; that the recoveries are generally made within 2–18 days of release; that the movements of prawns are restricted within the fishing grounds and that they grow at a fast rate. Further intensive tagging experiments on prawns under the National Tagging Programme is in progress.

Recently, tagging of catfish at Waltair has been initiated.

Organic Productivity, Plankton and Fishery Oceanography

Organic productivity and phytoplankton

Early studies on phytoplankton and productivity were confined to taxonomic accounts of the main

constituents of diatoms and on their seasonal and quantitative fluctuations together with the environmental factors regulating their occurrence. Altogether about 300 species of diatoms, 200 species of dinoflagellates and more than 50 species of other components of phytoplankton have been identified and described from the Indian seas. In addition, studies on littoral and freshwater diatoms of India including electron microscope studies have also been conducted in a few laboratories.

During the last two decades, there has been considerable progress in the study of organic production in the Indian Seas. Off Calicut, standing crop of phytoplankton was measured by various methods which led to the conclusion that the production on the west coast of India is of a high order which can be compared to any other fertile regions in the world. Detailed measurements were made from the Gulf of Mannar and Palk Bay, west coast of India and Lakshadweep Sea, using oxygen and radioactive carbon methods from the early nineteen sixties. It was found that the shallow regions of the Gulf of Mannar and Palk Bay are very highly productive with an annual gross production of 443 and 561 gC/m^2 respectively.

On the west coast, the maximum production is towards the coast within 50 m depth and gradually decreases seawards. The mean value within 50 m is 1.24 gC/m^3/day with the highest rate during the southwest monsoon season. The minimum is during the premonsoon when the mixed layer is deepest and moderately high rates are found during the postmonsoon. The daily rate of production for the rest of the shelf is 0.47 gC/m^2/day and for oligotrophic regions outside the shelf, it is only 0.18 gC/m^2/day.

The annual gross production for the inshore regions on the west coast within 50 m is 453 gC/m^2 and for the rest of the shelf 170 gC/m^2. This would amount to an annual gross production of 50 x 106 tonnes of carbon for the inshore regions comprising 1,14,520 sq.km and 30×106 tonnes for 1,68,790 sq. km of the outer shelf regions.

The rates of primary production on the east coast are 0.63 gC/m^3/ day on the shelf and 0.19 gC/m^2/day outside the shelf and annual estimated gross production is 25×10^6 tonnes of carbon for 1,11,150 sq km of the shelf.

By comparison with areas where there is intensive exploitation and by tracing the carbon production through the different tropic levels using various ecological efficiency factors, an estimate of a potential harvest of about 3–4 million tonnes of fish has been derived for the Indian seas which is about 3 times the present yield.

Similar calculations have been made for 51 $x10^6$ sq. km of the Indian Ocean for which the International Indian Ocean Expedition data are available. The annual net production is computed at 3.9×10^9 tonnes of carbon which is about one-fifth of the estimated world organic production, while the catch is only one-twentieth of the world production of marine fish. The shelf areas of the Indian Ocean alone account for 0.56×109 tonnes of carbon or about one-seventh of the total production in the Indian Ocean. The potential yield from the Indian Ocean at the present level of world fishing is about 11 million tonnes of fish. The Indian Seas could provide an annual sustainable yield of about one-fourth of the potential yield from the Indian ocean as the productivity studies indicate.

The organic productivity of the Cochin Backwater, Vellar Estuary at Porto Novo, Mandovi Estuary in Goa have also been investigated in recent years. Annual gross production measured in the Cochin Backwater using various techniques has been found to range from 272–293 gC/m^2 and net production from 184–202 gC/m^2. Detailed investigations conducted in the Vembanad Lake and connected backwaters have shown that for a total area of 300 sq. km the annual gross production ranges from 150–650 Cg/m^2 with the maximum during pre and post monsoon periods. The total organic production has been estimated at 100,000 tonnes of carbon.

The seasonal and spatial abundance of phytoplankton in the Cochin Backwater indicated that two peak periods are usually observed with the diatoms playing the major role. An analysis of variance indicates that the spatial variation is as high as the seasonal variation. In addition, plant pigments,light penetration and nutrient cycle also have been studied in the Cochin Backwater.

The productivity of coral reefs, on the southeast of India, Lakshadweep sea and Andaman seas,

seagrass bed and liberation of particulate organic matter by coral reefs in an atoll have also been studied as part of the organic productivity investigations.

Zooplankton

Research on zooplankton carried out in the country mainly relates to studies on the standing crop of zooplankton organisms in the tropic cycle and their inter-relationship in the ecological niches, and the correlations between the plankton and fishery resources. The taxonomy, distribution, ecology and biology of several groups of zooplankters such as amphipods, cladocerans, copepods, chaetognaths, euphausiids, ostracods, siphonophores, appendicularians, bryozoans, pteropods, gastropods, cumaceans, anthozoans, hydromedusae, etc. have been described. Several new species have been described and new records have been made for all the groups of the above plankters. The occurrence and abundance of larval cephalopods along the southwest coast and the Lakshadweep sea have been investigated. Detailed investigations of bioscattering and deep scattering layers were undertaken along the west coast and Lakshadweep seas to study the diurnal vertical migrations, areas of the occurrence and biological constituents. Interesting relationship between the local fisheries and the abundance of different groups of zooplankton of coastal waters have been recorded at different centres. It has been found that several species of plankters occur in greater quantities on the west coast than on the east coast and this is reflected in the quantity and composition of catches in the respective regions.

A wealth of information on the zooplankton of the inshore waters, their abundance in space and time along with the hydrological data is available for centres Bombay, Karwar, Mangalore, Calicut, Cochin, Vizhinjam, Mandapam, Tuticorin, Madras, Waltair, Minicoy and Port Blair.

Based on the data collected during the International Indian Ocean Expedition plankton atlases depicting distribution pattern of fish eggs and larvae, standing crop of zooplankton and seasonal variations of several groups of zooplankters have been prepared.

Fishery oceanography

While dealing with fish and fisheries resources of India it is essential to have an idea about the geographical, climatic and oceanographic features which together profoundly influence fisheries resources of the country. The vast alluvial plains of the north, the Deccan plateau, the mountain barriers which surround the plains to the west, north and east are some of the characteristic features of peninsular India. The atmospheric temperature and rainfall provide wide contrasts during different seasons in the various parts of the country. Recorded temperatures range from —9.5°C to 49.5°C and annual rainfall from less than 127 mm to 11,000 mm. The northeast monsoon during winter and the southwest monsoon during summer months characterise the weather conditions and the heavy precipitation accompanying these monsoons result in the fluctuations in the physical, chemical and biological features of the rivers, estuaries and the seas around India.

The hydrography of the waters around India was surveyed in the past by the expeditions of *Challenger, Investigator, Valdivia, Dana, Discovery II, Mabahiss,* etc. and by the ships of the British Admirality.

Systematic investigations on the oceanographic conditions in the inshore and offshore waters was initiated in 1957 by the CMFRI with the co-operation of the Indo-Norwegian Project (now known as Integrated Fisheries Project). The first vessel utilised for this purpose was *M. O. Kristensen* followed by *R. V. Kalava* and from 1961 onwards a fully equipped Research Vessel, *Varuna* was put into operation. More than 175 cruises were undertaken by these vessels and about 3,500 oceanographic stations were occupied. Very valuable information on various oceanographic parameters were collected, especially in relation to the inshore demersal and pelagic fisheries.

From the investigations carried out by *R. V. Varuna,* a large convergence zone has been found during early winter along 8°N around 74°E meridian. These convergence zones form suitable spawning and forage grounds for fishes. Around Lakshadweep islands there exists circulatory movements upto a notable depth (100–200 m) from the surface and this helps to maintain the highly productive waters in the vicinity of fishing grounds for pelagic oceanic species such as skipjack tunas.

In recent years, the Pelagic Fishery Project has carried out extensive oceanographic surveys with their vessels *R. V. Rastrelliger* and *M. V. Sardinella.* The

valuable information collected by them along the west coast from Ratnagiri to south of Cape Comorin has resulted in a better understanding of the stock, abundance and distribution of important pelagic fishes such as oil sardine, mackerel and anchovies. Our knowledge of oceanography of the Indian Seas has also been greatly enriched by the findings of the International Indian Ocean Expedition. and by the continued research effort of the institutions such as CMFRI, PFP and NIO.

While some detailed information is available about the equatorial current systems, the IIOE brought to light the Somali stream - a fast moving current which links up with the south west monsoon current and establishes a clockwise circulation in the Arabian Sea and Bay of Bengal. As a result of this circulation a southerly drift gets established along the west coast of India and a weak north easterly current along the east coast.

The northern Arabian Sea is characterised by high temperature and salinity and in contrast lower salinities have been observed in the Bay of Bengal due to the influence of major perennial rivers and estuaries.

The monsoon systems set in motion a process of upwelling which is more pronounced along the west coast of India. Valuable data has been collected on the commencement of upwelling in deeper waters and the areas of upwelling. These investigations while pointing to the relative richness of the waters along the southwest coast, should also help in understanding the fluctuations in the major fisheries in this area. Small-scale upwelling takes place along the east coast also in some areas.

The shifting of the oxygen minimum layer to the surface in some parts of the Arabian Sea during certain seasons results in mass mortality of fishes. Even very productive areas can be influenced by oxygen minimum layers. In the shelf waters of Gulf of Cambay and in some parts of the Arabian Sea azoic conditions prevail with deficient oxygen content.

Seasonal fluctuations in the nutrients (inorganic phosphates, nitrates and silicates) of the shelf waters along the southwest coast have been investigated and the area between Quilon and Alleppey and off Calicut was found to be relatively richer in nutrient concentration. The east coast of Andaman and Nicobar Islands is also fairly rich in phosphate content.

Marine pollution

Water pollution and fish mortality on a small scale have been known since long back from the maritime States of Maharashtra, Kerala, Tamil Nadu and West Bengal. Occasional fish mortality has been reported from the vicinity of the industrial cities mainly in the estuarine areas. Research on marine pollution is, however, limited to the local and isolated problems pertaining mostly to the fresh water and estuarine resources, and on problems like radiation hazards in the marine environment and up take of metals etc. carried out at the Baba Atomic Research Centre, Bombay, till recently. An awareness on a national scale on aquatic pollution is, however, created only after India's active participation in the International Conference on Human Environment at Stockholm in 1970. Since then, survey on the large scale occurrence of tar-balls on the west and east coasts of India has been carried out. Monitoring of pollution at Bombay, Goa, Karwar, Cochin and Trivandrum has been taken up. Investigations conducted on the pollution in the Hooghly-Matlah estuarine system have shown that the total load discharged per day works out to 106 tonnes of BOD, 2,308 tonnes of total solids, 1057 tonnes of suspended solids, and 1251 tonnes dissolved solids. The Kulti estuary in West Bengal used to have important fishery resources till a few years ago. But it has in recent years been heavily polluted by Calcutta sewage, and the seeds of commercially important fishes and prawns are significantly absent in the upper strethesc of the estuary, the caustive factor being the formation of "Sewage pollution block" which prevents up stream migration of the larvae and juveniles. Apart from this, research is progressing on the bioassay and toxicity testing aspects with different pollutants such as BHC, DDT and Malathion.

Monitoring studies on marine environmental damage are being carried out in the Cochin Backwater and the industrial suburbs. Causative factors for mass fish mortality in the region have been studied. The intensity of sewage pollution from human and animal waste is monitored by the determination of indicator organisms and BOD measurements. The relationship of micro-organisms to the sediment structure is also

investigated. Toxicity experiments in order to determine the LC - 50 using crude oil and pesticides are conducted. Phytotoxicity measurements are also made. Besides, following the grounding of an oil tanker TRANS HURON at Kiltan Island (Lakshadweep) extensive ecological observations on the immediate and long term effect of oil pollution on the marine biota are made. Regular monitoring programme on marine and estuarine pollution at Calicut, Karwar and Tuticorin is being continued.

COASTAL AQUACULTURE
(mariculture and brackish water culture)

As the fishing pressure steadily increases especially along the narrow coastal belt where indigenous crafts operate in considerable numbers, the yield from capture fisheries can not be expected to be of a sustained nature and already signs of overfishing were discernable in the case of prawns in some areas along the southwest coast. Further the various environmental factors cause considerable fluctuations in the yield from capture fisheries. In order to overcome these difficulties and to increase production of fish and other animals on an area or watershed basis, increasing attention has been paid to mariculture and sea farming in the recent years. The significant results obtained especially by the CMFRI are detailed as follows:

Fish culture

Many species of fishes such as milkfish, mullets, perches and eels are suitable for culturing in low lying areas and impounded brackish water. The work carried out by C.M.F.R. Institute at Tuticorin has shown that the production of milk fish in saline lagoons and in saline ponds can be substantially increased by resorting to proper management procedures. A production rate of 857 kg per hectare was obtained. The institute has developed methods of culturing the eel, *Anguilla bicolor*, in running water. This species is abundant along the east coast and they breed in the open sea. The elvers ascend the rivers during rainy season. Elvers are collected from suitable locations and are reared in experimental culture tanks. This species has given a production rate of 38,000 kg per ha. at the end of a period of two years. Cultivated eels have a good export market and are in great demand in countries like Japan. Another species of fish, *Sillago sihama* is also being successfully cultured by the Research Centre at Mangalore. This species grows to about 200 mm in 7 months.

Marine prawn culture

In India prawns are cultured at present in Kerala and West Bengal in the brackish water ponds and low lying areas adjacent to the backwaters by traditional methods. The young ones of different species of marine prawns such as *P. indicus, P. monodon, P. semisulcatus, M. monoceros, M. dobsoni, M. affinis* and *M. brevicornis* brought in by tidal currents are trapped and cultured in these fields. In the seasonal fields of Kerala, paddy is cultivated during the monsoon months (June-September) and prawns in the other months (October-May), while in the perennial fields, prawns are cultivated throughout the year. In West Bengal, culture fisheries is carried out in the brackish water ponds, called "Bheris". About 4500 ha of fields are utilised at present for prawn culture in Kerala and 9600 ha in West Bengal. The yield of prawns from these fields varies from 500 to 1200 kg per ha per annum, the average production being about 700 kg per ha per year. The total production of prawns from the fields of Kerala is estimated to be about 3500 tonnes per year. The prawn culture practices of the seasonal and perennial fields of Kerala have been evaluated and improvement measures involving culture of selected species such as *P. indicus*, and *P. monodon* for longer duration of 3–4 months have been suggested for enhancing the efficiency of management and production.

Rearing of prawn larvae at the Prawn Culture Laboratory of CMFRI, Narakkal

Intensive investigations on culture of prawns have been taken up only recently and these are directed towards developing techniques for large scale culture of prawns on scientific and modern lines. As a result of these investigations, commercial prawns such as *P. indicus, P. monodon, P. merguiensis, M. monoceros, M. dobsoni, M. affinis* and *P. stylifera* have been spawned in the laboratory and their larvae reared through different stages up to stocking size under controlled conditions. One of the species, *M. dobsoni,* has been successfully domesticated, as the stocked juveniles grown in the brackish water ponds attained sexual maturity and spawned in the brackish water medium liberating viable eggs which have been further reared through different larval stages to stocking size in the same medium. The requirements of medium, environmental conditions and food for the culture of individual species have been studied. Fairly good percentage of survival rate has been achieved in the rearing experiments. In the case of palaemonid prawns, a salinity range of 20–25% is found to be ideal for spawning and rearing of their early larvae. Besides these, techniques for mass culture of several species of diatoms, *Artemia salina,* and zooplankters which form the food of larvae and juvenile prawns have also been developed. A survey of the seed resources in the surf region, estuaries and backwaters is being undertaken. The konkan krishi Vidyapeeth, Ratnagiri is also engaged in the prawn culture and *P. merguiensis* and *Macrobrachium* are the species being cultured. In the CIFE farm at Kakinada polyculture of fish (chanos) and prawns (*P. monodon*) has been undertaken with promising results, similar to those obtained by CIFRI in polyculture of prawns and fish at their Kakdiwp farm, Calcutta.

The results of field experiments carried out at different centres have indicated that (1) the prawns grow very fast in the culture fields and reach marketable size in 3–4 months; (2) encouraging production could be raised by culture of prawns in salt pans with simple management procedures; (3) prawns can be cultured along with other compatible fishes such as *Chanos chanos,* mullets and *Etroplus*; (4) by intensive culture, a production rate between 1000–1500 kg could be realised per ha per annum.

Realising the importance of transfer of technology to various levels for quicker development and establishment of an organised culture fisheries for prawns, steps have been taken to train both technical personnel and actual farmers through organised training programmes under the Krishi Vigyan Kendra, Narakkal (Cochin) and through short-term courses.

Mussel culture

The culture of mussel in India was initiated in 1971. Two species, namely, *Perna indica* (Brown mussel) and *Perna viridis* (Green mussel) occur in the country, the former confined to the southern most peninsular region from Quilon to Tirunelveli Coast, while the latter is distributed all along the rest of the Indian Coast. Experiments conducted at Vizhinjam on the culture of brown mussel followed the "Suspended" or "Raft culture" method using ropes. The seeds of mussel were collected from the natural beds and transplanted to these ropes. The results of the experiments have shown that the seed mussel of average weight of 0.29 g transplanted in September grew to an average weight of 34.97 g in September of the next year, and a production of 22.97 kg per metre length of rope was recorded. The annual production rate was estimated at 60 tonnes of mussels with shells, per ha. In 1975, culture of green mussels in the open sea at Kozhikode employing the raft culture techniques was taken up. In the experiments conducted at this centre, the seed mussel of average length 26.7 mm and live weight of 1.48 g transplanted in December grew to a size of 80 mm weighing 28.7 g in April. The production rate for a period of 5 months amounted to 235 tonnes per ha. It is also observed that the growth of mussels in the farm is very rapid (12 mm per month) as compared to those in the natural bed (8 mm per month). The results of these experiments indicate great prospects for culture of mussels in the inshore waters of our coast. Culture of green mussels on rafts in the open sea at Kovalam near Madras is progressing. The Konkan Krishi Vidyapeeth, Ratnagiri has taken up an ICAR scheme for culturing mussels along Ratnagiri Coast. Further intensive investigations on the culture of mussels and studies on the economic viability of the culture operations are in progress.

Culture of edible oysters

Experiments on the culture of edible oysters were started in the country as early as the beginning of this century. However, these were given up due to

unsatisfactory progress. Nevertheless, intensive investigations on the culture of the edible oyster, *Crassostrea madrasensis* have been taken up recently at Tuticorin. The techniques of oyster culture consists of two items, namely, collection of spat by employing different methods and growing this spat to the adult stage by different methods such as rack culture, long line culture pole culture, tray culture etc. The different methods of capture of spat on lime coated tiles, oyster shells strung on galvanised iron wire, empty coconut shells,

Edible oyster

rubberised coir mats etc. are being tried. The best time of the year for spat collection varies with species, locality, fluctuation in temperature, salinity, tide, etc. Investigations are also being carried out to develop the hatchery method of inducing the oysters to breed under controlled conditions. Preliminary experiments carried out at Tuticorin have shown encouraging results on the culture of oysters and have indicated that the growth of cultured oysters is relatively faster than in the natural beds.

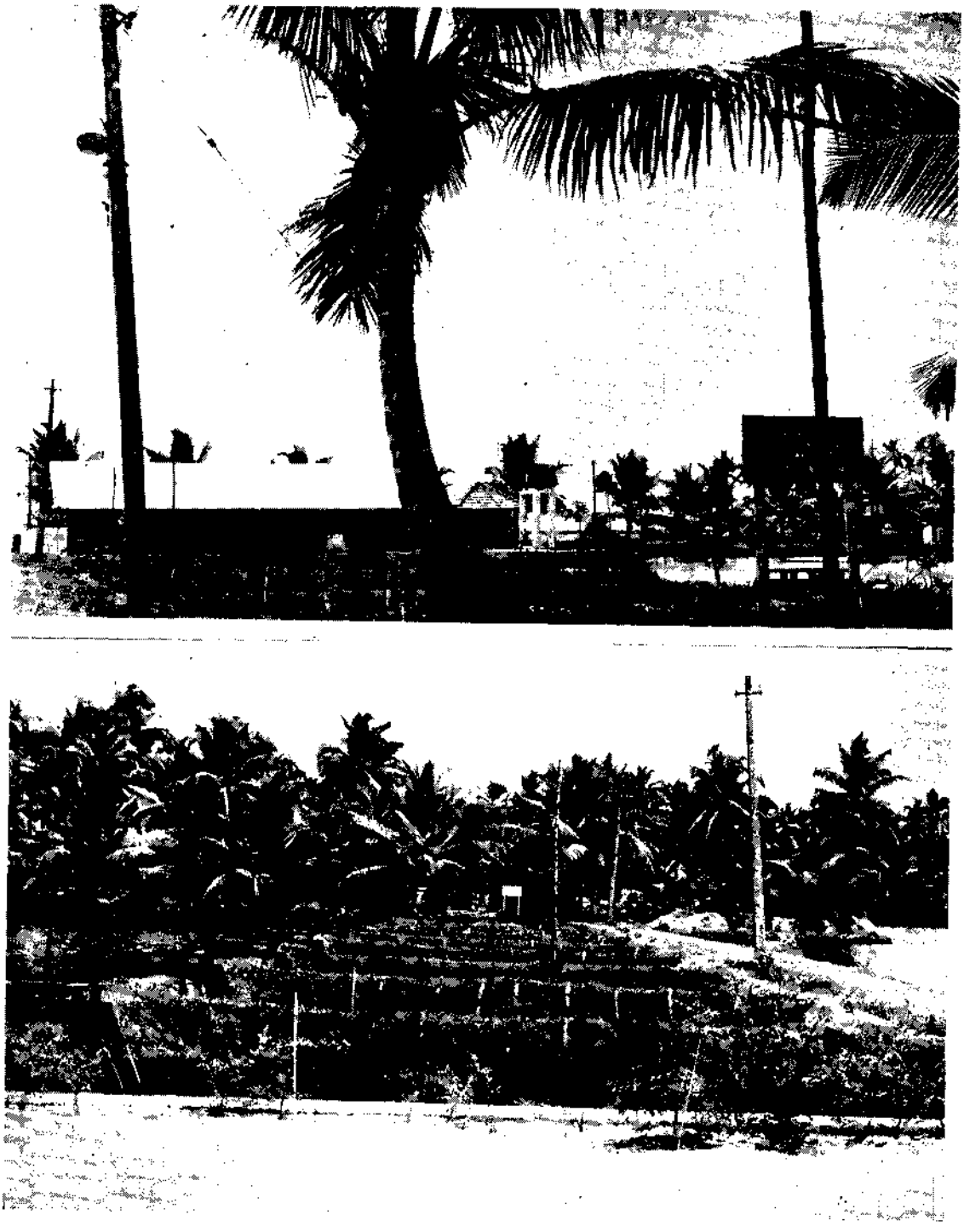
Pearl culture

The techniques for production of cultured pearls and farming of pearl oysters were developed indigenously at the Central Marine Fisheries Research Institute in 1973. Prior to this, attempts to develop the techniques had been made at two centres at Krusadai Island by the Department of Fisheries, Tamil Nadu and at Sikka by the Department of Fisheries, Gujarat, but without much success. The pearl culture project was started in 1972 at Tuticorin with a field laboratory and open sea oyster farm at Veppalodai. Raft culture was introduced to rear the pearl oysters. The important species cultured is *Pinctada fucata*. The surgery is performed in the shore laboratory after conditioning the oysters with menthol. The operation consists of grafting a piece of mantle of the donor oyster in the gonad or hepatopancreas region of the oyster, followed by the implantation of a spherical shell-bead nucleus. The breakthrough in production of spherical pearls was achieved in July 1973.

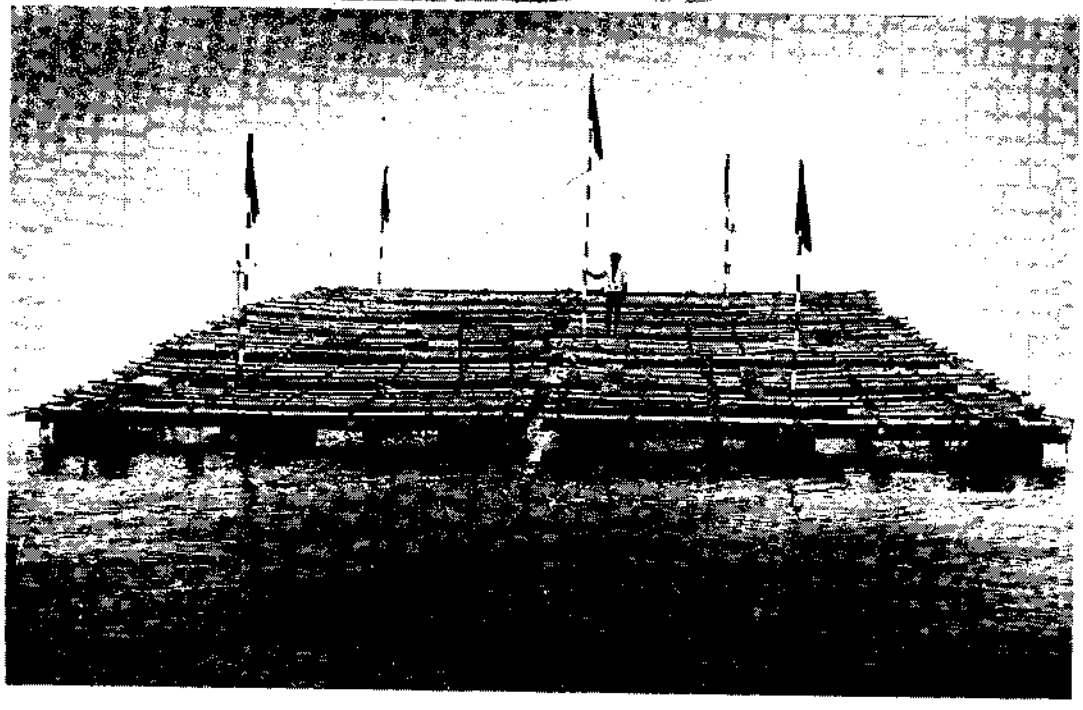
Although cent per cent success has been achieved in certain batches, the average production is about 60–70%. Multiple production of pearls in individual oysters has been achieved. The size of nucleus employed ranges from 2 mm to 7 mm diameter depending on the size of the oyster and choice of single or multiple implantation. The rate of deposition of nacre is high in the tropical sea and hence the duration of post-operative culture is considrably reduced, requiring only 3 months to 18 months for the range of 3 mm-8 mm pearls for maturity. The shell beads required have been produced from the conch-shell wastes (after preparing the conch bangles), using the grinding technique. The surgical tools have been fabricated indigenously.

Since October 1973, the researches on pearl culture at Tuticorin are carried out under a collaboration scheme between the Central Marine Fisheries Research Institute and the Department of Fisheries of Tamil Nadu. Emphasis is laid on the development of pearl oyster resource to procure oysters required for the pearl culture operations. The recent surveys of the pearl banks of the Gulf of Mannar have indicated the possibility of a revival of the pearl oyster population, probably for the first time since the pearl fishery of 1961. Besides, spatfall has been observed in the coastal waters, particularly in the new artificially created harbour basin at Tuticorin. Through a Project of the Central Marine Fisheries Research Institute at Vizhinjam on the Kerala coast, the fall of pearl oyster spat in the fishing harbour under construction has been taken advantage of in raising pearl oyster stocks.

The Central Marine Fisheries Research Institute conducts two kinds of training courses in pearl culture.



Prawn culture laboratory and experimental ponds of CMFRI at Narakkal near Cochin

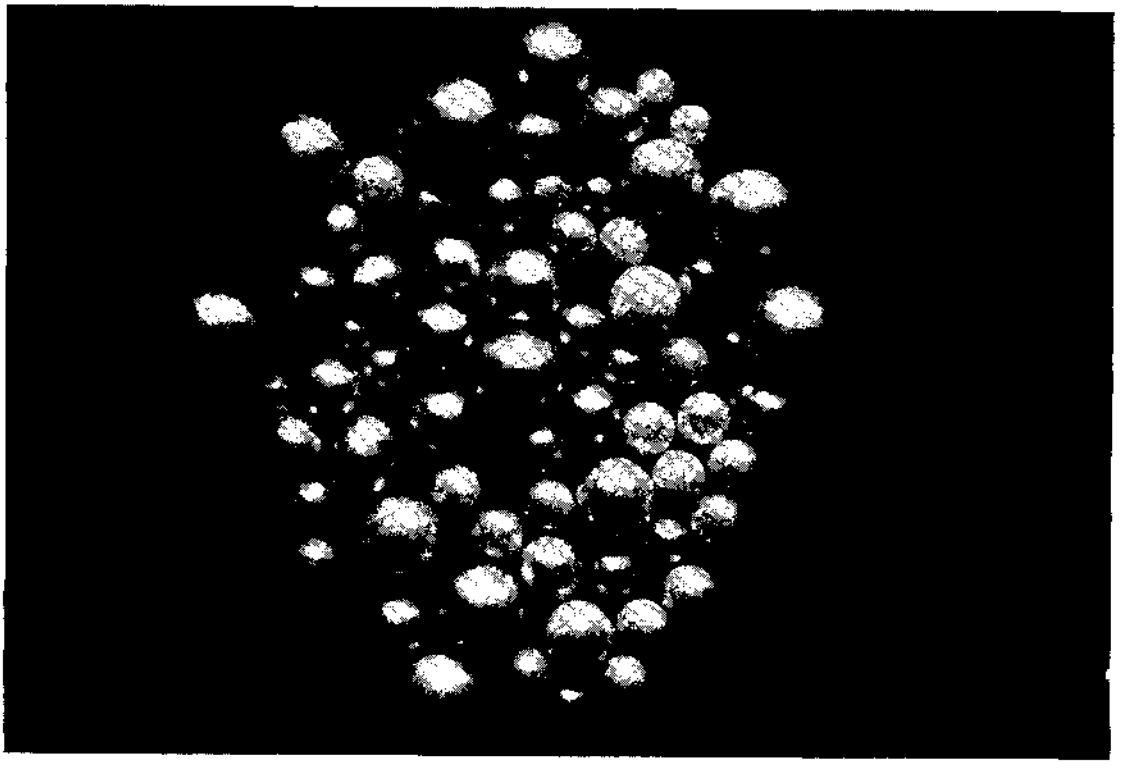


Top: Two tonnes of cultured mussels – a part of harvest taken at Calicut from open sea mussel culture
Bottom: Rafts used for mussel culture at Calicut Research Centre of CMFRI

Pearl oyster,
Pinctada fucata

Cleaning of cultured
pearl oyster

Pearl oyster surgery and implantation of nucleus



Cultured pearls produced by CMFRI, Tuticorin

The comprehensive long term programme of six months' duration is a Trainers' Training Course and the short-term programme of four weeks aims at technician's level training in the specific field. These courses are demand-based for the benefit of the maritime states.

Twin and Triplet pearls

The development of a sound technology for the production of cultured pearls and the knowledge of a possible revival of pearl oyster resource in the Gulf of Mannar, supported by the good spatfall in the new harbour basins as at Vizhinjam and Tuticorin have lead to the launching of a Pilot Project for semi-commercial production of cultured pearls.

Culture of seaweeds

The cultivable seaweeds are agar yielding plants like *Gracilaria* and *Gelidiella* species and algin yielding plants such as species of *Sargassum* and *Turbinaria*.

Preliminary culture experiments carried out with some of the economically important seaweeds such as *Gracilaria edulis, G. corticata, Gelidiella acerosa* and *Sargassum* spp. have indicated that the species could be cultured successfully in the coastal waters. Seaweed culture has been done by introducing fragments of the seaweed in the twists of coir ropes which are fabricated in the form of frames tied to wooden poles fixed in the coastal waters.

The experimental cultivation of *G. edulis* near Mandapam has revealed that the ideal time for planting is June-July. It was also found that three harvests could be obtained, the first, five months after planting, the second three months later and the third, a further two and half months later. The annual yield has been calculated as 3.5 kg of fresh seaweed per metre of rope.

In the case of *Sargassum*, duration of about 9–10 months was observed for it to settle on artificial substrata such as concrete cylinders after which rapid growth was observed and near-mature plants were seen within nine months. A growth of 37 to 52 cm for an initial height of 10 cm in *Sargassum cinctum* was reported within forty days. With *Gracilaria edulis*, 4–5 kg and 4 kg of seaweed per square metre in 4 x 2 metre and 2 x 2 metre size coir culture frames respectively within a span of 80 days for an initial 1 kg of seed material was obtained. In *Sargassum wightii* an average growth of 15.5 cm from an initial average height of 7.67 cm within 60 days was obtained. *Gelidiella acerosa* which was not giving encouraging results hitherto had shown a growth of 3 kg from an initial 1 kg after 77 days in the recent experiments. It was also observed that *Gracilaria edulis* cultured in Athankarai estuary showed slight bleaching than that cultured in inshore waters. Low salinities near the estuary mouth during rainy season have been found to be favourable for the growth of *Gracilaria edulis*.

An alternative method of culturing seaweeds is to rear the spores by keeping some suitable sbustrata like coral and concrete stones on which the spores settle, germinate and grow into adult plants. It lessens the utilization of the natural resources but the method by using fragments is easier and the yields are quicker. The spore output in algae such as *Ulva fasciata, Turbinaria* spp., *Sargassum* spp., *Gracilaria* spp. and *Gelidiella* spp. has been studied, and the number of spores produced in different species experimentally was found to be abundant by various workers.

INLAND FISHERIES RESEARCH

Before the establishment of the CIFRI in 1947 the research and developmental activites in the inland fisheries sector have been of a scattered and disorganised nature. Evolving suitable methods for the conservation, development and rational exploitation of the inland fishery resources in India was the main objective of the Institute.

Capture Fisheries

Capture fisheries investigations involved detailed studies on the fishery biology of a number of carps and

catfishes inhabiting the rivers and estuaries; hydrobiologic factors affecting the fisheries of several rivers and estuaries; besides locating spawn collection centres for the seed of major carps and culturable riverine and estuarine fishes and prawns. Studies on migration, life history and population dyamnics of commercially important fishse and environmental factors affecting the abundance of fish stocks have been undertaken.

Estuarine fisheries

Major estuarine systems of India have been surveyed and information on the fish and fisheries of these regions along with environmental factors has been gathered. Similarly, the fisheries of the brackishwater lakes particularly of Chilka Lake in Orissa, Pulicat Lake in Tamil Nadu and Vembanad Lake in Kerala have been extensively studied. The species supporting the estuarine and brackishwater fisheries of the country are mostly the marine species which enter into these ecosystem tolerating wide variations of the salinity, the most important of which are, *Hilsa ilisha, Nematolosa nasus, Anchoviella* spp., *Anadontosoma chacunda,* mullets, catfishes, *Lates calcarifer, Etroplus* spp., threadfins, *Sillago sihama,* prawns and crabs. It is also found that this ecosystem serves as nursery ground for many of the marine fishes.

Riverine and Lacustrine fisheries

Detailed investigations on the fish and fisheries of the Ganga River System, of Bharmaputhra, Godavari, Krishna, Cauveri, Tapti and Narmada Rivers have been carried out. The fishery of the Ganga River System is supported by the major carps, (*Labeo rohita, L. calbasu, Cirrhinus mrigala, Catla catla*), cat fishes (*Mystus aor, M. seenghala, Wallago attu*) and the clupeid (*Hilsa ilisha*). The fish fauna of Bhramaputhra in Assam includes 126 species, the important commercial species supporting the fishery being *Labeo, Wallago attu, Puntius sarana, Notopterus notopterus, N. chitala* and *M. seenghala.* The principal fishes contributing to the fishery in the southern peninsular rivers are carps, cat fishes, *Hilsa ilisha,* murrels, eels, feather backs and prawns.

Studies carried out on the effects of construction of dams across the rivers have indicated that it adversely affects the fish migration. The dams on the Godavari, Krihsna and Cauveri Rivers have affected the *Hilsa* migration and led to the decline of the fishery. Indiscriminate discharge of domestic and industrial wastes has created pollution problems in many of the Indian rivers, causing destruction of spawning grounds of the important freshwater fishes such as major carps which require special environment for breeding. However, monitoring on pollution of important rivers has been taken up.

Besides the rivers, natural lakes with a total area of 0.72 million hectares, constitute another aquatic source for fishery production. However, research on lacustrine fisheries of India has been scanty, except for preliminary fishery survey along with the physicochemical and hydrobiological condition of a few lakes.

Reservoir fisheries

There are about 295 major and medium reservoirs in India. Fish production in some of the important reservoirs is as follows:

Reservoir	State	Fish production(kg/ha)
Govindsagar	Punjab	206.00
Rihand	Uttar Pradesh	9.31
Sardasagar	Uttar Pradesh	24.87
Dohra	Uttar Pradesh	27.58
Keetham	Uttar Pradesh	250.00
Dhandraul	Uttar Pradesh	20.02
Panchet	Bihar	4.09
Tilaiya	Bihar	3.46
Gandhi sagar	Madhya Pradesh	4.86
Hirakud	Orissa	0.21
Malampuzha	Kerala	5.03
Tungabhadra	Karnataka	4.13
Mettur Dam	Tamil Nadu	39.10
Bhavanisagar	Tamil Nadu	13.00
Amaravathi	Tamil Nadu	93.00
Nizam Sagar	Andhra Pradesh	3.30
Nagarjunasagar	Andhra Pradesh	1.76

Average fish production of the reservoirs works out to 6–7 kg per ha. Research and developmental efforts taken up to improve the reservoir fisheries are:

1) survey of the fish fauna of the reservoirs;
2) clearance of submerged obstructions;
3) establishment of fish farms;
4) stocking of the reservoir with selected species;
5) survey of fish seed resources;
6) topographical survey of the reservoirs; and
7) conservation and management of the reservior fisheries.

During recent years, survey of the fishery resources of the Tungabhadra, Bhavanisagar, Damodar Valley Corporation reservoir and Hirakud has been carried out. Introduction of Mahseers and *Macrobrachium malcolmsonii* in the Damodar Valley Corporation reservoir has been found to be successful. Major carps, peninsular carps, *Cyprinus carpio, Chanos chanos, Etroplus suratensis* and *Tilapia mossambica* have been stocked in the reservoirs of Kerala to increase their productivity.

Investigations on the ecology and fisheries of selected reservoirs in different agroclimatic zones of the country have been carried out under an All-India Co-ordinated Research Project on Reservoir Fisheries. Largely through manipulation and intensification of phase-wise fishing effort to 1.67 times over the conventional effort, the yield from the Bhavanisagar reservoir in Tamil Nadu, has been raised to 75 kg per ha. in 1976 as against 19 kg per ha in 1971. Investigations at Moolathuria on the Bhvani River has revealed the availability of spawn of *Catla catla, Labeo calbasu, Cirrhinus mrigala* and *L. fimbriatus* indicating possibility of natural stocking of the carp seed in the reservoir.

Cold water fisheries

Cold water fisheries of India is mainly constituted by trouts *Salmo gairdneri gairdneri, S. trutta, S. levensis* and *Onxorynchus norka,* the mirror carp (*Cyprinus carpio*), *Tina tina, Carassius carassius* and snow trouts. These fishes were introduced into the Indian waters from Japan, England, Sri lanka and Central Europe. The trout fishery at present exists in Nilgiris, Kodai Hills, high ranges of Kerala, Kashmir, and Himachal Pradesh in the lakes of Kumaon Himalayas. The important trout hatcheries in the country are at Avalanche, Rajamally (Tamil Nadu), Caribal and Harwar (Kashmir), Katrain (Kulu) and Barrot in Himachal Pradesh.

The taxonomy of the Nilgiri trout has been dealt with in detail. Various methods of augmenting the biota of the streams in the Nilgiris have been tried with a view to increasing the natural food supply for the trout. The measures adopted are improvement of calcium content by dumping coral rocks, plantation of weeds for providing shelter to the food organisms, etc. Paucity of food, overfishing and lack of facilities for the movement of the fish have been found to adversely affect the Nilgiri trout fishery. The insect and other animal life in the trout streams have been surveyed. *Cyprinus carpio* has been reported to also breed in the plains. Mahseer is an important food and game fish whose food and feeding habits, migration and breeding has been studied. It has been reported that the fish is insectivorous in the juvenile stage but become herbivorous in the adult stage.

Productivity of potential lakes supporting the cold water fisheries has been assessed. Studies have also been undertaken in physico-chemical features, surface plankton, vegetation, bottom biota, and catch/man/hr. Cumulative percentage of survival from green egg to fry stage has been studied. Field trials for feeding pelleted feed to brown trout and rainbow trout have been conducted. Brown trouts sampled from streams are found to feed mainly on developmental stages of *Trichoptera, Ephemeroptera* and *Diptera.* With the increase in size the fish preferred to feed on aerial insects and fish. Researches on the food and feeding of trouts have been intensified.

Inland Fish Culture

Culture of freshwater fishes in ponds is an age-old industry of the country, practised traditionally in the eastern states of West Bengal, Bihar and Orissa. The freshwater ecosystems such as ponds, tanks, lakes and reservoirs, irrigation and navigational canals, running and stagnant waters, sewage-fed basins and oxidation ponds, are suitable for culture operations. Although a variety of fishes are found to be amenable for culture, the commonly cultivated species are: Catla (*Catla catla*), rohu (*Labeo rohita*), mrigal (*Cirrhinus mrigal*), Silver Carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*) and common carp (*Cyprinus carpio*). Among the prospective species suitable for culture in freshwater are the air breathing fishes (*Heteropneustus fossilis, Clarias magur, Anabas testudineus, Ophiocephalus* spp., *Notopterus* spp., etc) frogs, eels (*Anguilla bicolor, A. bengalensis*), trouts in cold waters of upland and masheer and other sport fishes in cold waters. Among prawns, *Macrobrachium rosenbergi, M. malcolmsonii, M. choprai,* and *M. idella* are ideally suitable.

During the past three decades, extensive research on different aspects of freshwater fish culture has been carried out. Noteworthy achievements of these studies are in the field of seed production, induced breeding, transporation of seed, composite fish culture and management of large scale fish culture.

Induced breeding of fishes

Necessary techniques have been evolved and perfected for inducing the Indian and Chinese major carps to breed through injection of pituitary extract. The techniques have been further simplified so that farmers could resort to induced breeding of fishes to meet their own seed requirement. The pituitary extracts are ampouled to solve the problem of preservation and use at desirable time. A 'Pituitary bank' has been set up at CIFRI Research Centre at Cuttack.

Injecting a fish with extract of pituitary hormone

Selective breeding and hybridization of fishes has been undertaken for the first time in India through induced breeding and several intergeneric hybrids of Indian and Chinese carps have been produced. The F_2 generations of some intergeneric and interspecific hybrids have been raised and some of them show better qualities than the parental stock.

The techniques of hatching carp eggs have been improved with the establishment of suitable hatcheries with continuous circulation of water.

Catla, rohu and mrigal have been experimentally induced to spawn twice, both at the beginning and again towards the end of the monsoon, thereby doubling the production of eggs from the same individual. The mullet (*Mugil cephalus*) was induced to breed for the first time in 1961. From 1971 onwards attempts were made to raise fry and fingerlings on an experimental basis.

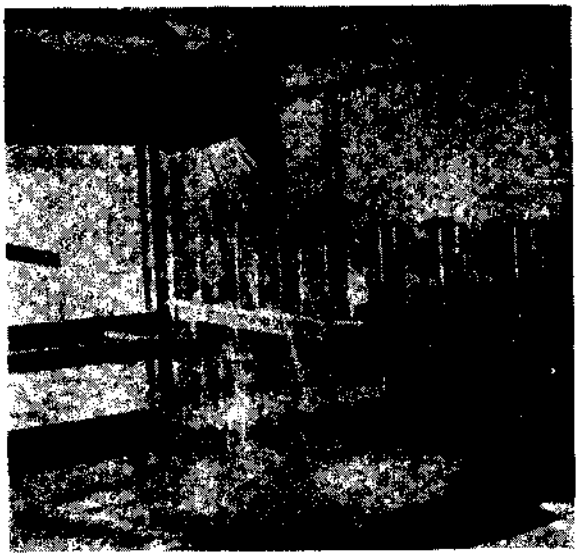
Seed production

Methods of seed production of cultivable varieties of fishes include collection from natural riverine source and production in *bundhs*. During the past 10 years several riverine stretches and collection centres of the seed of major carps have been located. Several new collecting gears have been designed. Production of seed in wet and dry bundhs involving stocking and care of breeders, location of breeding grounds in wet bundhs, collection of eggs and their further rearing have been described.

Along with success achieved in seed production techniques of rearing and preparation of nursery ponds have been considerably improved and modified so that a fish farmer could now nurse as many as 10 million spawn per ha. with survival rate of over 65%.

Mass culture of fish-food organisms

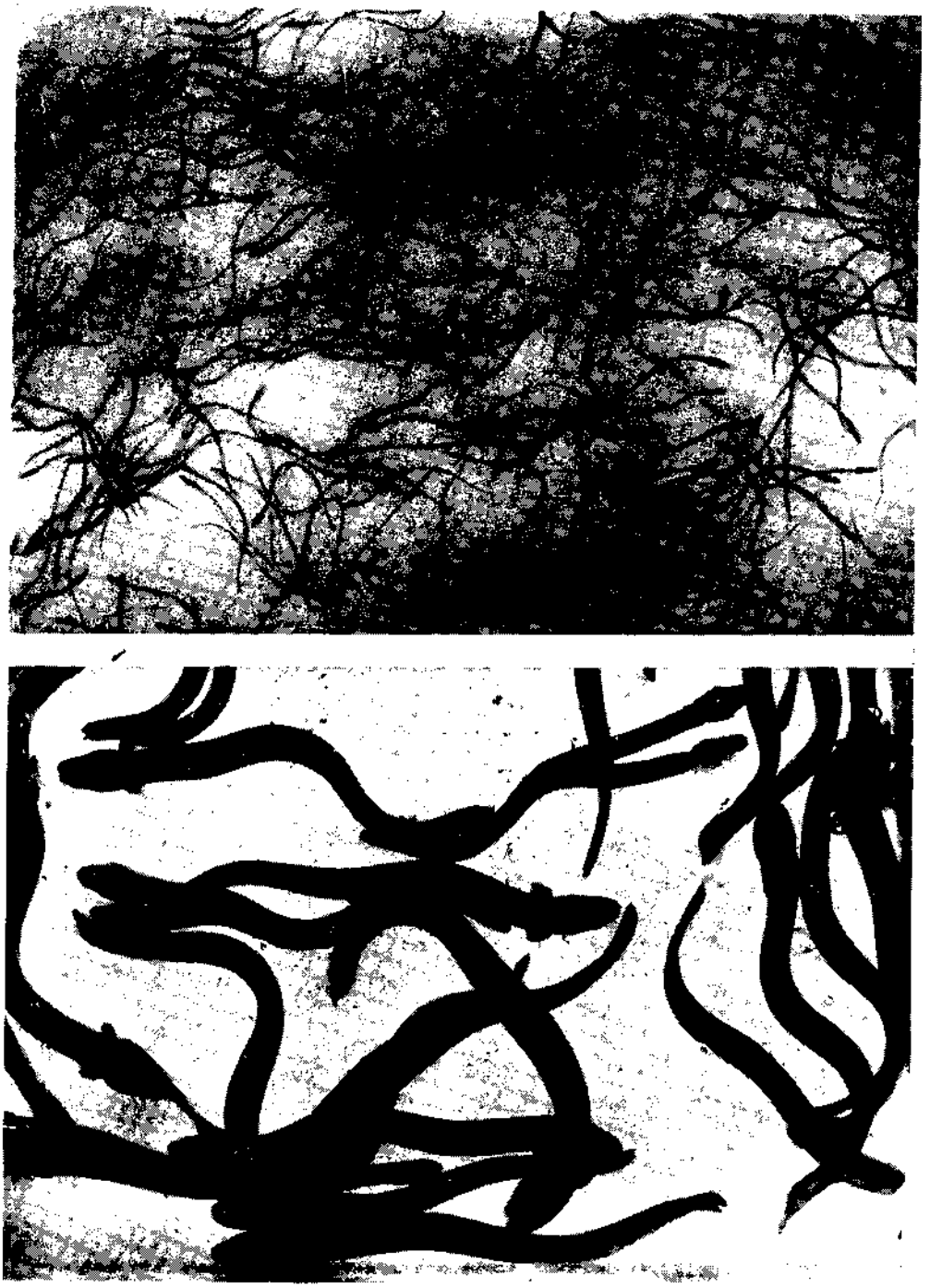
Mass culture of *Chlorella vulgaris* and *Daphnia similis* has been developed with inorganic fertilizers and poultry manure as sources of nutrients. Freshly cultured *Chlorella* was used as food of *D. similis*. This development would lead to establishment of fish-feed farms.



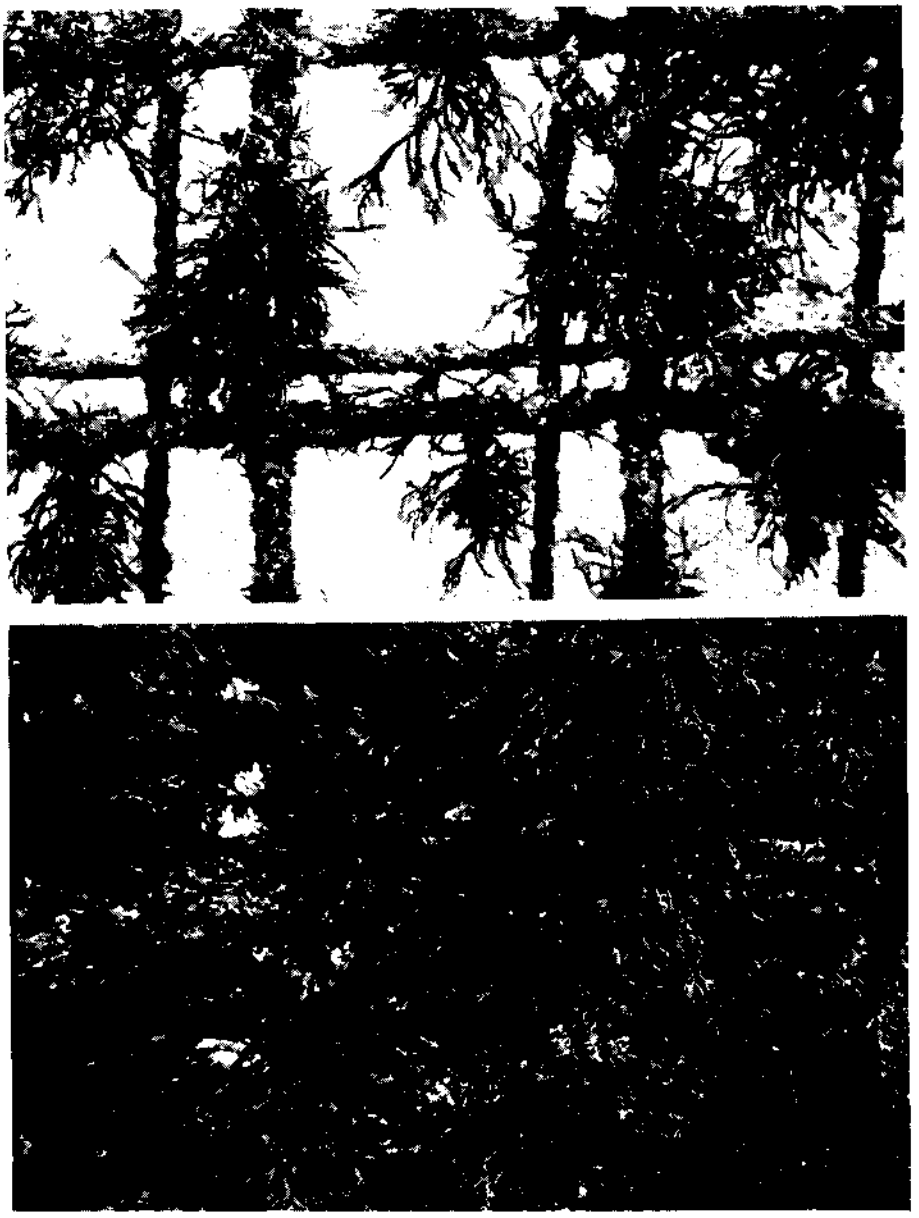
A glass-jar hatchery complex for induced breeding of fish

Composite fish culture

A system of pond management called mixed fish farming or composite fish culture which was practised in

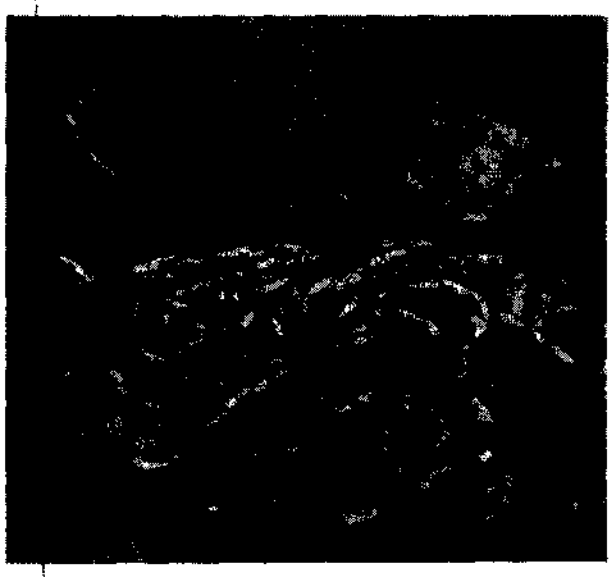


Top and Bottom: Elvers and cultured eel at CMFRI Regional centre at Mandapam Camp



Culture of sea weed *Gracilaria edulis*, CMFRI Regional Centre, Mandapam Camp

many parts of the Southeast Asian countries in ancient times, is now being practised in our country also with remarkable success. The basic principle of composite fish culture is that, fast growing compatible species of fish of different feeding habits, or different weight classes of the same species, are stocked together in the same pond so that all its ecological niches are occupied by fishes yielding high production per ha. of water body.



A haul of fish from a pond under composite fish culture

In order to increase the per-hectare production from fish culture ponds, initial experiments with differerent combinations of Indian major carps (Catla, rohu and mrigal) gave productions of 1,500–3,000 kg/ha/yr. However, when exotic carps (silver carp, grasscarp and common carp) alone were cultured, production of about 3,000 kg/ha/yr was obtained. But a combination of Indian and exotic carps in the ratio of 1:1 : 1;3 : 1.5: 2.5 of catla (*Catla catla*), rohu (*Labeo rohita*), mrigal (*Cirrhinus mrigala*), silver carp (*Hypothalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*) and the common carp (*Cyprinus carpio*) gave a production varying between 2,200 to 4,200 kg/ha/yr. With intensive fertilization and supplementary feeding and higher rate of stocking (10,000 fingerlings/ha) gave a net production ranging from 8,000 to 9,000 kg/ha/yr. In these experiments each of the six species have attained a weight of over 1 kg. This technology when applied to a farmer's field would increase the yield sevarl times from the average production rate of 600 kg/ha/yr from fish ponds in India.

The technology of composite fish culture has been applied to different agro-climatic conditions through a Co-ordinated Project. The results are given in Table 4.

Table 4. *Yield from composite culture of Indian and exotic carps (six species combination)*

Centre	Production rate (kg/ha/yr)
Kalyani	6521–7820
Poona	5136–5596
Bhavanisagar	2570–3499
Jaunpur	4199–4693
Karnal	5135–6052
Sunkesulla	2602

In brackish waters composite culture of prawns and mullets (in a six species combination) gave a net production of 2,617 Kg/ha/yr.

Under the operational Research Project at Krishna Nagar, West Bengal, the technology of composite fish culture is demonstrated to fish farmers. Adopting suitable management policies and multiple cropping, yields of over 3,637 kg/ha/yr were obtained.

Air-breathing fish culture

Swampy or derelict waters which are not utilized for any productive purpose extend to about 0.6 million ha in our country. The carrying capacity of swamps is high due to organic matter in the bottom silt and the occurrence of a variety of benthic fauna. The air-breathing fishes such as *Heteropneustus fossilis, Clarias magur, Anabas testudineus, Ophiocephalus* spp., *Notopterus*, etc. constitute the natural fauna of swamps and they have high protein and low fat content. Under the Co-ordinated Project on culture of air-breathing fishes, in controlled and mixed culture of these fishes a gross production of 1,200 kg/ha per 7 months was obtained in Bihar. In Karnataka, the production of 3,159 kg/ha/8 months was obtained in the monoculture of murrels in swamps. In Assam, cage culture experiments yielded 35,000 to 50,000 kg/ha in 200 days when computed over the production per cage area.

Frog culture

In yard and field experiments, natural environment was stimulated for the culture of frogs such as *Rana hexadactyla*. This species breeds continuously for three months in rainy or cloudy weather. 100% hatchings of eggs was obtained and 3,000 tadpoles developed.

Provision in the ponds of *Hydrilla* and *Lemna* gave a high rate of growth and survival. A survival of 90% metamorphosed juveniles was possible. Early juveniles were fed with termites and other insects and these grew to 15–60 mm size. By induced breeding 7,600 hatchlings of *Rana tigrina* were obtained. A survival of 70% tadpoles was obtained by controlled feeding. Reduction of water column with progressive growth hastens metamorphosis.

Freshwater prawn culture

Culture experiments on fresh water prawns are mainly carried out on *M. rosenbergii, M. malcolmsonii,* and *M. idella.* All these prawns have been bred under laboratory conditions and their larvae reared to stocking size. Experiments on large scale culture of these prawns are progressing. Preliminary experiments on the field culture of *M. rosenbergii* have indicated that the species grows well in ponds stocked with silver carp and mrigal, and the monoculture of *M. malcolmsonii* with a stocking density of 20,000 per ha. has realised a net production varying between 285 and 380 kg/ha/year. Natural seed resources of *M. malcolmsonii* have been located over the anicuts at Dowaleswaram on the river Godavari and near Cuttack on the river Mahanadi.

4

Aquatic Weeds and Their Control

Some aquatic weeds reproduce and grow to menacing proportions and they choke the water areas posing serious problems to pisciculturists as the weeds cause de-oxygenation and eutrophication.

The common weeds infesting our inland and estuarine waters are: *Salvinia auriculata, S. natans, Eichhornia crassipes, Pisita stratiotes, Lemna minor, Utricularia vulgaris, Myriophyllum spicatum, Hydrilla verticillata* and species of *Najas, Vallisneria, Nymphea, Colocasia* and *Panicum*.

A large percentage of the inland fresh water areas in India is rendered useless for the cultivation of fish on account of large infestation of weeds. Profuse growth of the aquatic vegetation in the water bodies cause imbalance in the nutrient and oxygen content, limits living space for fish, upsets the physico-chemical equilibrium of the water, restricts plankton production, promotes accumulation of deposits leading to silting, increase the turbidity of waters, provides shelter to predators and obstructs fishing operations.

The common methods adopted for control and eradication of aquatic weeds are manual, mechanical, chemical and biological.

Physical control

Physical removal of weeds is the oldest and the most common method used all over the world. However, the equipments used for this purpose have undergone

considerable improvements. Physical control of aquatic weeds is free from residue of pollution problems. However, repeated removal of massive quantities of vegetation from a water body removes large quantities of nutrients from it. This may reduce food production in the primary as well as secondary trophic levels. Physical weeding is a non-selective process so that the chances of establishment of a specific weed are remote. Mowing, crushing, raking, burning and mechanical chaining, dredging and netting are some of the well known physical methods. Recently in some advanced countries, underwater weed cutters and ditch-bank movers have replaced older methods.

In India where labour is cheap, manual methods are often employed to remove weeds. In small water bodies, traditional methods of hand picking, uprooting of emergent and marginal weeds and cutting them with scythes are considered suitable. In West Bengal weed cutting launches having 'V' shaped sickles have been used for cutting *Colocasia* and other tall weeds in shallow waters. Power winches are employed in Assam to clear shallow waters thickly infested with water hyacinth. Recently diesel operated winches are used in Orissa to eradicate dense rooted submerged vegetation. Marginal weeds could also be controlled by grazing and deepening of the marginal shelves; floating weeds can be prevented from spreading by draining, desilting and by erecting barriers.

Chemical control

Chemicals can provide an efficient means of reducing or eliminating the growth of undesirable aquatic weeds. A single herbicide that controls the weeds and at the same time is absolutely safe to all the water uses is yet to be developed. The main considerations in the use of herbicides in fihsery waters are that they should be (i) effective in killing weeds at reasonably low rates of application, (ii) cheap and easily available, (iii) non-toxic to human and stock animals and (iv) should not pollute the treated water or have any adverse effect on the water and soil. However, the advantage of chemical control is that the chemicals can reach the weeds otherwise inaccessible to mechanical or other methods of control. Unlike the mechanical control, chemical control sinks the weed growth to the bottom avoiding thus loss of plant nutrients from the water bodies. The common herbicides widely used are: Copper sulphate pentahydrate (CSP), Acrolein, Silex (Fenoprop or 2,4,6-TP), Simazine, Diuron, Monuron, Endothall, Dalapon, ATA (amitrol) and so on.

In our country, hyacinth, lotus, lillies, cyperus, *Typha* and *Ipomea* are controlled by the use of herbicides such as 2, 4-D sodium salt, hormone weedicide, which are easily available at cheap rates. Taficide 80, in combination with detergent 'Surf' at 0.25% concentration kills water hyacinth as well as Simazine at the rate of 5 kg per ha. sprayed in aqueous emulsion. Dalapon is effective against aquatic grass, *Panicum*. Other floating weeds such as, *Pistia* and *Salvinia* have been controlled by H. S. D. and Powerine. Gramoxone has been found to clear more than 90% of Pistia infestation. Taficide 80, Tafopon and 2, 4-D are effective against marginal weeds. Copper sulphate alone or in combination with ammonium sulphate has been used for controlling *Chara*, *Hydrilla* and *Vallisneria*. Sodium aresenite at 5–6 ppm, superphosphate at 500 ppm and urea at 50–100 ppm are quite effective in killing submerged weeds. Ammonia is toxic to all aquatic vegetation; though it kills fish, economic forms can be saved by sectional treatment. Simazine at 0.5 – 1.0 ppm could effectively control algal blooms. Noxious blooms of *Peridinium* sp. could be cleared by aqueous ammonia (2 ppm). Blooms of blue green algae *Microcystis* could be controlled by Diuron herbicide at about 0.3 ppm.

Biological control of aquatic weeds

A paucity of natural enemies is one of the main reasons for the abundance and aggressive nature of the weeds. Introduction of a suitable bio-agent can restore a desirable balance in the aquatic ecosystem by reducing weed growth without polluting the water. Bio-control is relatively permanent in its effect since the aquatic flora (the host) and the bio-agent tend to remain in a cyclic equilibrium.

Certain weeds can be controlled by selected varieties of herbivorous fishes such as grass carp, common carp, silver carp, Tilapia and silver dollar fish. Aquatic birds, mammals and some species of snails are also effective in bio-control. Certain insects like flea, beetle are specific feeders of the aligator weed.

The menace of 'African Payal'

In many areas of Kerala and Tamil Nadu, inland water masses, estuariecs and also inshore regions of the sea are infested on a large scale during certain seasons by the weed commonly known as 'African Payal' (*Salvinia* spp). This weed grows and spreads very fast and it affects pisciculturists, as well as paddy cultivators. The weed also affects movements of inland transport. Fish culture ponds, farms and paddy fields when infested with this weed creates de-oxygenation and mortality to fish fauna. Sluice gates, fishnets, and tackles are clogged by this weed. The propeller and other mechanical parts of fishing and transport vessels are choked by this weed resulting in obstruction to their free movement. During tidal movements especially in the backwaters and estuaries, the large quantities of these weeds are transported to the inshore regions of the sea and they pollute the beaches and intertidal zones thus affecting the littoral fauna. The inshore benthic community is also affected to a great extent by the settlement of dead and decaying *Salvinia*. The control of this weed has been engaging the attention of research institutes since 1966. The CIFT has developed two types of harvesting machines one for eradicating submerged weeds and the other for removal of both submerged and floating weeds. The area occupied by *Salvinia* at times is so vast that physical removal involves considerable labour and cost. Chemical control would involve the use of large quantities of chemicals which may pose a threat to the inland and estuarine fauna. Methods of controlling this weed by biological means such as using the insect *Polynea* sp. or a Hymenopteran has not made much headway. The control of this weed needs co-ordinated efforts by research institutions, other government agencies, and the public.

It may also be necessary to investigate whether *Salvinia* could be put to some use. The resources are said to be insufficient to support an industry such as the manufacture of coarse packing boards.

5

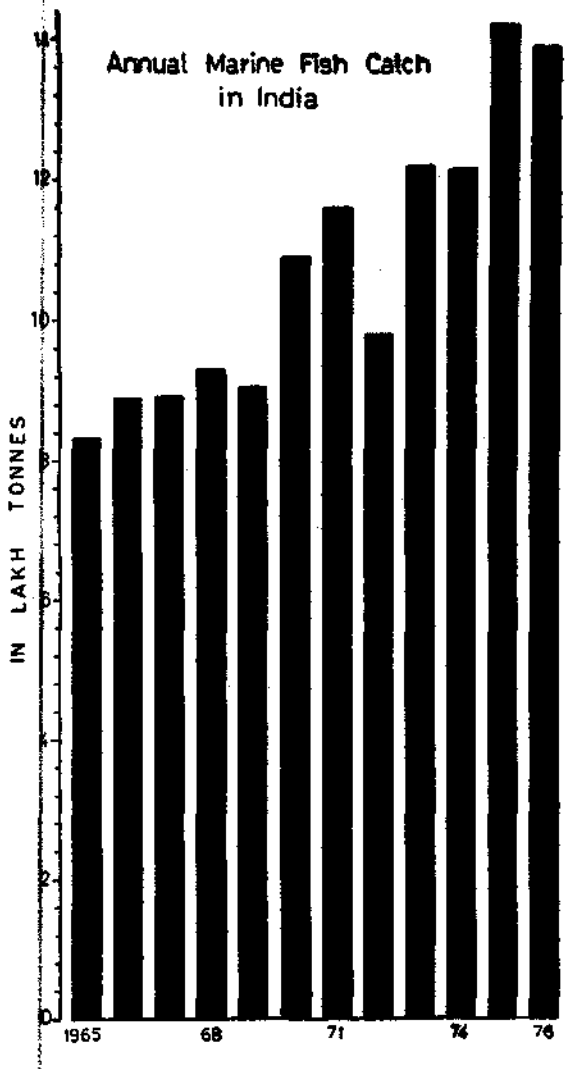
exploited and potential fishery resources

MARINE FISHERY RESOURCES

As indicated earlier, marine fishery resources of the country are characterised by a variety of fishes, crustaceans and shell fishes, that co-exist in the fishing grounds. The fishery at present is restricted to the inshore waters of the continental shelf. The topographical features of the coastline and the environmental and meteorological conditions on the east and west coasts influence the distribution pattern and seasonal abundance of fishes. This together with the diversity of fishing crafts and gears employed in the fishing, numerous landing centres distributed all along the coast and the conservative nature of the fishermen, make the collection of fishery statistics data more complex and complicated. Taking into consideration the various characteristics of the marine fisheries of the country, a multi-stage stratified random sampling over space and time has been evolved at CMFRI to collect the exploited fishery resources data. Under this system,the entire Indian Coast is divided into zones, each zone comprising of about 20–30 landing centres. From each zone, a trained field staff collects information on the fish landings, gears employed, effort expended, and data on size, weight and maturity conditions of the major commercial species, price structure and developing infrastructure facilities. Based on these data, estimates of species-wise, gear-wise and the season-wise catch for All-India as well as for each State are made. Trend of exploited fishery resources in terms of catch and effort, season and region, as well as variety is studied.

For the 15 year period, 1962–1976, the maximum, minimum, and average marine fish production for the country as a whole were 14,22,693 tonnes (1975), 6,44,244 tonnes (1962) and 1011484 tonnes respectively. All India and State-wise annual catch are depicted in the accom-

panying Map. Most of the fishing at present is confined to the near shore waters up to about 50 m depth. Along the south-west coast of India, the fishing has been extended to grounds beyond 75 m to about 450 m along the



Total annual marine fish catch in India 1965–1976

upper continental slope for perches, deep water lobsters, prawns and fishes. The explored areas in the continental shelf, the continental shelf edge and the upper continental slope are also shown in the Map. Among the maritime States, Kerala ranks first in the total marine fish production followed by Maharashtra, Tamil Nadu (including Pondicherry), Gujarat, Andhra Pradesh, Karnataka, Goa and West Bengal and Orissa. The best fishing seasons for the country as a whole is during October to December, when all the maritime States of the west coast of India record higher landings. For Maharashtra and Gujarat the period July to September and for Kerala and Karnataka the period April to June, are relatively poor. On the east coast, conditions vary from State to State. In West Bengal and Orissa, the peak fishing period is during October to December, while in Andhra Pradesh and Tamil Nadu, it is from January to March. Fishing is relatively poor in these two States during the period April to June.

The trend of exploitation of marine fishery resources shows a steady increase in the demersal fish catches along the Maharashtra Coast, a decrease in the fishery for Bombay duck in the Gujarat waters, and wide fluctuations in the mackerel and sardine fisheries along the Kerala, Karnataka and Goa Coasts. Hardly anything is known about the pelagic fishery resources of the north-west coast and the east coast. Available information indicates the occurrence of mackerel, sardine, lesser sardines, anchovies, carangids and other important groups of pelagic fishes from these areas also. Epipelagic and Meso-pelagic fishes such as Myctophidae and oceanic squids may also form important components in this area. There is an urgent need for planned exploratory surveys in these regions to assess the pelagic fisheries potential.

The All-India fishing effort shows an overall increase. However, the catch and catch per unit effort evince variations mainly due to the large scale fluctuations in the major pelagic fisheries for mackerel and oil sardine. The catch per unit effort for the country as a whole is not more than 5 kg per man–hour. Along the west coast, in Gujarat the catch per unit effort is less than that of the other States.

Estimates of 10 to 20 million tonnes of potential fish production for the Indian Ocean have been given by various authors based on the relative productivity of the waters, exploratory surveys and so on. For the Indian Seas, the potential annual fish production has been estimated at about 4 million tonnes, which in other words represents slightly over a three fold increase of the present. Recent surveys carried out in the depths beyond 50 m have brought to light the potentially good fishing grounds for demersal fishes and shelf fishes at different depths along the continental shelf edge and upper continental slope. In the sub-surface

or column waters in the deeper neritic zones and upper continental slope, the potential resources of *Nemipterus* spp. *Emmilicthys* sp., *Psenes indicus, Chlorophthalmus agassizi, C. corniger, Cubiceps natalensis, Pseniopsis cyanea* and Prawns such as *Parapandalus spinipes, Heterocarpus gibbosus, H. wood-masoni* and *Aristius* sp. are available. Along the northwest coast of India, an abundance of the catfishes in the depth zone 40–59 m and elasmobranchs in the depth zone 60–75 m has been recorded. Good catches of deep-sea lobsters and the deep-sea prawns along the upper continental slope off Quilon are indications of good potential resources along the upper continental slope. Estimated potential demersal fishery resources of the continental shelf edge and the upper continental slope of the southwest coast of India are given in Table 5.

Table 5. *Estimated potential demersal fishery resources of the continental shelf edge and the upper continental slope off the southwest coast of India*

Depth zone	Area (Sq. km)	Estimated total demersal fishery resources based on average catch rates (in tonnes)	Estimated potential sustainable yield at 60% (in tonnes)
Depth zone - I (75–100 m)	11,363	7,542	4,525
Depth zone - II (101–179 m)	11,916	32,556	19,539
Depth zone – III (180–450 m)	20,240	58,891	35,335

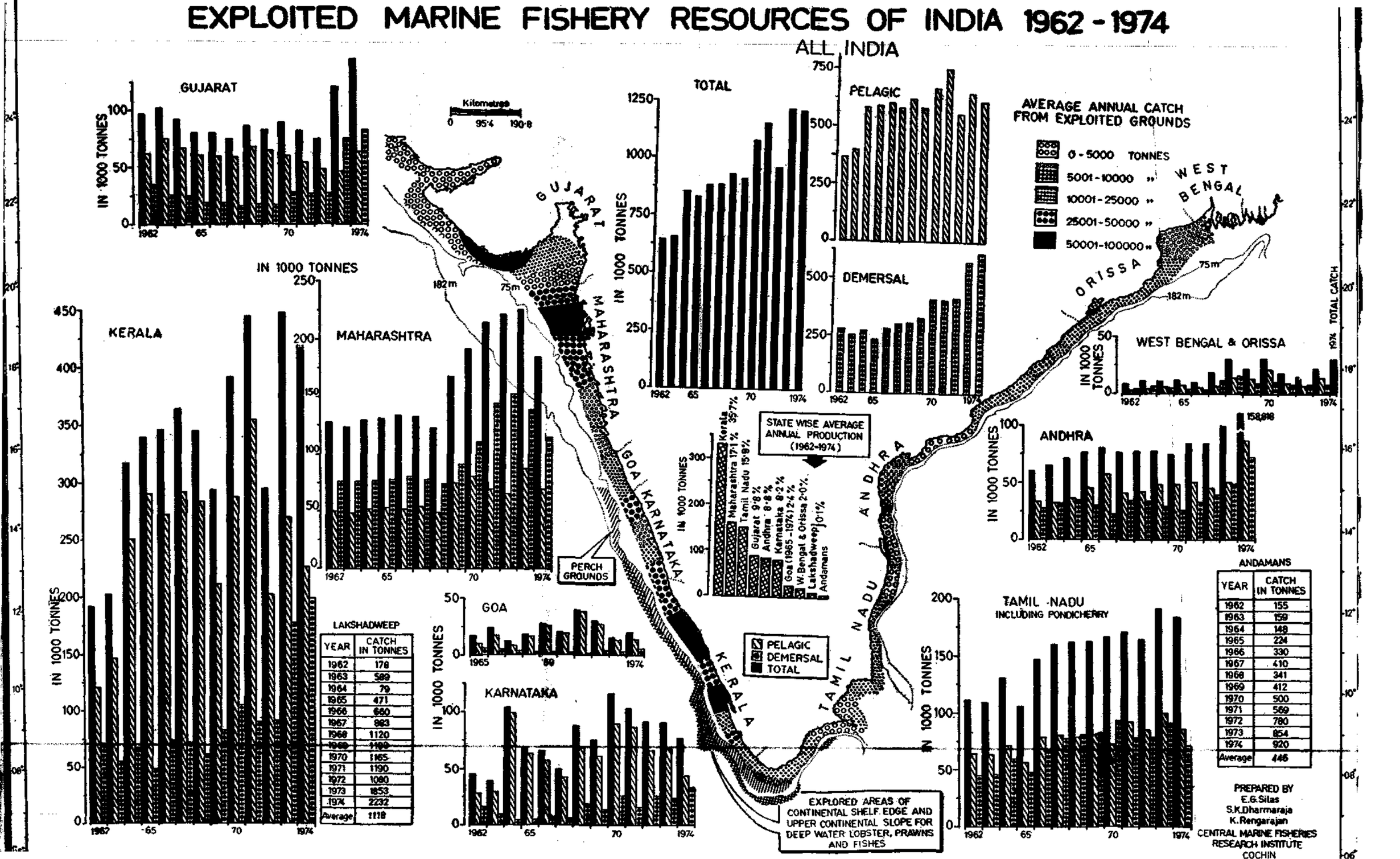
The studies carried out on the major pelagic fishery resources of the country (oil sardine and mackerel) have indicated that an increase in the fishing effort in the traditional fishing grounds, will not yield any increase in the catch of these fishes. The average annual stock of these two major fisheries has been estimated as 127,000 tonnes for mackerel and 400,000 tonnes for oil sardine in the present fishing grounds. The surveys have also shown that along the west coast in depths upto 40 m there exists a diversity of species such as anchovies, ribbonfishes, catfishes, silverbellies and lesser sardines of several hundred thousand tonnes.

Besides these conventional resources, exploratory surveys have also indicated potential of rich resources of cuttlefishes, squids, oceanic crabs, deep sea gastropods, oceanic tunas and pelagic sharks. The large populations of dolphins and lesser toothed whales in this area are yet another indicator of the rich pelagic fishery resource of this area. Although there has been some decline in the catches of whales from the Indian Ocean, it is reported that a good number of them are available in the southern Indian Ocean.

Besides the exploitable resources available in the sea, the potential for coastal aquaculture is considerable taking into account the vast areas along our coast which include inundated areas, coastal lagoons, swamps, etc. It is estimated that about 2.6 million ha. of estuarine and brackish water areas are suitable for culture of marine fishes, prawns, molluscs, etc. of which only about 15,000 ha. are utilized at present. The culture technology developed in the country has indicated that a production rate of above 1000 kg/ha/year of prawns; 235 tonnes of mussels with shells /ha/season could be obtained. There is also considerable scope for the culture of economically important seaweeds in our costal waters particularly in the lagoons of Lakshadweep Island and in the protected bays of the Andaman and Nicobar Islands as well as in some areas along the east coast. Culture of fishes such as milkfish, mullets, *Sillago* and pearlspot has great possibilities in coastal aquaculture. Sea cucumber is yet another species that can be cultured in the lagoons and protected bays. It will not be too long before proper techniques for the culture of lobsters and other animals such as turtles especially the green turtle, *Chelonia mydas* are developed.

With the increasing research activities and explorations on fishery resources and corollary subjects by several national and international organisations, voluminous data on different aspects are being collected. A need has been felt to store these data in a central place for ready reference and better analysis, so that the results could be made available to the interested agencies whenever required. With this in view, a Fishery Data Centre has been established at the Central Marine Fisheries Research Institute and it has started functioning with the use of modern equipments. This centre when fully developed would form a depository of all data pertaining to fish and fisheries of the country.

EXPLOITED MARINE FISHERY RESOURCES OF INDIA 1962 - 1974



LAKSHADWEEP

YEAR	CATCH IN TONNES
1962	178
1963	589
1964	79
1965	471
1966	660
1967	983
1968	1120
1969	1189
1970	1165
1971	1190
1972	1080
1973	1853
1974	2232
Average	1118

ANDAMANS

YEAR	CATCH IN TONNES
1962	155
1963	159
1964	148
1965	224
1966	330
1967	410
1968	341
1969	412
1970	500
1971	569
1972	780
1973	854
1974	920
Average	446

PREPARED BY
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Scientists of CMFRI getting ready for under water exploration using SCUBA

Survey of the pearl bank at Tuticorin

Edible oyster beds at Attankarai

Sacred chank at Tuticorin ready for market

INLAND FISHERY RESOURCES

In India, the collection of basic data on inland fish production is handicapped by various factors such as the highly dispersed and isolated nature of fishing and landing areas, the diversity of fishing gear and tackle employed, a high percentage of subsistence fishing, the innumerable landing centres, the migration of fishermen from one place to another for fishing, the disposal of the catches to fish merchants from the fishing boats at the fishing spots, the multispecies composition of the catches, the landing of catches in unsorted condition and the limited nature of transport facilities for making direct observations at lower estuaries and remote landing centres. Besides the above, the vast expanse of the fresh and brackish water areas in India poses additional problems as far as the estimation of fish production is concerned. It is estimated that the main rivers of India including their important tributaries have a total length of about 27,000 km, a network of canals and irrigation channels extends to over 112,000 km, the lakes and reservoirs cover an area of about 2.9 million ha. and fresh ponds and lakes extend to about 1.6 million ha A sampling technique that has proved to be effective in the estimation of total landings, such as at the Hoogly-Matlah estuarine system and the river Godavari, is that based on the relation between actual catch and effort potentialities in a region, which requires a total enumeration of effort potentialities in the form of craft, tackle and fishermen population in the entire region as a prerequisite. However, the multiplicity of gears in use involved in both inter-and intra-type variations create additional problems in estimating the total effort.

The inland fish production in India was estimated at about 200,000 tonnes in 1951 and over 860,000 tonnes in 1975–76, registering almost a four-fold increase. As seen from the available statistics for 1975–76, out of the 860,000 tonnes of inland fish, West Bengal accounted for 260,000 tonnes, Tamil Nadu 175,000 tonnes, Andhra Pradesh 100,000 tonnes, Bihar and Karnataka about 65,000 tonnes each and Kerala, Orissa and Uttar Pradesh 25,000 tonnes each. Among the major varieties of freshwater fishes supporting the fishery are crabs, catfishes, live fishes, prawns, featherbacks, mullets, eels, herrings and anchovies. Table 6 gives production of inland fish in India from 1961–62 onwards.

Table 6. *Production of inland fish in India from 1961-62 onwards (in 1000 tonnes)*

Year	Catch
1961–62	269.8
1962–63	261.4
1963–64	314.8
1964–65	412.3
1965–66	458.3
1966–67	473.4
1967–68	533.3
1968–69	616.8
1969–70	646.2
1970–71	659.1
1971–72	683.6
1972–73	734.5
1973–74	784.1
1974–75	803.8
1975–76	862.7

Of the total inland fish production of 0.8 million tonnes, capture fisheries contribute to less than 10%. Nevertheless by introducing improved technology of fishing it will be possible to step up the yield significantly. However, greater prospects of augmenting inland fish production is through the development of an organised culture fisheries. It is now considered possible to produce on an average 2000 kg/ha/year from freshwater culture fisheries, leading to a production of 3.5 million tonnes of fish from freshwater culturable areas.

6

fisheries technology

Fisheries technological research in India received very little attention prior to the establishment of the Central Institute of Fisheries Technology. Steady increase of fish production and the prospects of further exploitation of fishery resources made it imperative to organise proper research on design of fishing crafts, gears, fishing techniques, methods of handling, means of preservation and utilisation of fish. The progress of research and development on different aspects of fishery technology during the last three decades are discussed below.

Fishing crafts

The implementation of the programme of craft mechanisation in India was broadly divided into a 'Base' and four development phases, *viz*:

Base	...	Country craft
1st development phase	...	Country Craft motorization
2nd development phase	...	Introduction of small mechanised boats
3rd development phase	...	Introduction of more specialised boats
4th development phase	...	Broadening into fishing fleets

A survey on the traditional fishing crafts of the country has shown the existence of 17 principal types of fishing crafts, which fall under the following broad classes according to the locality:

1. Plank-built boats of the west coast — North;
2. Dugout canoes of the west coast — South;
3. Plank-built boats of south-east coast,
4. Catamarans of the Coromandel Coast;
5. Plank-built boats of the Andhra Coast;
6. Plank-built boats of the north-east coast.

These crafts have been indigenously evolved on the basis of their suitability for operation in the respective local condition. All of them are using oars or sails as the main aid for propulsion.

The motorisation of the indigenous crafts is perhaps the first step in the introduction of fully mechanised fishing. In many of the Indian maritime States, there is a general paucity of indigenous fishing boat types which could take in a motor. The following list indicates the indigenous designs which were found to be suitable for motorisation.

1. Lodhias and Machwas	West Coast -North
2. Satpati and Versova boats	

3.	Tuticorin boats	South-east coast
4.	Andhra Nava	Andhra Coast
5.	Chot and Batchari boats	North-east coast

These boat designs were motorised, a few on an experimental basis and the others on a fairly extensive scale.

To replace the dug-out canoes and catamaran which operate from the open surf beaten beaches with motorisd boats, several experiments were conducted to evolve a beach landing boat. A number of prototypes were constructed and trials taken. Although, as a result of these extensive trials, a fairly good idea of a standard design could be formed, the main difficulty encountered was the lack of trained personnel for handling such a boat on the beach and while negotiating through the surf.

A purse seiner

Many designs of small and medium sized mechanised boats to be operated from harbours and sheltered bays were introduced into the fishing industry since the year 1953. The base of this mechanisation programme was the design popularly known as "Pablo". More and more larger boats were introduced in subsequent years. With the introduction of larger boats gear handling and fish detection facilities were also improved. Commencing from the designing of a mechanized beach-landing craft, 12 designs of fishing boats in the size range of 7.6 to 15.2 m suitable for operation from harbours, creeks and sheltered bays were developed. Detailed drawings and specifications of these were supplied to interested agencies. Besides these, six designs of fishing boats 6.24 to 9.12 m long for reservoir fishing, one boat 11.6 m long for pole and line fishing, and one boat of 18.42 m of trawling-cum-fish-carrying vessel and another of 17.5 m steel trawler-cum-purse-seiner were prepared and supplied against specific request. Attention is now directed towards larger class of steel vessels. Fishing boat development has thus registered steady progress.

With the increase in the cost of construction material of conventional fishing craft, a detailed study of the properties of various indigenous timbers was under-taken and 30 different species of timber were identified as suitable substitutes. The use of such secondary timber for the construction of fishing craft would bring about considerable savings. Similarly, investigations showed that the use of aluminum-alloy sheet in place of costly copper sheet used as sheathing material for wooden boats would bring about substantial savings in cost and foreign exchange.

Fishing gear and methods

The indigenous gears, in the country are mainly gill nets, bag nets, boat and beach seines. The advent of mechanisation of the crafts, however, did not greatly benefit in the early years the gear in use and the method of their operation. In fact, initially, the mechanised crafts still used the indigenous gears. It soon became apparent that returns by way of catch was not commensurate with the extra investment on mechanistion. Stern trawling, particularly for prawns, was attempted even with the small boats and met with unprecedented success. Consequent to the expansion of the prawn processing industry, the interst in this new fishing method grew steadily and has come to stay. The Indian Standards Institution have also brought out requisite standards for the stern trawling gear for the different class of vessels. The other gear and methods to be introduced are outrigger trawling, midwater trawling, purse-seining and long lining. Specifications on different net materials have also been worked out.

Several new designs of fishing gear were introduced during the last few years. Particular mention may be made of a design of a 15.25 m four-seam trawl for operation from a 9.45 m trawler and a 15 m bulged belly trawl suitable for a 10.97 m trawler. The main advantage of these nets is the enhancement of the catch by about 30%. A special gill-net was evolved for lobster fishing so that the lobsters caught suffer the least injury.

Several mechanical fishing accessories, ancillary fishing equipment and electronic testing devices of practical value in fishing operation were evolved during the past few years. These include a combination of winch for a 7.67 m boat, a power-isolation clutch for power transmission from engine to winches, designs of gallows, jockey pulleys, and mechanical spraying arrangement for chumming of fish. Among the electronic devices, mention may be made of designing of impulse generator for carrying out electrical fishing. A telemetry-type electromechanical net-depth meter for continuous measurement of the depth of operation of the trawl net was developed and its prototype was successfully fabricated and tested. The two mechanical deweeding machines developed for operation in small and medium inland water-bodies proved to be highly beneficial in eradicating floating as well as submerged weeds from waters used for fish culture.

The advent of synthetic man-made fibres is yet another landmark in fishing gear development. The non rotting character of synthetics is of great importance, particularly in tropics. The laborious and expensive rot-proofing treatments can be dispensed with and gear could also be stored without drying. Gill nets, in particular, have greatly benefited by man-made fibres. The main requirements of materials for gill nets are fineness, pliability, elasticity, durability and invisibility when used in water. Polyamide (Nylon) continuous filament yarns are, therefore, in great demand for gill nets.

For most parts of a trawl net the theoretical requirements are to have fine twines to minimise hydraulic resistance against current. The twines should be strong and be of low specific gravity so that the net fully opens up under water. Suitable synthetic materials are polyamide, polyethylene and polypropylene, which are all manufactured within the country. Polythylene and polypropylene are usually in the form of twisted monofilaments. High density polyethylene are also available in the form of tape-twisted twines and fibrillated tapes for twisting, both of which processes eliminate knot slippage.

Six net making factories are in operation in the country. More factories are likely to be established, when the demand for machine made webbings increases. Indian Standards Institution have already issued standards for the different textile materials used in fishing gear.

Fish processing and product development

The traditional form of processing in the country was salting and sun-drying . Since this form of processing is likely to continue for years to come, primarily to cater to the needs of the rural areas, many forms of artificial dehydration units like tunnel dryer, single and multideck; rotary drum dryer and solar dryer have been developed using indigenously available materials. These equipments ensure production of good quality products.

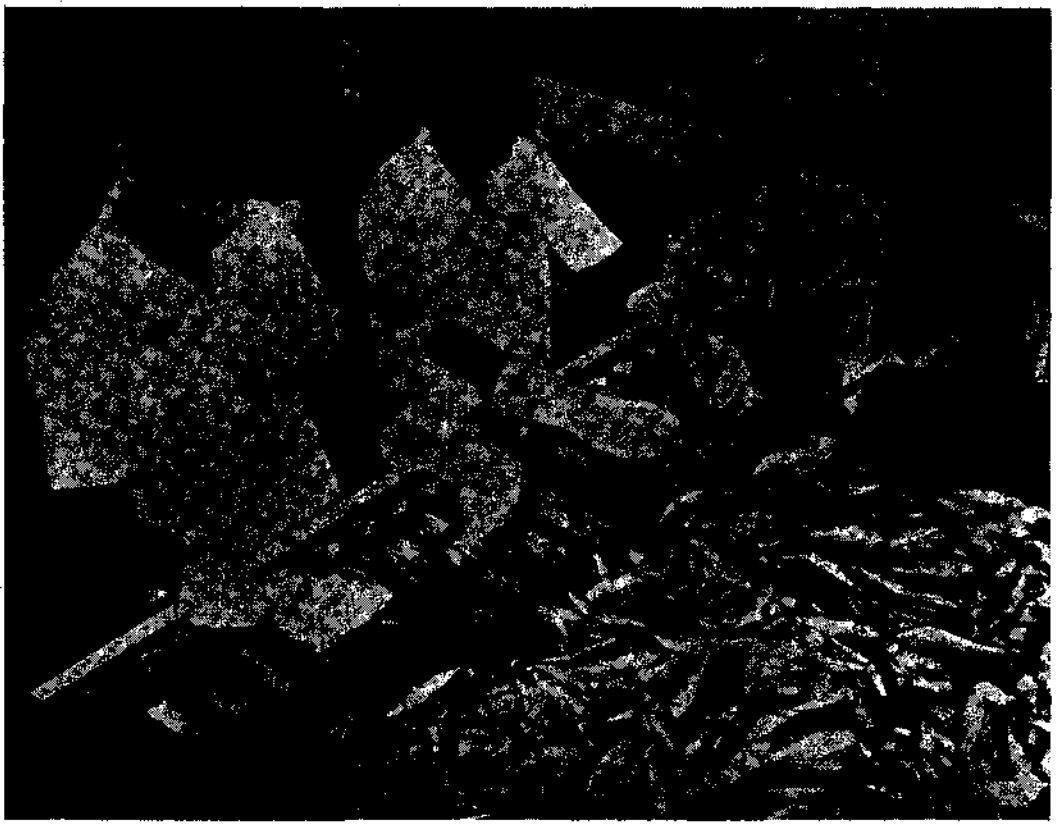
Cleaning shrimps in a freezing plant

The traditional cured products have limited shelf life and unattractive appearance. To obviate both these defects extensive research has been undertaken. Rubbing the normally cured fish with salt containing 3% sodium propionate has been found to be very effective in preventing mould growth and attack from red halophylic bacteria, thus presenting an attractive apperance to the product with extended shelf life of over 4 months. Improvement over the traditional method of 'Colombo curing' of mackerel incorporating sodium benzoate and other fishes using tartaric acid and garlic as preservatives, development of processes for smoke curing different fish are other significant achievements.

In the urban centres as well as in the export of fishery products, a thorough shift has been noticed from traditional dry/cured products to more sophisticated ones like frozen and canned. Microbiological investigations on fresh fish and shell fish brought out

the pattern of changes in the qualitative and quantitative composition of microflora in fresh and icestored fish as well as frozen fish products. This has helped in eliminating potential food-poisoning agents. A method for processing froglegs free from *Salmonella* infection was developed. This has helped in improving the quality of the export products. An effective method of pre-treatment of fish in 15% brine for 3 minutes was evolved for controlling belly-bursting during freezing and storage of oil-sardines, which was causing considerable loss to the industry.

With ready markets existing for frozen and canned prawns, the industry had in the past been reluctant to set foot on any other commodity, partly due to the uncertainty of the reception of the new commodity in the international market and partly because the technology of production of many products, which could have a demand, was not fully known. It is now clear that the future of the industry will entirely depend on diversification in the produce as well as markets both within the country and abroad. Of late, a greater awareness to this problem has been generated and significant contributions have been made by research laboratories to develop new fishery products. The Indian Standards Institution has also evolved quality standards for the different products developed.



Beheading and nobbing of sardine and mackerel

Fillets made from fish which are generally not considered as table fish e.g. kilimeen (*Nemipterus* sp.), cat fish (*Tachysurus* spp.) and sciaenids, when frozen into consumer type packs, have been found to have great demand in the domestic markets. Likewise flesh of other cheap varieties of fish, which do not find a ready market as such, can be extruded and made into frozen consumer packs. Jew fish, cat fish, sharks, skates, rays, anchovies, pomfret, seer, tunnies, threadfin, ribbon fish, eel and perches, when frozen in different forms like whole, filleted or in chunks can have, apart from domestic demand, export possibility. A method

has been developed for canning sardine in its own 'juice' called the 'natural pack' which besides dispensing with the use of the costly filling medium, also saves

Bactereological test for quality control

labour to some extent. To provide an impetus, there also exists a scheme for payment of 20% subsidy on the f.o.b. value of the exported canned sardines. Methods have also been developed for smoking and canning sardine in different media. Technology for canning mackerel in oil, has already been developed. Similarly, canning mackerel in 'natural pack' has also been perfected. However, the most significant method is one recently developed for canning mackerel as skinless and boneless fillets. Yet another species having a high potential in production from Indian waters is the anchovy. Methods have been developed for canning them in different media such as oil, sauces and the response from consumers have been good. Canning processes have been standardised for smoked eel, tuna, seer and cat fish. These products can also have possible export markets.

Crabs are good raw materials for canning. The main problem connected with its canning is the discolouration of meat during storage. This has been successfully overcome by proper bleeding of crab meat before cooking so that the copper and iron contents, the causative factors for blackening, come down to a level so that their effect become insignificant.

Mussels, clams and oysters are the untapped resources. They render themselves very well for canning and probably hold a good potential for export trade. Suitable methods have been developed for canning clams and mussels taking care of the problem of grittiness commonly met with, when such items are canned.

Whereas the problems faced by the organised fish processing industry can find solutions by the diversification programmes, the problem of utilisation of the so-called 'trash fish' still remained, until the launching of the All-India Co-ordinated Research Project on 'Utilisation of trash fish.' The project has made much headway and a number of products have been developed, some of which have been taken up by the industry for commercial production. Suitable methods have been worked out for preparation of fish wafers, fish soup in powder and tablet form. A process has been developed for the production of functional fish

Canning plant

protein concentrate as also the preparation of fish hydrolysate by using enzymes papain and pepsin. Bacteriological peptone prepared from 'trash fish' has been found to be equal in all characteristics to the

imported brands. A number of products prepared with fish meat in different forms like meat flakes,minced meat or hydrolysed, partially hydrolysed meat like canned fish paste, fish cake etc. have also been developed. Another item of importance is the solid food mix prepared with fish ensilage using defatted rice bran and other vegetable products.

A very simple method has been developed for preparation of edible fish flour from non-fatty fish with a view to incorporating it as a cheap dietary supplement for combating protein malnutrition of the rural population. The methods consists of cooking fish followed by drying, pulverization and partial removal of bones. Feeding trials have shown promising results.

Processing fish invariably produces wastes. Proper utilisation of waste can support an auxilliary industry. It is estimated that more than 40 thousand tonnes of waste, comprising prawn shell and head, is turned out each year by prawn processing industry alone. Prawn shell contains chitin which has application as such in the preparation of antibiotics or converted into chitosan used in textiles. Besides, this waste, particularly the head, contains a good amount of protein, which can be recovered and put to proper use.

Dried fins of shark form an item of export from India. The importing countries process them into fin rays. Processing of fins within this country for rays would not only save freight charges but also generate employment. A simple method for extraction of fin rays has been developed which can be used on a cottage industry basis.

The body oil from oil sardine contains highly unsaturated fatty acids. Because of this property, after proper modification, the oil can be used for many industrial applications. Methods have been developed for preparation of a mineral rubber used in rubber compounding industry, base for paints and printing ink and as a lubricant. It has also been shown that sardine oil has a potential in bringing down the blood cholesterol content.

7

fisheries education and training

In the year 1945, the Government of India sponsored the All-India Fisheries training courses at Barrackpore, Calcutta, for training in inland fisheries, and at Madras, with emphasis on marine fisheries as a part of the post-war reconstruction programme for training district level officers. For development of deep-sea fishing as a part of the post-war reconstruction programme, an *ad hoc* scheme for training of deck and engine side officers was initiated in 1948 to meet with the statutory requirements for manning of deep-sea fishing vessels. The above marked the beginning of organised programmes for education and training of fisheries in India, although the various State Departments of Fisheries had, even then, their own in-service training programmes for the staff recruited into their departments.

With the introductin of mechanised fishing and the accent on fish farming under the first and second Five Year Plans, it became clear that a programme of education and training had to be carried out simultaneously if these developmental programmes had to succeed. The Fishermen Training Centre established with FAO assistance at Satpati in 1954 was a forerunner of a chain of such centres in all the maritime States of India to train fishermen in operating mechanised fishing boats. Subsequently, to put the pattern of education and training in India on a firm base, a committee on Fisheries Education was constituted in 1959. This Committee recommended the setting up of two national level institutions. This resulted in the establishment of the Central Institute of Fisheries Education (CIFE) at Bombay in 1961, and the Central Institute of Fisheries Nautical and Engineering Training (CIF NET) (erstwhile Central Institute of Fisheries Operatives) at Cochin in 1963, thereby paving the way for proper institutionalised education and training programmes for fisheries in India.

The Indian Council of Agricultural Research (ICAR) has been playing a significant role in the field of Agricultural education as the University Grants Commission does in the case of general education. With the transfer of Central Fisheries Research Institutes to ICAR, the Council started taking active interest in promoting fisheries education in the country through Agricultural Universities, arranging advanced training of teachers and scientists in reputed institutions within and outside the country, awarding scholarships and fellowships, and through Krishi Vigyan Kendras (Farm Science Centres) and Trainers Centres. These activities are further strengthened with the creation of Department of Agricultural Research and Education (DARE) in 1973 which liase closely with the Central and State Governments. The various technical programmes of fisheries education and training under Indian Council of Agricultural Research are entrusted to the Scientific Pannel on agricultural education.

The aim of fisheries education and training in India is to develop skills and proficiency to increase the fish production through resources assessment, improved fishing techniques, handling, preservation, distribution and utilisation by applying modern know-how, and by efficient managment for achieving greater profitability and also for the social advancement of the fishing community, which has been traditionally backward. To achieve the above objectives, the fisheries education and training in India has been evolved under a four-tier pattern, namely;

Operative technical personnel for the artisanal fisheries (Base level);

2. statutorily required personnel for manning ocean going vessels and trained personnel for handling, processing and marketing as well as shore-based personnel for maintenance of vessel and machinery and fabrication of fishing gear etc. (Under- graduate level);

3. development and managerial personnel to plan and to be incharge of developmental programmes (Graduate and Post-graduate level); and

4. scientific and technical personnel for stock assessment, exploration, introduction of new technology etc. (Post-graduate level).

As the education and training requirements for each of the above category of personnel were different, necessary separate establishments had to be created at the State, national and University levels. In addition to regular institutionalised programmes, *ad hoc* training programmes are also conducted to meet specific needs.

Operatives for artisanal fisheries (basic level training)

The training of artisanal fishermen was started in 1954 with the establishment of Fishermen Training Centres in different States. These training centres have limited objective of training the fishermen in the operation of small mechanised fishing vessels and their maintenance. This is achieved by a combination of class room teaching and practical demonstration at sea over a period of 6 to 10 months, the subjects covered being fishing methods, fishing gear technology, elementary principles of navigation and running and maintenance of small internal combustion engines.

There are at present 31 such Fishermen Training Centres in the country with a total intake capacity of around 900 candidates, details of which are furnished in Table 7.

Table 7. *Statement giving details of Fishermen Training Centres in India*

Name of the State	Location of the Training Centre	Maximum intake capacity	Duration (Months)
Kerala	Vizhinjam	40	9
,,	Neendakara	40	9
,,	Ernakulam	40	9
,,	Beypore	40	9
,,	Cannanore	40	9
,,	Ernakulam	10	10
Tamil Nadu	Mettur Dam	20	10
,,	Mandapam	60	10
,,	Colachel	50	10
,,	Tuticorin	70	10
,,	Nagapattinam	50	10
,,	Cuddalore	53	10
,,	Madras	50	10
Karnataka	Mangalore	30	10
,,	Gangolli	30	10
,,	Karwar	30	10
,,	Honnavar	30	10
,,	K. R. Sagar	20	3
,,	Bethamangala	20	3
Maharashtra	Alibag	22	6
,,	Versova	22	6
,,	Ratnagiri	22	6
,,	Bassein	22	6
Andhra Pradesh	Kakinada	20	10
Orissa	Paradeep	...	10
West Bengal	Calcutta	...	10
Goa	Panaji	...	10
Lakshadweep	Kavaratti	...	10
Gujarat	Veraval	...	10
,,	Satpati	...	10
Madhya Pradesh	Nowgong	50	10

The minimum entry requirement to these centres is a basic education upto 5th standard with at least 5 years fishing experience. The trainees are normally paid a stipend to meet their expenditure. As an incentive, some State Governments encourage these trainees to form co-operatives after successful completion of their training and give them preference in the allotment of mechanised fishing boats. About 8000 candidates have so far been trained in these centres. This course also forms the training ground for young enterprising fisher boys with necessary education, who can eventually man large fishing vessels by following up their training with advanced training for certification under the Merchant Shipping Act.

(iii) fabrication and repairs of fishing gear and
(vi) communication between ship and shore.

Each of the above disciplines requires specialised training which is imparted through the CIFNET at Cochin and Madras and the Integrated Fisheries Project at Cochin (IFP) as listed. The first 4 courses are conducted by CIFNET and the last 3 by IFP.

(1) Boat Building Foremen
(2) Shore Mechanics
(3) Fishing Gear Technicians
(4) Fishing Vessel Electronic Technicians
(5) Refrigeration Technicians

Training Vessels of CIFNET

Under-graduate level training

(a) **Technicians for shore-based establishments**

Any modern fishing industry to be succesful should be backed by the necessary facilities on the shore to look after,

(i) handling and processing of catch,
(ii) maintenance of vessel and machinery,

(6) Fish Processing Technicians
(7) Purse seine Operators

The training facilities are extended both to the personnel serving in the Departments of fisheries in the States and also in the private industry.

(b) Personnel for manning of ocean going fishing vessels

The expansion of deep-sea fishing of the country necessarily involved the introduction of large ocean

going vessels which attract the provisions of the Indian Merchant Shipping Act 1958, for purposes of manning and safety of life at sea. The rules under the Merchant Shipping Act require that all fishing vessels of 15 tonnes nett and above have to be registered with the Mercantile Marine Department and all vessels exceeding 25 tonnes gross should be commanded by duly certificated deck officer/officers. Similar regulations are existing for manning the engine rooms of fishing vessels also by similarly qualified engineers. Although from 1948 onwards an *ad hoc* programme for training these personnel through actual sea and engine room service was in existence and was implemented by the then Deep-Sea Fishing Organisation of the Government of India, and from the vessels of the Government of West Bengal and the IFP, regular institutional follow-up commenced only in 1963 with the establishment of the CIFNET, Cochin with the principal objective of training these categories of fishing vessel officers. The Madras Unit of the CIFNET was established in 1968 to meet the increased demands for trained personnel. These two organisations between them are

Workshop practice at CIFNET

imparting the necessary training to candidates who wish to qualify as Skippers (Fishing Vessel), Fishing Secondhands, Engineers (Fishing vessel) and Engine Driver (Fishing vessel), and to obtain the necessary Certificate of Competency, issued by the Ministry of Transport and Shipping of the Government of India, through the Directorate General of Shipping.

These training courses are initially institutional in nature for a period of 15 months and are followed by the requisite qualifying sea/workshop service to meet with the eligibility requirements to appear for the respective Certificates of Competency examinations. The Institute also offers refresher courses for Fishing Secondhands and Engine Drivers appearing for higher Certificates of Competency examinations and also conduct updating courses for Skippers on the application of acoustic methods in modern fishing, fishing fleet management, and so on.

The teaching faculties of the Institute are organised under 5 divisions *viz.* Seamanship & Navigation, Marine Engineering, Craft and Gear, Fishing Boat Building and Fishing Vessel maintenance & operation. The Institute has well equipped workshops and laboratories. The onboard training is imparted from 5 training vessels of the Institute. This training fleet will be strengthened by the addition of a 33.5 metre training vessel and a 17.5 metre multi-purpose fishing vessel during the Fifth Five Year Plan Period.

The Institute has capacity to train upto 160 students per batch at Cochin and Madras in the core courses of Fishing Secondhands and Engine Drivers. In addition, the Institute at Cochin can train upto 75 candidates and at Madras 35 candidates in the ancillary courses for shore-based technicians. Nearly 50% of the students is sponsored by the maritime State Governments and the industry and the balance is filled by open selection. The minimum entry qualification is a pass in matriculation or equivalent. The training is imparted free of cost. Hostel accommodation is compulsory and is free, but students will have to meet their boarding charges.

On completion of the institutional training, the trainees are given placements onboard fishing vessels of appropriate tonnage/HP and in recognised marine workshops for their sea/engine room/workshop service to enable them to obtain the necessary eligible service to appear for the respective Certificates of Competency Examinations. For this post-institutional training the trainees are paid either stipend or salary.

CIFNET at Cochin and Madras have so far trained 1449 candidates and another 209 trainees are undergoing training in the various courses. Details of the achievement of the Institute in training of technical manpower are furnished in Table 8.

Table 8. *Number of marine fisheries operatives trained at the Central Institute of Fisheries Nautical & Engineering Training*

Category of personnel trained	Total No. trained		Under training	
	Cochin (1963-77)	Madras (1969-77)	Cochin (1977-78)	Madras
Fishing Secondhands	331	206	40	40
Engine Drivers	306	192	40	40
Boat Building Foremen	78	Not offered	6	Not offered
Shore Mechanics	80	6	5	7
Fishing Gear Technicians	91	11	4	4
Fishery Electronic Technicians	76	51	14	9
Trained teachers for Fishermen Training Centres	21	Not offered	...	Not offered
Total numbers trained/ under training	983	466	109	100

Besides the above training courses, the State Boards of Technical Education of the Government of Tamil Nadu, Kerala and Andhra Pradesh organise diploma level training in Fisheries Technology and Navigation meant mainly for training junior level administrative personnel for serving in the Departments of Fisheries. While the Polytechnic in Andhra Pradesh and Kerala have since been discontinued, the Central Polytechnic in Madras continues to offer a 3-year course for post-matriculation students leading to Diploma in Fisheries Technology and Navigation.

The Marine Products Processing Training Centre established in Karnataka State in 1963 with Japanese collaboration, train candicates in handling of fish, freezing, canning, quality control and related aspects at post-matriculation level.

The Regional Training Centre for Inland Fisheries Operatives at Agra established in 1967, offers a 9 months course to post matriculation students in the various aspects of inland fish culture.

Development and managerial personnel to plan and to be in charge of developmental programmes (graduate and post-graduate level)

Fisheries as a subject for graduate level of education is a recent development in Indian Universities. The University of Agricultural Sciences, Bangalore,etablished the College of Fisheries in Mangalore, Karnataka in 1969. This was the first college to start a 4 year graduate course in Fisheries. (B.F.Sc.) The entry qualification is a pass in Pre-University or equivalent. The College has an intake capacity of 40 students each year. The University has since introduced a post-graduate level course also in Fisheries Science (M.F.Sc.) of 2-years duration after B.F.Sc. with two special subjects *viz.*, Industrial Fisheries Technology, and Fish Production and Management. This course has an annual intake of 6 students for each of the subjects. In addition to these courses, post-diploma courses in Fish Processing Technology and in Fish Culture Technology, each of one year duration, are also offered.

The Calicut University started a Faculty of Fisheries at Calicut, Kerala, with the degree course leading to B. Tech. (Fisheries) in early 1970 which has since been discontinued. The Tamilnadu Agricultural University, Coimbatore, is in the process of setting up a Fisheries College at Tuticorin initially lading upto B.F.Sc. The Inland Fisheries Training Unit of the Central Institute of Fisheries Education at Barrackpore offers Certificate Course of one year duration in inland fisheries development and administration to candidates, sponsored by State Governments and private individuals, who possess a degree with Zoology as one of the subjects.

The Central Fisheries Extension Training Centre at Hyderabad set up in 1973 imparts specialised training over a period of 10 months in extension techniques and methods in fish culture practices at post-graduate level mainly for in-service personnel from different states.

Post-graduate level training

The Central Institute of Fisheries Education, Bombay,was established in 1961with UNDP assistance and with the objective to train in-service fisheries officers of the various States in the country in a comprehensive course of fisheries science over a period of 2 years, aimed at equipping the candidates with necessary technical know-how for implementing fisheries development projects. The Institute also admits a limited number of private candidates nominated from the Fishing Industry and candidates from foreign countries. The Institute awards a Post-graduate Diploma in Fisheries Science (D.F.Sc.) which is recognised as an alternate qualification to M. Sc. degree in Biological Sciences of Indian Universities.

The syllabi of the course cover fisheries biology, fish processing technology, fishing technology, fisheries

Navigation and chart work training at CIFNET

Boat building and net mending at CIFNET

administration, fisheries economics, statistics, marketing and co-operation. The intake capacity is 60 students per year. The Institute has well equipped laboratories and a 15.25m long fishery training vessel. 2 field stations, one for brackish water fish culture and the other for freshwater fish culture have been set up at Kakinada and Balabadrapuram respectively in Andhra Pradesh. The Institute has trained so far 383 candidates.

The University of Cochin started in 1976 a post-graduate level course leading to M.Sc. degree in Industrial Fisheries with accent on management of commercial fisheries activities. The course is conducted in 5 semesters each of approximately 6 months duration. The intake capacity is 15 students per year.

Besides, the Staff Training Institute of the Department of Fisheries in the various States of India offered inservice training to the junior level officers at graduate and post-graduate level for 6 to 12 months.

The Scientific and Technological Research personnel

Conventional Universities like Kerala, Cochin, Madras, Karnataka, Andhra, Annamalai, Madurai, Bombay, Gujarat, Aligarah, Banaras etc. offer fisheries/marine biology as special subject for the Post-graduate course. These Universities also have facilities for carrying out researches on fish and fisheries leading to Doctoral and Post-doctoral degrees. Besides, National Institutions like the National Institute of Oceanography, Panaji, Central Marine Fisheries Research Institute, Cochin, Central Inland Fisheries Research Institute, Barrackpore and Central Institute of Fisheries Technology, Cochin offer training as well as research facilities on fishery science, fishery technology environmental sciences and cognate subjects.

8

fisheries development

Small-scale Fisheries

The small-scale fisheries comprising of the traditional fisheries and related activities as practised by the artisanal fishermen, play a significant role in the Indian fisheries. About one million active fishermen employing the indigenous crafts and gears and following the traditional methods of fishing are engaged in the small-scale fisheries of the marine region. It contributes to above 65 per cent of the total marine fish production of the country. On the inland fisheries side, the small scale fisheries include almost the entire fishermen as well as the fish farmers and the entire inland fish catch.

The number of indigenous crafts and gears employed in the small-scale fisheries of the country is given in Table 9.

Salient features of the important indigenous crafts and gears are given in the Tables 10 and 11 respectively.

Normally, the fishermen engaged in the traditional fishing carry out a day's fishing, leaving the villages in the early morning hours and returning to the landing centres during the course of the day. Fishing is carried out in the inshore waters extending to 10–15 km from the shore. The gears such as shore-seines, inshore drag nets are operated from the beach, while the boat-seines and drift nets are operated with the help of crafts in the sea. Bag nets and stationary types of nets are fixed in the tidal region in the estuaries, backwaters and inshore sea with stakes or with floats and sinkers. Cast nets are operated both from the shoreas well as in the open waters. The craft and gear combination employed in different regions of the coast is given in Table 12.

Table 9. *Crafts and gears engaged in small-scale fisheries*

Craft		Gear	
Type	Number	Type	Number
Catamarans	47,000	Drag nets	2,56,000
Dugout	47,000	Gill and drift nets	5,98,000
Plank-built boats	39,900	Cast nets	4,24,600
Shore-seine boats	17,000	Traps	7,45,200
Others	67,700	Shore-seines	1,20,900
		Others	4,16,800

Prior to the introduction of mechanised fishing boats, the entire marine catch of the country was produced by the traditional fishing. In 1974, traditional marine fisheries landed an estimated catch of 8,43,961 tonnes out of the total marine fish catch of 12,17,797 tonnes; in 1975, the contribution from this fishery was of the order of 915,058 tonnes in the total marine fish production of 14,22,673 tonnes. The pelagic as well as mid-water fish catches are almost entirely landed by the traditional fishery.

The above data on the number of fishermen, fishing craft and gear, and fish production from this sector indicate the significance of the small-scale fisheries of the country. It is well-known that the inshore sea where the traditional fishery is carried out are productive fishing grounds, and significant increase in fish production can be achieved by improving the gears and fishing methods. Studies conducted by the Programme Evaluation Organisation of the Planning Commission have indicated that the return per unit of investment of non-powered boats is twice that of the powered boats, and generate almost seven times more direct employment opportunities than the mechanised boats. Considering the importance of this sector, the Working Group of Fifth Five Year Plan on fisheries has recommended that not less than 15 percent of the outlay on marine fisheries development should be earmarked for the sector.

The small-scale fisheries received relatively less attention in the early Plans. The important schemes taken up for the development of the sector prior to Fourth Five Year Plan, were the establishment of Fishermen Co-operative Societies with financial and managerial assistance from the State Governments, establishment and improvement of fisheries schools, fish curing yards, introduction of synthetic twines and assistance to procure these. Model schemes were also implemented for community development in selected fishing villages. In the Fourth Five Year Plan, various State Governments continued to provide assistance to this sector. In the Fifth Five Year Plan, several programmes for the development of the sector have been included, the most important of which are the improvement of craft material and designs of the boats, mechanisation of traditional crafts, assistance to Fishermen Co-operative Societies, provision of ice at the important landing centres, landing and berthing facilities for the boats.

To provide education to the children of fishermen, most of the States have established fishery schools. Besides, the fishermen are also being trained in the Fishermen Training Centres set up in the different States, in the operation and maintenance of the mechanised boats and fish culture.

Although considerable progress and improvements have been achieved during the last 3 decades, the problems of small scale fisheries concerning the methods of operation, inefficient crafts, low production rate, marketing of the catch, procurement of production requirements, conservative nature of fishermen and

Table 10. *Salient features of important fishing crafts of India*

Craft	(Size metre)	Construction	Life-time (years)	Propulsion	Crew	Operational area
Catamaran	L: 4-7 W: 0.7-1.4	2 to 5 logs of wood tied together in a raft fashion	10	Manual	2–4	Inshore
Dug-out boats	L: 3.6 - 10 W: 0.5 - 1.25 D: 0.45-0.7	Hollowing out a single log of wood	10	Manual	2–8	Inshore
Dug-out canoe (Flat bottom)	L: 9.5; 5.4 – 6.6 W: 1.6; 0.9 – 1.3 D: 0.7; 0.5 - 0.6	Hollowing out a single log of wood	10	Manual	—	Inshore
Plank-built boats	L: 6–14 W: 0.9–3.3 D: 0.6–1.0	Wooden planks stitched or nailed to form a rigid frame	10	Manual some are mechanised with 15-30 h.p. engine.	7–12	Inshore

L: Length; W: Width; D: Depth.

their reluctance to adopt new ways and methods of fishing, require immediate attention not only for increasing fish production from the sector, but also for improving the socio-economic conditions of the fishermen and the rural economy. In this connection, the concept of blending the traditional fishing activity with the culture of selected species such as prawns, mussels, oysters, sea weeds etc. in suitable inshore waters based on the indigenous technology is worth mentioning. To test this concept and demonstrate its viability, an Operational Research Project involving the fishermen of a fishing village near Madras, has been drawn up by the Central Marine Fisheries Research Institute.

Table 11. *Salient features of the important indigenous fishing gears of India*

Gear	Size (length in metre)	Mesh size (cm)
FIXED NETS		
a) 'Dol' nets	12-200	1 at cod end, 4-12 near mouth
b) Ganja	5	1 at cod end
c) Bag nets of east coast	13-7-35	0.5 - 10 at cod end; 4 - 10 at mouth.
d) Stake nets	12 - 30	1-2 at cod end
SEINE NETS		
i) *Boat seines*		
a) Kollivala	73	1 at cod end, 2 at mouth
b) Tanguvala	50 - 65	2 at cod end
c) Madivala	49	-do-
d) Boat seine of the east coast	22 - 26	1 at cod end; 9 at mouth
ii) *Shore seines*		
a) Rampan	200–600	1.2 - 5
b) Yendi	80–150	-do-
c) Kambavala	316	0.8 at cod end
d) Korubalai	9	1.0
e) Bari	5.5	1.0
f) Karavalai	317	1.2 at the centre
g) Alivivala	364–634	1.2
h) Drag nets	3.6 - 18.3	0.6 - 1.2
CAST NETS	2.5 - 6 in radius	1.2
SCOOP NETS	9 - 10 square 1.8 - 14.2	0.2 at cod and 0.7-2.1 at cod end
DRIFT NETS		
a) Kanthabala	48 - 125	5 - 6
b) Pattavala	216 - 270	3.0
TRAPS	0.5 - 1.8 high	—
LONG LINE AND HANDLINE	Sevral hooks of 1 - 3 number	

Table 12. *Craft and gear combination employed in different regions of the coast*

Craft	gear combination	Region
Satpati type boat	drift net, fixed net, bag net, seines, drift net, drag net	Gujarat and Maharashtra
Satpati type boat	longline	
Mechanised Plank-built outrigger boat	shore-seine, boat-siene gill net, drag net	Goa and Karnataka
Dugout boat	cast net, boat-seine	Karnataka and Kerala
Catamarans and Tuticorin-type boat	drift net, longline, gill net, boat-siene	Tamil Nadu and Andhra Pradesh
Masula boat	drift net, drag net	Andhra Pradesh and Orissa
Chandi type boat	Bag net, seines, drift net	Orissa

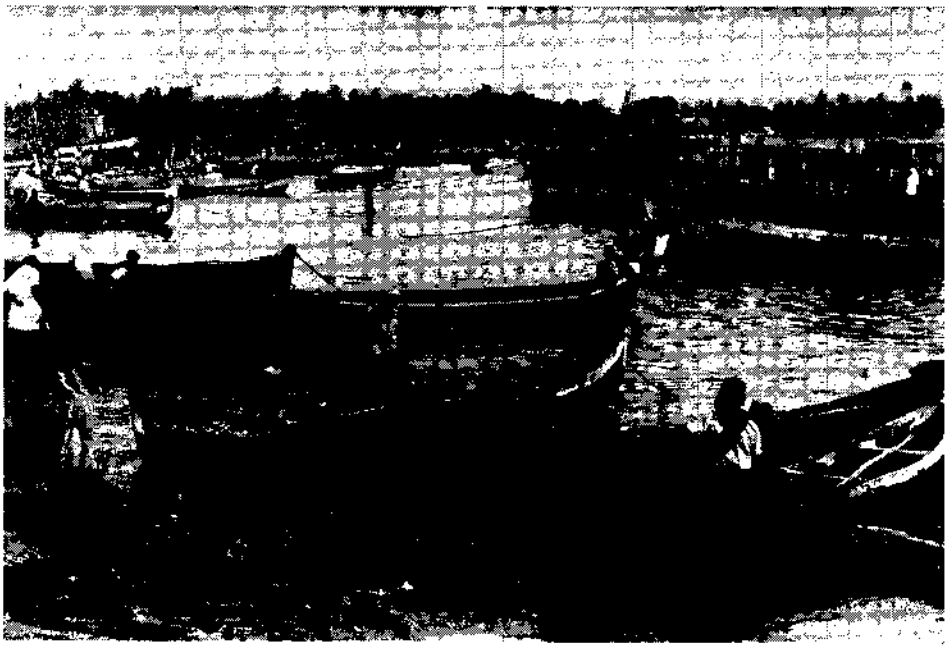
The results of this project when completed and its extension to other centres by the Institute, would go a long way in the adoption of this new concept of integrated rural development on a wider scale for improving the fish production, income of fishermen as well as the coastal rural economy.

Besides the national programmes for the development of the small-scale fisheries, a project for "the Development of Small-scale Fisheries in the Bay of Bengal" under FAO/SIDA Regional programme is being implemented. The purpose of the project is to assist participating countries (Bangladesh, India, Pakistan, Sri Lanka) to improve the standard of living and the quality of life of the small-scale fishermen families and increase supply of fish. The immediate objective is to develop and demonstrate techniques by which this purpose may be achieved, including *inter alia* the promotion of increased technical co-operation among the participating countries and

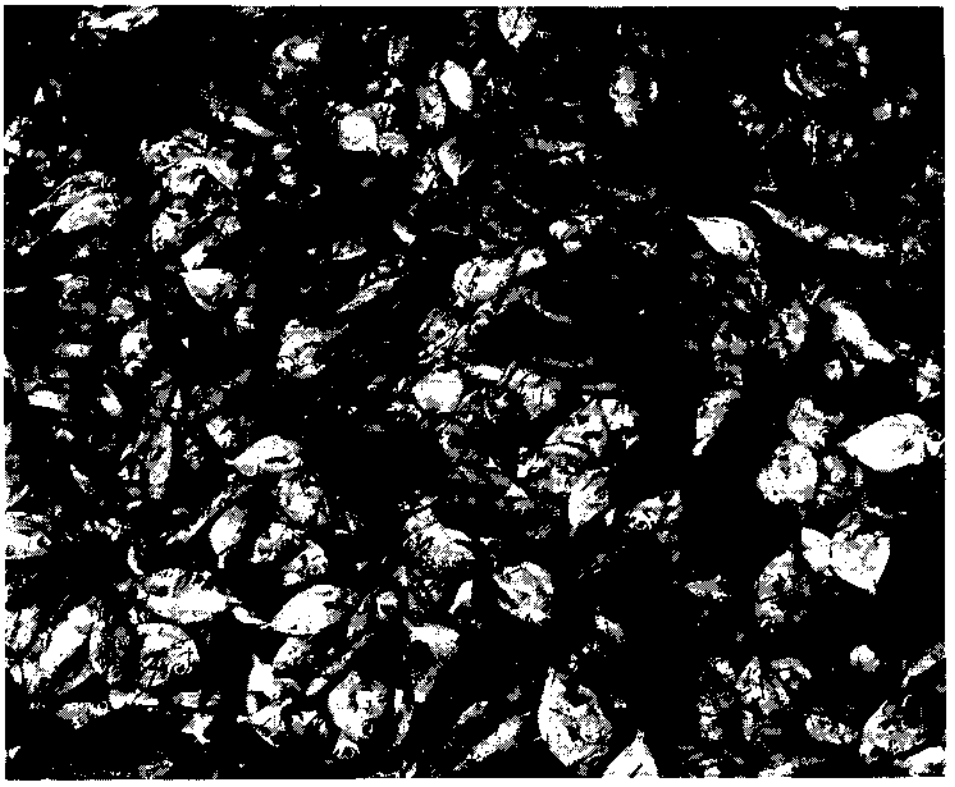
(i) "improvement, development and application of appropriate existing fishery technology and/or, where required introduction of new technology;

(ii) promotion of and direct assistance to research and development programmes of existing national institutions in support of (i) above;

Mud bank fishery and bumper catch of prawns at Purakkad, Alleppey, Kerala



Fish landing centre at Rameswaram



Catch of Silverbellies

(iii) strengthening existing extension services with special emphasis on development and/or strengthening of training institutions to provide adequate training in marine fisheries extension work;

(iv) training of fisheries personnel, managers and operatives of small-scale fishery enterprises, including fishermen's cooperative organisations and other associations;

(v) strengthening, where appropriate, the role of fishermen's co–operative organisations and associations, especially in the areas of fish distribution and marketing;

(vi) demonstration of an effective system of collection, analysis and dissemination of relevant information with particular emphasis on information and data resulting from project activities, and assistance in implementation of such a system;

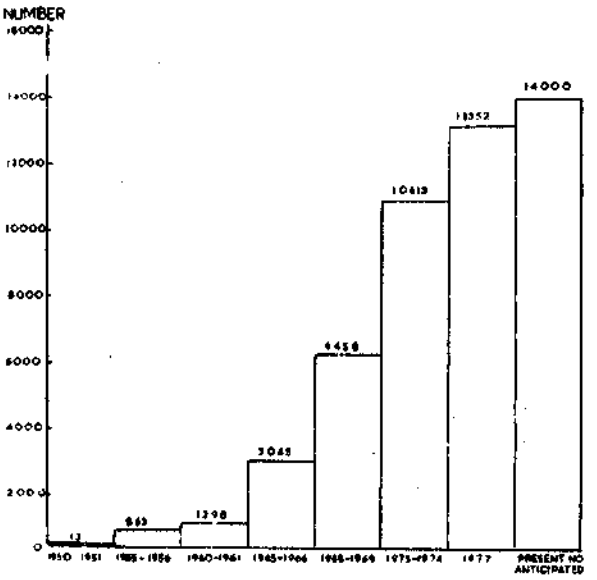
(vii) assisting participating countries in the application of the results of successful project activities, and in formulating specific small-scale fishery development plans and projcts."

Coastal Mechanisation Programme

Coastal mechanisation programme has been one of the main thrusts in the development of marine fisheries in India. In all about 16,000 mechanised boats have been introduced so far, against which about 14,000 are in operation at present.

Although there are a large number of mechanised boats in operation, still they account for only about 5% of the total fishing crafts in India. It has been the endeavour of the Government to see that the primitive crafts are progressively replaced by modern fishing crafts and traditional fishermen get the benefit of updated technology and assistance to procure better fishing vessels.

During the First Plan, a thorough examination of the various designs of traditional crafts was carried out and it was found that only a few designs of traditional crafts were suitable for mechanisation. These were mostly in the erstwhile Bombay Presidency. In other States, it was found that the traditional craft was not suitable for taking an inboard engine. Simultaneously attempts were made to see whether these boats could be motorised with outboard motors. By and large, the boats were found to be unsuitable due to the high stern. In some boats the outboard motor was mounted on a special bracket fixed for the purpose. An experiment was conducted at Muttom, near the southern tip of the country to motorise catamarans. The high cost of petrol and the quick wear and tear of outboard engine has created apprehension of the economic viability of such programmes. At the same time, outboard motors were found to be economical along the Gujarat coast for 'dol' net (stake net) fishing, mainly due to the availability of increased proportion of high quality table fish in such operations.



NUMBER OF MECHANISED BOATS IN OPERATION
(PLAN WISE)

One of the first series of small mechanised boats fit for trawling was made by the Indo-Norwegian Project in 1957. The Central Institute of Fisheries Technology, Cochin has also brought out a large number of designs and these are being adopted for construction of mechanised boats. Lured by the higher prices offered for shrimp in the export market, the emphasis in mechanised fishing was suddenly shifted towards shrimp trawling. To begin with, most of the mechanised boats used trawl nets without winches. Very soon trawl winches suitable for small

mechanised boats were indigenously developed and small trawlers became the popular type of fishing craft in India. Initially 9 metre boats powered by 30 to 40 h.p. engines were used. Recent years have witnessed an increase in the size of the boats and the horse power of the engines used. However, the efficient use of the mechanised boat is dependent on the availability of landing and berthing facilities. In this context, need for surf landing mechanised boats is more keenly felt.

Boat Building Material

Teakwood (*Tectona grandis*) has been the traditional boat building material. In the wake of high cost of teakwood, alternate substitutes such as "aini" (*Artocarpus hirsuta*) and "venteak" (*Lagerstroemia lanceolata*) have become popular. So also an attempt has been made to replace the costly copper sheathing with aluminium alloy sheathing. The latter has not been fully successful. Attempts were also made to make boats in ferro-cement as well as fibreglass reinforced plastics. While the former proved to be a bit heavy for small mechanised boats, the latter was too costly to be popular. However, the search for a suitable alternate as boat hull material is being actively pursued.

Marine Diesel Engines

Until 1966, marine diesel engines were imported. In the meanwhile, a few indigenous firms were awarded licence for the manufacture of marine diesel engines. Some of the licensed units have stopped production, but there is adequate capacity within the country to meet the present requirements of marine diesel engines for use on small mechanised boats. Over the years, the demand for the engines of higher horse power has significantly increased. The current demand for marine diesel engines within the country is about one thousand per annum.

Financing

With a view to popularising use of mechanised boats, the scheme of introduction of such boats was intially supported with a high element of subsidy, most of the States providing 50% subsidy on the engines except in the Union territories, Lakshadweep and Andamans, where the entire cost of the engine was given as subsidy. However, over the years, the subsidy was progressively tapered off and the beneficiaries were encouraged to avail of the institutional credit. Around 1965 refinance facilities at lower rates of interest were offered by the Agricultural Refinancing and Development Corporation. This enabled flow of institutional finance for the introduction of a large number of mechanised boats. Eventhough there was initial enthusiasm about this financing, failure on the part of corporate agencies to make repayment in time, dampered enthusiasm in further financing. Unlike the low rate of interests charged for Government loans, the interest of institutional financing was as high as 12½% in Agricultural Refinancing and Development Corporation and 16% when commercial banks financed the project. In additon, the obligatory insurance also proved to be a further financial burden. Some States preferred compensating this financial burden by giving the margin money as outright grant, others subsidised the interest. A new concept in this direction is to provide insurance cover free of cost by the State agencies and provide a revolving capital at low interest rate. However, financial assistance to coastal mechanisation deserves a new approach and a close review with special reference to viability of operations.

Diversification of Fishing Effort

The cost of mechanised boat has increased several fold in recent years. The present day cost of a 15 metre mechanised boat is about Rs. 2,25,000 and that of a 12 metre boat about Rs. 1,50,000. The high capital cost and the interest burden have led to selective fishing, particularly for shrimp. Government has been lately encouraging fishing by other methods with a view to ensuring better utilisation of all the resources. In respect of certain varieties of fish which occur in large shoals the possibility of introduction of purse-seine has been tried. During the last few years about 60 small purse-seiners have been introduced along the south-west coast. 14 purse-seiners operating along the Karnataka coast are fishing on an average 400 tonnes of fish within a period of 5 months which performance is quite satisfactory.

Gill netting is one of the traditional methods of fishing . Motorised boats are used for gill netting also. Relatively high priced varieties of fish are caught in the gill nets. This, together with lower horse power of gill netters and consequent lower capital and operational cost, the longer life of the engine in the absence of strain as in the case of trawling, make the economics

of gill netting as attractive as trawling in such areas as Gujarat, where better quality fish is available.

Pole and line fishing for skipjack tuna is restricted to Lakshadweep, where about seventyfive mechanised boats are in operation. Long lining from small mechanised vessels is relatively new in this country and about 40 long lining mechanised boats of 38′ have been introduced. These boats catch shark, tuna and tuna-like fishes.

The future expansion of coastal mechanised fishing has to be carefully planned. Increasing the fishing effort for shrimping is not likely to bring in proportionately increased catch in several coastal areas, particularly along the south-west coast where coastal shrimp stocks are showing a level of stabilisation of boat, effort and catch. However, there is scope for further expansion of coastal shrimping in limited pockets on the west coast and more significantly on the upper east coast. The upper Andhra Pradesh Coast and Orissa Coast are attracting shrimping units of other areas. Diversified fishing for coastal resources has to be encouraged and liberal technical and financial assistance have to be diverted to this sector. If subsidy and loans could be considered for deep sea fishing programmes, it is still more required for encouraging coastal fishing, particularly diversification of effort in this area. Vagaries of fish stock availability, often result in large fluctuations in the abundance of fish and is making both the borrower and lender in the fishing industry apprehensive. There is no "crop insurance" in the fishing industry. In times of distress, due to consecutive years of fish famine, some sort of assistance like "interest holiday years" for bank loans for borrowers in the fishing and ancillary industries appear unavoidable and will considerably lift the morale and confidence and dignity of the small boat fishermen and the small scale fish processors. Easy credit facilities with marginal interest rates alone can make coastal fishing economically viable, particularly when non-shrimping is contemplated. If financial institutions are unable to lower the interest rates and service charges, the difference may have to be adjusted under some sort of development assistance scheme. The scope of extending Shipping Development Fund Assistance to the coastal fishing sector requires a close look. These are under active consideration, and that development of artisanal fishery is continuing to receive close attention and assistance both in technological improvements, infrastructure facilities and for financing. Every effort also has to be made to bring down the cost of engines to economic levels and the optimum horse power requirements have to be worked out to save operational costs. Alternate boat building materials have to be tested to bring down the cost of hull and relieve the shortage of quality wood for hull construction.

Deep sea Fishing

The policy of the Government is to establish a deep-sea fishing industry in the country oriented to exploiting the entire fishery resources in the Exclusive Economic Zone of 200 miles, declared recently. The policy is to encourage the public and private sector fishing companies and fishermen co-operatives to take up deep-sea fishing. As deep-sea fishing is a capital intensive industry requiring large investments, the policy is to encourage all those who are in a position to make investments in the field.

The deep-sea fishing is a comparatively new activity in India. It is proposed to achieve a level of 200 of deep-sea fishing vessels by the end of the Fifth Plan. Of these, 30 have already been introduced and arrangements have been finalised for the import of 30 more from Mexico by 14 Indian enterprises. 16 vessels under this programme have already started arriving. A further programme to permit import of 60 deep-sea fishing vessels and construction of 40 vessels indigenously by Indian fishing enterprises has been notified by the Government in June 1977 for implementation in 1977–78. Deep-sea fishing programme involves the introduction of deep-sea fishing vessels, application of sophisticated fishing technology, setting up of infrastructure facilities such as fishing harbour, shore processing plants, facilities for repairs and maintenance of fishing vessels, net making facilities, supply of fuel and lubricants.

The indigenous industry for the construction of fishing vessels is not fully developed. Hence, while permitting import of vessels, simultaneous steps have been taken to develop indigenous construction capability. Under an important scheme introduced in 1968, it was stipulated that for every vessel imported, one vessel should be constructed indigenously. However, due to the problem of financing and the state of indigenous industry, not much progress was achieved in this respect. In order to stimulate indigenous construction, the

ship building yards are permitted to import designs and drawings of suitable fishing vessels from abroad. They can also avail of services of foreign experts to acquire the requisite technology. Government has also plans to provide subsidies as an incentive for indigenous construction. Loans to the extent of 95% of the cost of vessels are also available from the Shipping Development Fund. In the case of imported vessels, loans are available to the extent of 90% of the cost.

With a view to facilitate acquisition of technology relating to operation of fishing vessels, Indian fishing enterprises are permitted to employ foreign technicians for limited duration, with an arrangement to provide training to Indian counterparts.

In a public notice issued by the Government in July, 1977, applications were invited from interested Indian parties for the import of 60 deep-sea fishing vessels of 20 m overall length and above, new or second-hand, from reputed foreign shipyards. Second-hand vessels should, however, normally be not more than 5 years old and covered by a certificate of sea-worthiness by a recognised agency. Parties were permitted to apply for the import of such number of vessels as they intend to operate from any suitable source. Applications for obtaining vessels on charter were also invited, without any limitation on numbers or source. Applications for foreign collaboration in the field of deep-sea fishing were also invited. The collaboration may involve sale or charter of deep-sea fishing vessels, (new or second-hand) to the joint venture Indian company which will be established in accordance with the Indian regulations. From the enthusiastic response to this notice, it is expected that in the next two years there will be substantial number of deep-sea fishing vessels in operation in the Indian Economic Zone. In order to exploit both the offshore and deep sea resources, vessels in different size ranges with facilities for processing onboard are necessary. Similarly, vessels that could be deployed for different fishing techniques in order to ensure optimum exploitation of both pelagic and demersal resources are also necessary. It is for this reason, special steps have been taken to encourage introduction of different types of vessels in our waters.

In order to undertake pre-investment fishery resources surveys and to train Indian personnel in deep-sea fishing techniques arrangements have been made to obtain survey and training vessels under bilateral aid programmes. Mention must be made of the programme of construction of eight vessels under Norwegian Assistance Programme (of which two have commenced construction at Goa Shipyard) and two larger vessels availing of Dutch credit. Discussions are being carried out to strengthen the progress through acquisition of additional facilities under UNDP/FAO Programmes also. An industrial fishery resources survey with Polish assistance is under operation along the north-west coast covering Maharashtra and Gujarat Coasts and upto depths of 200 metres and beyond.

Infrastructure Facilities

Fishing villages

With a coastline of 6,500 kilometres and 1,300 fish landing centres and innumerable markets including weekly ones spread over 3,280,483 sq. kms, it has been a difficult task to provide all the necessary infrastructural facilities for fish landing, processing, transporting and marketing, at all the centres.

Basic infrastructural facilities were lacking in most of the fish landing centres when planned development was taken up in 1951. Approach roads, water supply, electrification and fishermen housing are provided under normal developmental schemes included in the Five Year Plans of the States. However, in many areas, lack of basic infrastructure has proved to be a limiting factor in the development of fisheries, otherwise having good potential. In this context State Fisheries Departments are earmarking funds towards development of infrastructure.

By now most of the fishing villages are in some way or other linked with existing roads and highways but in many cases these require improvements for motor vehicles transport by way of culverts, road strengthening, black topping and extension to the fish landing sites. The position with regard to water supply is inadequate, and well water continues to be the main source. Under the rural electrification scheme, most of the fishing villages are being covered. Fishermen housing is a sector in which the State Governments are undertaking a phased programme of development. Apart from general amenities, special amenities are required in the fish landing centres. These

include provision of ice, gear sheds, hard ground for fish drying and so on. Under a centrally sponsored financial assistance scheme, a beginning has been made to provide infrastructural facilities in an integrated manner to a limited number of villages in each State. The approach is that on successful completion of the provision of infrastructural facilities in these selected villages, the necessary interest would be created for generating funds within the village economy for extension of such facilities to other areas. Under the centrally sponsored scheme, approach roads, water supply, ice plant including extension of power supply, insulated trailer-cars and a fish curing yard, will be provided. The Rural Development programmes have also come in a big way for assistance to fishing villages, both coastal as well as in the inland centres.

Fishing harbours

While there is demand for developing every fish landing centre into a fishing harbour, the high cost limits provision of such facilities to the more promising centres only. It is anticipated that with the provision of self-contained fishing harbours, there will be polarisation of fishing activities around these centres and ultimately the number of centres would get reduced. Minimum landing and berthing facilities have already been provided at about 70 centres. Fishing harbours have been attached to practically all major ports, and in most of the minor ports, fishing harbour is the most important component. A separate project for conducting pre-investment surveys of fishing harbours was established in 1968 with UNDP assistance and has a staff of harbour engineers and economists specially trained for undertaking pre-investment surveys of fishing harbour projects. In all 123 sites have been reconnoitered, 29 sites surveyed and project reports have been prepared in respect of 24 sites. This does not include survey and project report in respect of fishing harbours at 5 major ports. Based on the economic viability, priorities, financial constraints, etc., projects are sanctioned by the Government of India of which several of them are nearing completion. Capacity to handle fishing boats and vessels in the fishing harbours already sanctioned as well as to be sanctioned both at major and minor ports is given in Table 13.

Proposals for fishing harbours are being processed with adequate care taking into consideration not only the engineering aspects, but also its full utilisation, possibilities synchronising with the programme of introduction of coastal and deep sea fishing vessels. The capacities already sanctioned would be adequate to handle 4,302 mechanised boats, 369 medium boats and 125 deep sea fishing vessels. If the additional

Table 13. *Fishing boat and vessel component capacity in fishing harbours*

Name of harbour	Capacity to handle fishing boats and vessels			
	Draft in metres	No. of vessels in upto 16 m (2m draft)	No. of vessels between 16-25m (2-3.5m draft)	No. of vessels between 25-50 m (3.5-5 m draft)
Already sanctioned				
Kandla	—	—	—	10
Sasoon Dock	2.3—3.5	400	—	—
Karwar	2.5	100@	—	—
Honnavar	3	160	10	
Malpe*	3	210	23	
Cochin	5	900	59	
Tuticorin	3	400	—	
Kodikkarai	1–2	40	—	
Mallipatnam	1–2	54	—	
Cuddalore		50@		
Madras*	6	500	200	100*
Vizag Ist state	6	150	—	15
Roychowk*	4.5	—	15	
Port Blair	4.5	50	20@	
Dhanra		50		
67 Minor site	4	750@		
Mangrol	2.5	180(148M)	—	—
Veraval*	4	430	42	—
Kakinada	2	298	—	—
Ratnagiri	2.4–3.3	390	—	—
To be sanctioned for which project reports are ready/ nearly ready				
Porbunder	2.1	400	—	—
Agardanda*	4.5	282	12	—
Beypore (State)		258	—	—
Neendakara (State)	2.5–3.8	210	30	—
Vizhinjam (State)*	5	285	12	—
Chinnamuttom	2.5	244	—	—
Nizampatnam	2	54	—	—
Vizag 2nd phase*	6	150	—	41
Nagpur	2	40		
Paradeep*	5–5.5	250	20	—
Karanjhalen(Goa)	2–2.5	260	—	—
TOTAL		6,735	443	166

@ estimated; *can take vessels of over 25 m OAL

sites for which project reports are already available are also sanctioned, the capacity created would enable handling of 6,735 mechanised boats, 447 medium vessels and 160 large vessels. Some of the large projects including vessels' component, infrastructure and processing and marketing facilities, have also been posed for assistance by the World Bank. Already a proposal covering 2 fishing harbours in Gujarat has been agreed to for the World Bank financing. More such proposals are in the pipeline. The facilities to be provided at fishing harbours would cover provision of breakwaters, dredging of basin, reclamation of foreshore, construction of landing, bunkering and mooring quays, auction hall, gear shed, canteens, slipway and commercial plots for putting up processing plants and workshops. In addition, local agencies are to provide the necessary water, electricity, approach road, etc. as part of their obligation in this regard. The management of fisheries habrours is proposed to be entrusted to a fisheries terminal organisation, which may be a division of the Fisheries Department of the State. It is envisaged that the revenue realised by way of port charges, auction hall charges, rental from commercial plots, slipway charges, etc. would be sufficient for maintenance and operation of the proposed terminal.

Fish processing

There are three distinct processing sectors, namely: drying, freezing and canning. Prior to 1950, road connections and transportation facilities at the landing centres were meagre. Fish in fresh condition were sent only to nearby places. Rest of them, which formed the bulk of the landing was utilised for curing, turning into offal or using straight as agricultural manure.

The chief methods of curing fish in India are:

1. Sun-dried without salt — the fish is dehydrated by spreading them directly under the sun.

2. Dry salted — the fish is first salted, and after partial extraction of water from the fish, they are sun-dried.

3. Wet salted — the fish is salted in high concentration, causing partial extraction of water, and then marketed without any further drying.

4. Colombo pickling — with salt and tamarind.

In small quantities, fish are cured, in one of the above forms, in individual fishermen houses, in which case, proper care is taken for gutting, cleaning, washing, etc. In some varieties, the fish are even split open, and salted and some are laminated. In glut season the fish were sun-dried just on the open sandy beaches. In 1940's when salt was costly, Government opened curing yards, and issued salt at concessional rates, thus inducing the processors to cure the fish in the Government Yards in order to ensure hygienic process.

The "Ceylon type" of pickling was mostly with mackerel, after gutting, cleaning and washing. This was for export to Sri Lanka, and this has since been discontinued.

There are two methods for curing prawns; (1) simple sun drying as whole especially the smaller varieties; (2) cooked and dried — in this method the prawns are boiled, sun-dried and shells removed. An improved version of this, known as "semi-dried" when sealed in tins with Carbon dioxide, could be kept for nearly an year. In Orissa, there is a special method of drying the prawns, over a quick but smoky fire. Smoking of fish has not come to India so far, though some experiments are being conducted on pilot scale.

Preparations such as fish paste, fish powder and fish curry in various combinations and styles are made in different parts of India. Other products of commercial importance are shark fins, fish maws, beche-de-mer (Sea cucumber), fish oil, shark liver oil, "mas min" (dried skipjack), dried turtle meat, etc. Many of these are exported to different parts of the world. The latest export information indicates 58 different items of marine products having been exported to 60 countries of the world.

The curing of fish is still done in the same old way as was done decades ago by the fisherfolks of the coastal belt. Though improved methods of processing and packing of dried fish have been evolved by various Research Institutions, none of these has been applied on a commercial scale. In short, the dried fish processing and marketing have still not risen to the status of a modern industry.

Quick freezing of shrimp was started in early fifties. The first attempts were so successful, that several freezing plants sprang up in parts of the country in

a short span of 5 to 6 years. Today there are nearly 250 freezing plants and they are largely engaged in freezing of shrimp for export. Besides shrimps, lobsters, fish, cuttle fish, squids and frog legs are also included in the production line. The present total holding capacity of frozen storage is 25,000 tonnes.

The shrimps are frozen as (1) headless tail-on, (2) peeled and deveined, (3) peeled undeveined, (4) cooked and peeled, and so on. Export packings are in 2 kg/5 lbs blocks which are institutional packs. There are no regular arrangements for processing in consumer packs.

There are about 70 canning plants in India,engaged in the canning of marine products. Here too, their main business is shrimp canning, though lately they have taken up canning of sardines, mackerel, skipjack, crab, mussel, etc. in certain localities and seasons.

Processing of cheap fiish

The trawler catch has a high representation of cheap fish, which may or may not be discarded at sea in preference to the proper on board storing of prawns and quality fish. Potentially the largest resource of cheap fish includes *Anchoviella,* silver bellies, sardines and the small sciaenids. Large vessels operating for cheap fish has not been found to be economical as the landed price is low. A technology has to be developed for the economic utilisation of these catches, without which fishing ventures based on these varieties may not prove to be economical.

The easiest method of utilisation would be to convert them to fishmeal, but this has to be viewed in the light of the following points. Firstly the value realised from fish meal is not steady. Secondly, fish meal goes as poultry and animal feed and the ultimate production of protein by way of meat, milk or eggs is much less than what would otherwise be avilable if directly used for human consumption, which should have a priority in a country like India.

There is a good demand for cheap varieties in the dried form if hygienic units are set up. But here also the high cost of power and fuel would make it viable only under certain conditions, as the product is consumed mostly in the small income sector. The third alternative would be to make value added products out of them. This can be by the preparation of items such as minced meat, frozen block and various derivatives like sausage, ham, noodles, spreads and wafers.

Utilisation of fish

Prior to 1950, 42.7% of the production was consumed fresh, 25.9% converted into sun dried fish and 24.8% converted into salt cured fish, 6.6% reduced into fish manure. Since 1970,the pattern of consumption of fish in the domestic market has undergone a drastic change. Cold storage and processing facilities have developed and transportation system improved. Fresh fish landed are transported overland to places over 500 km away to be sold in fresh form. As a result, there is a great shift in the demand for fish, from the dried to the fresh condition. The utilisation of the fish catch in the recent years is given in the following Table 14.

While detailed figures on the disposition of fish landings in the earlier years are not avialable, a comparison of the pattern of developent can be seen from the gross figures of 1945 and 1975 as summarised below:

	1945	1975
Consumed as fresh	42.7%	70%
Sun-dried	26.0%	12%
Salted	25.0%	9%
Frozen and canned	..	5%
Fishmeal and others	7.0%	4%

The increase in population, rising standard of living, change in the food habits of people, change in the attitude towards certain types and species of marine life etc., have resulted in the heavy demand for more fish. Those varieties of fish which were once considered as trash have become delicacies or costly exportable varieties. Though the dried fish production has relatively decreased, the demand for it is still great within the country. Though there are only very few fishmeal Plants scattered in different parts of the country, none of them is working to full capacity for want of raw material. When these Plants were established, their economy was based on "trash fish". But, the demand for these "trash fish" has become so high within the country that it has been found unworkable to use "trash fish" to feed the fishmeal plants.

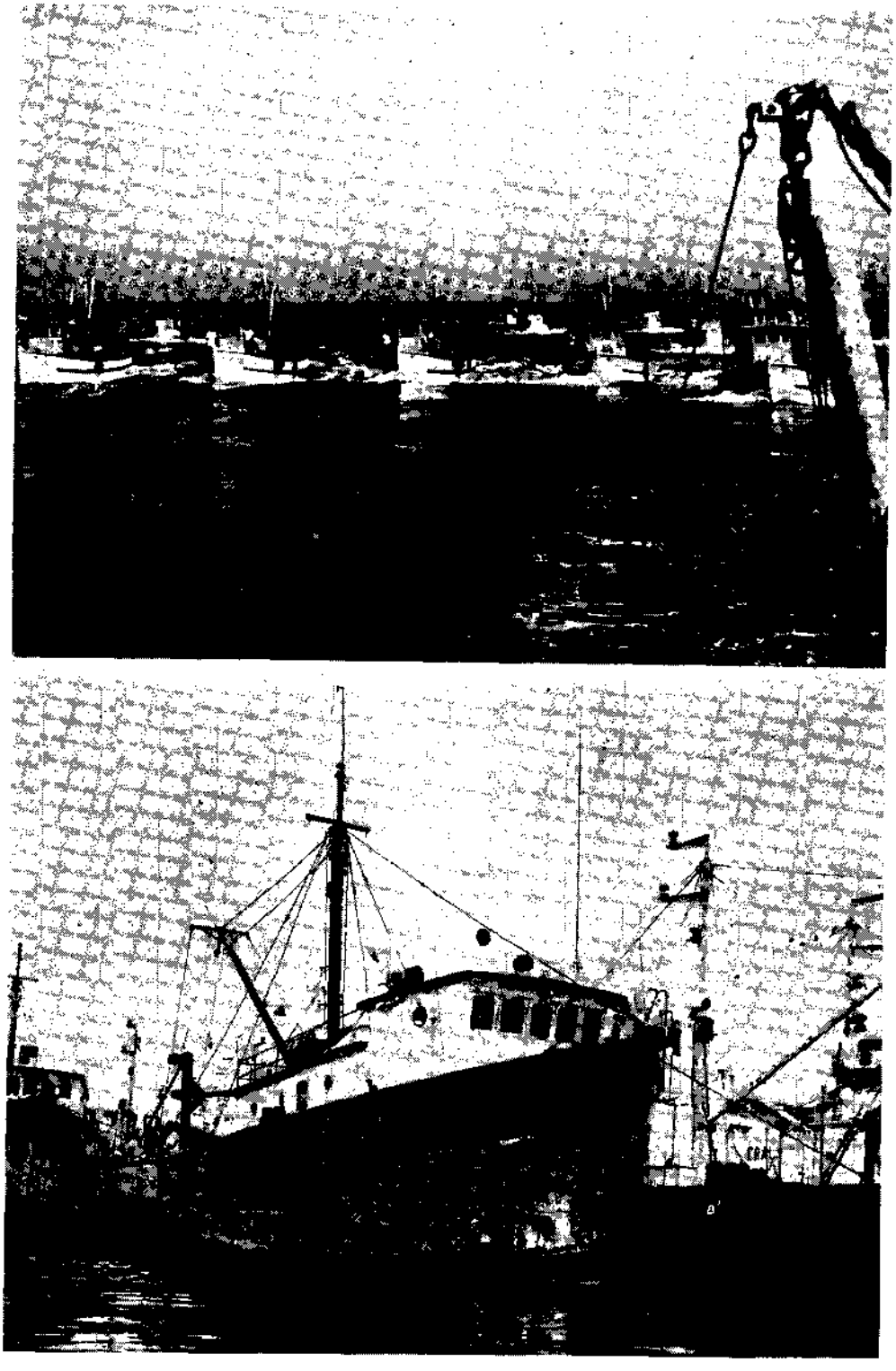
Table 14. *Utilisation of fish in India (Quantity in 1000 tonnes)*

Year	Fresh		Frozen		Canned		Dried		Reduction & Others	
	Qty.	%	Qty.	%	Qty.	%	Qty.	%	Qty.	%
1958	454.5	42.7	—	—	—	—	539.6	50.7	70.3	6.6
1961	460.4	47.9	—	—	—	—	419.9	43.7	80.7	8.4
1962	466.5	47.9	—	—	—	—	425.5	43.7	81.9	8.4
1963	704.9	67.4	4.3	0.4	1.4	0.1	282.7	27.1	52.4	5.0
1964	924.3	70.0	15.7	1.2	3.1	0.2	286.7	21.1	90.4	6.9
1965	908.7	68.3	17.5	1.3	5.1	0.4	340.5	25.6	59.0	4.4
1966	963.1	70.4	26.2	1.9	7.8	0.6	299.7	21.9	70.6	5.2
1967	968.9	68.8	48.0	3.4	11.2	0.8	275.1	19.7	103.0	7.3
1968	1055.1	69.1	61.8	4.1	11.0	0.7	294.9	19.3	103.1	6.8
1969	1090.7	67.9	56.6	3.5	10.4	0.6	345.1	21.5	104.0	6.5
1970	1177.3	67.0	80.7	4.6	12.3	0.7	356.4	20.3	129.4	7.4
1971	1222.4	66.0	97.9	5.3	13.1	0.7	358.7	19.3	159.5	8.7
1972	1119.1	68.2	82.2	5.0	9.5	0.7	286.0	17.5	142.4	8.6
1973	1278.6	65.3	105.5	5.4	15.9	0.8	379.7	19.4	178.3	9.1
1974	1437.0	63.7	101.1	4.5	9.9	0.4	524.0	23.2	183.3	8.2
1975	1616.4	69.4	65.2	2.8	4.8	0.2	441.6	19.0	200.0	8.6

Transport

The catches from the landing centres are transported to the consumers, retail markets, cold storages and processing plants, by various means. Headload is the most common and cheapest method to transport the fish to the nearby retail markets, or road-side or door to door sales. Bicycles are now widely used to take the fish to interior places, which are not too far. Fish, well preserved in ice, are sent to long distances in trucks or by rail. Attempts have been made in the last two decades to introduce refrigerated and insulated vans. As many as 30 refrigerated road vans and equipment for 9 refrigerated rail vans were imported. But operations were badly affected due to various reasons including delay in the import of spares. At present indigenous capacities are available for the manufacture of equipment required for refrigerated road and rail vans. However, the limiting factors are (i) on the return journey the empty space is not utilised for transporting other perishable goods as non-fish eating population object to persistent fish smell and (ii) the delicate insultation and linning of the road and rail vans would get damaged if heavy cargo is loaded in the empty space. Both insulated rail and road vans are generally returned empty and makes the programme uneconomical. The refrigerated railway van service introduced on Indian railways as early as 1960 is yet to gather momentum. Only in certain limited sectors, where alternate methods of transport are not available these vans carry full rated load. Due to a variety of reasons like lack of daily service, lack of booking from intermediate stations, lack of facilities for maintaining the refrigerated temperature at despatch and receiving centres etc., the trade is not adequately patronising these services. Instead, transport of fish by ordinary road and rail vans packed in wicker baskets continue to be the

Transport of fish by bicycle for local sales



Small mechanised fishing vessels and trawlers

Trawler catch and sorting onboard the trawler

popular method. In case of long distance transport intermediate repacking is arranged by the merchants. In the light of the above, the problem of transport of fish over long distances require a close look.

Marketing

Traditional Fishermen are engaged in fishing only. For the disposal of their catches they depend upon their household members or the fish merchants. The fisherwomen carry small quantities by headloads to nearby places. In some places, retail marketing is entirely carried out by fisherwomen. Large quantities are auctioned by the fishermen's agents or fish merchants, on the landing centres themselves or transported to the wholesale market. Sometimes, these wholesale markets may be just a vacant plot of land near or away from the landing centres, where the fish are bought by retailers, packed in small bundles, and carried to retail markets. Even though the country has increased its fish landing considerably, good wholesale or retail markets are still very few only. There are numerous fishermen co-operatives and fish marketing federations engaged in production and marketing. In some States, Fisheries Co-operative Federations have been established to develop fish marketing. The Central Fisheries Corporation and some State Fisheries Corporations also promote marketing. Some of them do not have any link up with production units/co-operatives. An efficient marketing system is very much needed for better management of the catch and distribution of the same.

India is exporting fish and fishery products to over 60 countries in the world. In the case of frozen marine products too, the marketing system is far from desirable. Though the value of export has reached nearly Rs. 2,000 million, what is being practised is not real "marketing" but mere "counter sales". The orders for the export of frozen products are booked directly with the buyers in foreign countries or through their agents in India. The main item of export is frozen shrimp, accounting for approximately 90% by value, frozen frog legs (approximately 4% by value), lobster tails (approximately 2% by value), cephalopods, frozen fish, dried fish and others (each approximately 1% of the value).

In view of the fact that frozen fish marketing is not practised in the domestic market, the price tend to fluctuate very sharply depending upon the availability of catch. When the catch is exceptionally good a situation of glut is created and the prices drop to such a level that for a few days fishing is suspended as it happens along the south-west coast during heavy landings of sardines. On the other hand, the domstic price goes up by almost 100% during the south-west monsoon, when sea fishing is suspended due to the bad weather conditions, and fishing from public waters is prevented under State legislation intended for conserving the breeding stock. Unless frozen fish marketing is taken up on a large scale in the domestic market, it will be difficult to stabilise prices of fish.

Export of Marine Products

Till early 1950s the export of dried fish products including dried prawns was of the order of 26,000 tonnes per year. The export pattern of fish products in 1945 is shown in Table 15. Of the total quantity of 26,340 tonnes exported, 22,302 tonnes (84.67%) was dried fish products and 4,038 tonnes (15.33%) fish manure. This export was mainly to the East Asian countries like Hong Kong, Singapore, Burmah and Sri Lanka. In the meanwhile, the demand for dried fish within the country has increased. Improved means of preservation of prawns, namely freezing and canning, started to utilise even the tiniest of prawns which were once sun-dried.

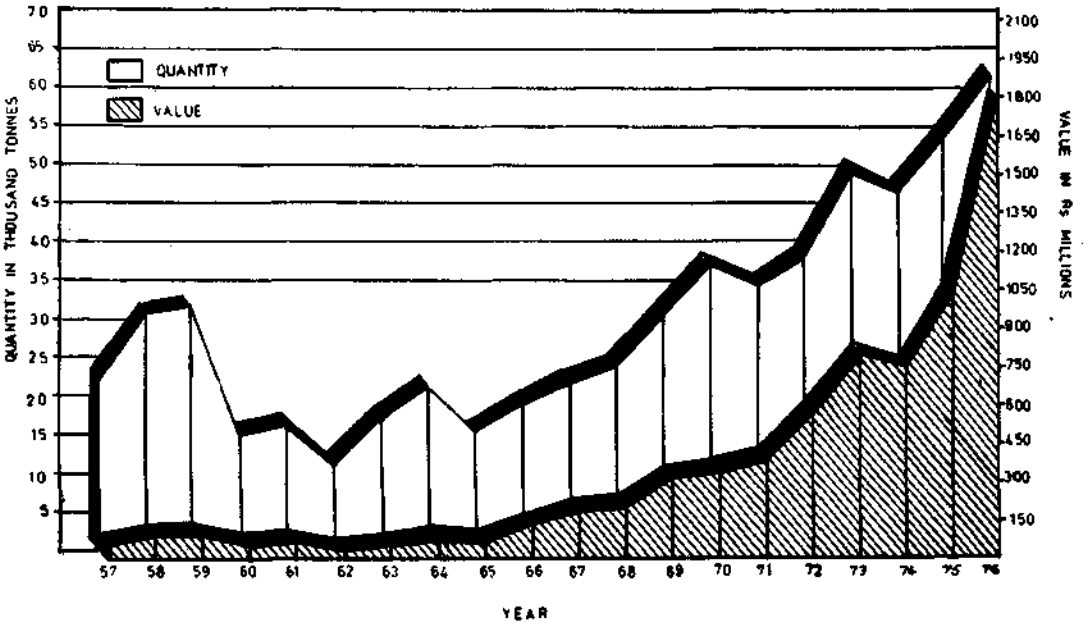
Table 15. *Export Pattern of Fish Products in 1945 (Average 1941–1945)*

Fish Products	Quantity (tonnes)
Fish, sun-dried	12,512
Fish, dry salted	7,822
Fish, wet salted	1,743
Fish maws & Shark fins	225
Fish; other sorts	...
Canned fish	...
Cod liver oil	...
Fish or Whale oil	...
Fish or Whale oil	...
Fish manure	4,038
Total	26,340

The change in export pattern from traditional items to an export of processed fishery products catering to the highly competitive markets is shown in Table 16. As against 84% by weight of cured products previously exported, frozen products now account for 82% by

weight of the present day exports. By value, previously cured products accounted for 96% while the same 96% is now taken up by frozen products. During 1976–77, marine products from India earned Rs.1,891 million accounting for 0.7% of the world trade in fishery products as well as 3.7% of the export earning of this country, ranking as 8 in the order of export earning commodities of India.

and preshipment inspection for the marine products were introduced, initially on a voluntary basis, with effect from 1st September 1963. Export (Quality and Inspection) Act, 1963 (22 of 1963) was enacted in the Indian Parliament in the year 1963 and came into force on and from 1–1–1964. On the same date the Export Inspection Council was also set up. The functions of the Council are to advise the Government



Export trend of Marine Products

With the change in commodities there has been a change in the countries importing marine products from India. So also depending largely on the unit value realised there has been shift in the importing countries also. Table 17 for 4 selected years will reveal this shift.

It may be seen that India's traditional markets for dried fish except for Sri Lanka has practically dried up. In the sixties USA was the main export market, accounting for about 55% of the export earning of this sector, followed by Japan accounting for approximately half the earning from USA. In the mid-seventies, this order has been reversed, the Japanese market accounts for 68% while the USA market only 22%.

Quality control

With the object of ensuring high quality of marine products exported from the country, quality control of India regarding measures to be taken for implementing the compulsory quality control of the various products from Indian Ports. The Act empowers the Government of India to notify the products which should be brought under the compulsory quality control and preshipment inspection prior to export and specify the type of quality control and inspection or both.

The marine products first to be brought under this Act were frozen and canned shrimp, with effect from 15th March, 1965. In a phased manner other marine products were brought under the purview of the Act. The following items of fish and fish products are at present covered by this Act.

		From
1.	Frozen shrimp	15- 3–1965
2.	Canned shrimp (wet pack)	15- 3–1965
3.	Frozen frog legs	1- 3–1966

4.	Dried shark fins	12– 1–1970
5.	Dried fish maws	12– 1–1970
6.	Dried fish	22– 6–1970
7.	Dried prawns	22– 6–1970
8.	Frozen lobster tails	28–12–1971
9.	Dried Bombay duck and laminated Bombay duck	5– 5–1973
10.	Canned crab meat	5– 2–1977

Preliminary notification in respect of Fishmeal was issued on 5–6–1976. Other items under active consideration are frozen cuttle fish and squid, and frozen pomfret.

plants were also laid down. Marine Products Export Development Authority have already laid down hygienic standards for fishing vessels, processing plants, storage premises, etc., which have been duly notified.

In-process quality control

The Export Inspection Council of India has tentatively decided in June 1977 to introduce an "In-process Quality Control" for marine products processed for export. This is scheduled to start from January 1978. The industry's progress in producing quality goods for export was remarkable and this is supported

Table 16. *Export of Marine Products from India (share percentage)*

	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Frozen shrimps	45.86	51.34	58.03	70.11	59.54	68.11	79.84	73.58	73.69	87.68
Frozen lobster tails	0.42	0.59	1.20	1.73	1.03	0.96	0.96	0.78	0.98	0.75
Frozen frog legs	2.91	3.61	1.82	2.79	6.85	4.26	4.76	5.53	3.12	2.47
Frozen fish	—	—	—	—	—	—	0.05	0.30	0.14	0.25
Canned prawns	7.95	1.01	9.02	5.43	6.93	5.48	2.76	4.51	3.25	0.49
Canned fish	—	—	—	—	—	—	—	—	—	—
Dried prawns	6.07	7.07	5.69	2.73	4.00	2.01	0.36	0.58	0.25	0.18
Dried fish	34.21	23.65	21.72	14.15	19.55	17.46	9.09	6.94	3.75	4.30
Others	2.58	12.73	2.52	3.06	2.10	1.72	2.18	7.78	14.82	3.88
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Actual Quantity (tonnes)	19,153	21,764	24,810	30,584	37,175	34,032	38,271	48,785	46,629	53,412
Value (Rs. million)	135.2	199.3	220.8	330.7	355.6	391.7	581.3	795.8	763.1	1049.1

Standards

The standards laid down for each item are internationally accepted and appreciated. These specifications or standards can be particularly classified into 4 categories, namely, physical, organoleptic, analytical and bacteriological. Since the industry was not well prepared, the standards set for the above were introduced in various stages. Cooked shrimp was brought under bacteriological standards in 1968; Frog legs in 1969. Phase I (Pathogenic bacterial test) of the bacteriological standards for frozen shrimp and lobster tails was introduced with effect from 1st August 1973, and the IInd phase (for total plate count) from 1st January 1974.

Besides standards for quality of the products, the minimum requirements for the packaging material and minimum hygienic conditions for the processing

by the fact that out of the total marine products processed and offered for quality inspection, more than 90% was found to strictly conform to the said standards. Once the "In-process Quality Control" scheme is finally implemented, the industry has to welcome it as the ultimate aim is perfection for its products and more more than that, uplifting of the country's product image abroad.

Export promotion

The Marine Products Export Promotion Council was formed in 1961 exclusively to promote the export of marine products from India. This Council having its headquarters at Cochin had undertaken several market surveys abroad and sent many Sales Team and Delegations in order to accelerate marine products exports. In 1972, this Body has been renamed as 'Marine Products Export Development Authority' under an Act of the Parliament and has been vested with more

powers including development of production for export. The effectiveness of this body was keenly felt by all sections of the Seafood Industry in the country.

Table 17. *Quantity of Export Commodities and its Value*

Commodities	Representation by weight (%) 1940–46*	1976–77	Representation by value (%) 1940–46*	1976–77
Dried fish	77	8.8	94	1
Wet fish, salted	7	Nil	2	Nil
Fish maws and sharkfin	1	0.4	2	1
Fish manure	15	Nil	2	Nil
Frozen shrimp	—	74.3	—	89
Frozenl obster tail	—	0.8	—	2
Frozen frog legs	—	4.6	—	4
Frozen fish	—	2.6	—	1
Canned prawns	—	0.2	—	Negligible
Others	Negligible	8.3	—	2
	100	100	100	100

* Includes the present day India, Pakistan and Bangla Desh

The Authority's specific functions include registration of fishing vessels, processing plants and infrastructure facilities, laying down standards and specifications for marine products, improve the marketing of marine products overseas by providing market intelligence, market promotion activities, supply of information on the types of products in demand in different countries, rendering financial or other assistance to exporters, regulation of export of marine products, and arrange for training in different aspects connected with export with special reference to fishing, processing and marketing. For disseminating information useful to the industry and for export publicity, the MPEDA has brought out several publications, and export commodity reviews.

The Authority assists the exporters in solving difficulties in regard to shipping space, export finance, supply of indigenous raw materials etc. The Authority also participates in International Fairs and Exhibitions abroad, organises Seafood Trade Fairs and sponsors Delegations and Study Teams to and from foreign countries.

Table 18. *Countries Importing Marine Products from India*

	1939–44 (Average) % by wt.	1961 % by value	1969 % by value	1975 % by value
Ceylon (Sri Lanka)	80.6	32.6	3.30	0.50
Mauritius and dependencies	1.2	—	—	—
UK	—	16.3	2.40	0.30
Other Commonwealth countries	1.9	—	—	—
Burma	16.1	22.9	—	—
USA	—	19.8	54.80	21.70
Japan	—	—	27.90	68.10
Australia	—	—	3.60	2.60
France	—	—	2.40	1.90
Hong Kong	—	—	0.96	0.26
Netherlands	—	—	0.22	0.15
Singapore	—	—	1.21	1.04
Sweden	—	—	0.02	0.63
West Germany (FRG)	—	—	0.58	0.19
Others	0.2	8.4	2.61	2.63
		100	100	100

Export policy and prospects

The general export policy is to encourage high priced low volume fish and fishery products to be reserved for domestic market. The export of marine products could be further enhanced by increasing fish production through the exploitation of areas where the level of exploitation is low and through aquaculture; by reducing rejection through better quality control and introduction of various diversified products particularly the non-traditional items in the export market.

9

fisheries extension

The first fisheries extension service established in the country was an Unit at the Central Inland Fisheries Research Institute, Barrackpore in 1950. This Unit organised a Fish Seed Syndicate, which helped the supply of quality fish seed to the deficit States. During the Second Five Year Plan (1961–66), 9 more extension Units were added. These units provided assistance to the fish farmers, fishermen and the fisheries departments in the survey, correction and improvement of water areas, fish seed production through river collection, induced breeding, 'bundh' breeding, improved methods of fishing, live fish transport, fish preservation, use of marine bye-products, etc. Later, based on the Balwantrai Commission's Report, 50 pilot blocks, each with a separate Fisheries Extension Officer, were started some time in 1960. This was followed by the Expanded Nutrition Programme and the Applied Nutrition Programme at the 'block' level, under which facilities were provided for the production and distribution of protective foods, including fish. Some of the ANP 'blocks' are still being continued.

Extension Units have since been established as adjuncts to fisheries research and development institutions. The States have also been advised to start Extension Units with properly trained and qualified personnel. At present, out of 22 States and 9 Union Territories, separate extension services for fisheries are available only in 10 states.

The Extension Wings of Central Fisheries Research Institutes undertake demonstrations of techniques evolved by the institutes, conduct *ad hoc* training programmes for extension workers of the State Governments, fish farmers and others, publish pamphlets on the new or improved techniques on fish culture topics, take part in exhibitions, conduct fish farmers' days, render consultancy service and liaise with other agencies in answering technical queries. The subjects on inland fisheries and inland fish culture is handled by the Central Inland Fisheries Research Institute, that on marine fishes and mariculture by the Central Marine Fisheries Research Institute and

on fisheries technology by the Central Institute of Fisheries Technology.

Realising the importance of transfer of technology to the actual fishermen/fish farmer, the Indian Council of Agricultural Research has recently established Krishi Vigyan Kendras. These Kendras function on a philosophy of "learning by doing". In the field of Fisheries, two such Kendras have been established, one at Dhauli (Orissa) with CIFRI, and the other at Narakkal (Cochin, Kerala) with CMFRI. The former Kendra offers training on inland fish culture to the fish farmers and also train the trainers. The latter centre imparts training on coastal aquaculture and mariculture.

From the developmental Institutes, extension work by way of demonstration of diversified fishing methods and popularisation of diversified fishery products are being carried out; periodical publication of the results of marine fishery resources survey, are also brought out for the benefit of the industry. A central scheme establishing Fish Farmers Development Agencies is under operation, wherein fish farmers are given training, initial inputs and long lease of water areas in order to personally experience the fruits of advanced technology. The State Governments are also given cash grant-in-aid, for preparing publicity material, purchasing extension literature, and audio-visual equipments. A Central Fisheries Extension Training Centre is functioning at Hyderabad (Andhra Pradesh) for training in service personnel on extension, oriented towards fish culture. For better utilisation of the fish catch, a proposal is under consideration for starting another such Extension Training Centre for fish handling and processing.

The extension activity under the State Governments is largely oriented towards popularisation of fish culture through supply of fish seed, training to pisciculturists on methods of fish culture, nursery and pond management, on inland fisheries side; demonstration/training on improved methods of fishing techniques, fish handling and processing in the field of marine fisheries. Extension pamphlets, bulletins, handouts and posters on fishery themes are also issued. Audio-visual publicity is undertaken in the rural areas. The Fisheries Departments participate in local and national 'fairs' and 'exhibitions'. Some State Governments have produced documentary films also.

On the export front, extension service is provided by the Marine Products Export Development Authority. It covers financial assistance, incentives for the export of non-conventional items, market intelligence, production, storage, shipping and marketing facilities, trade promotion, quality control, training, demonstration, participation in Indian and International fairs, publicity and consultancy service.

It is encouraging to note that the "user agencies" are given adequate opportunities to suggest priorities in applied research programmes, so that, need-based research projects are organised. Although the existing extension services help to disseminate the technology developed in the country to the fishermen, fish farmers and the industry to certain extent, a well planned system of extension both in the State and national levels is to be organised and strengthened to coordinate research, developmental and industrial activities so as to make the best use of the resources.

10

fishing industry

Three decades ago, thefishing industry of India was modest and covered merely the catching of fish and their disposal in fresh condition locally or processing the surplus by traditional methods, and trading with the neighbouring countries. With the commencement of export of frozen fish products from 1953, rapid mechanisation of fishing operations, application of modern methods of preservation and processing, a fishing industry oriented mainly towards export got gradually established in the country. At present, the fishing industry of the country includes the main industry of catching, processing, transportation, distribution and marketing, and the ancillary industries such as fishing vessels construction; manufacture of main and auxillary engines, fishing vessels components, fishing gears, refrigeration and cold storage equipments. The fishing industry is organised under private, corporate and co-operative sectors.

The Main Industry

Private sector

By and large, the fishing industry of the country is in the private sector. This includes the traditional fishing industry as practised by the small-fishermen; small partnership or limited companies and large business houses. Similarly, the investment on fishing establishments varies from a few hundreds of rupees by the small-fishermen to huge capital investment by the larger Companies. Likewise, its operation and management differs from simple catching and immediate disposal in the landing centres to an integrated system of fishing, processing and marketing, including export. While the traditional sector of the fishing industry is still in an unorganised state, the industry under the companies and larger houses is fairly well organised.

The number of indigenous crafts and gears, mechanised boats and trawlers, freezing and canning plants, cold storages, etc., involved in the fishing industry is given elsewhere in this publication. In the marine products export trade, there were 674 registered exporters in 1975. A review of the progress of the fishing industry *vis-a-vis* the resources and opportunities available, indicates that the pace of growth has been slow from the expected level. This is because

of the keen competition from the land-based industries which offer relatively less risk and comfortable business than the hazardous fishing operations. Further, the marine products industry is primarily oriented towards export and has a lean domestic base. This is mainly due to the price factor. There is tremendous scope for developing an internal market for fishery products and it is time that the agencies responsible for the development of the seafood industry address themselves to the development of the domestic market which is necessary for the overall growth of the industry. This should also help the industry to withstand the fluctuations in the export market which is influenced by the demand and supply at the international level. In India, with a vast area and population, it may not be difficult to develop a market for products which are comparatively cheaper and within the purchasing power of the Indian consumer.

Although several schemes and programmes have been taken up by the Government to promote and expand the industry, it still faces many problems. These relate to extreme fluctuations in the availability or raw material; inadequate financial assistance or flow of institutional finance for the establishment and expansion of the industry; lack of suitable vessels and equipments for offshore/deep sea fishing; non-availability of expertise and trained personnel in certain specialised fields of fishing; high cost of operation of fishing vessels; inadequate berthing and landing facilities for boats and other infrastructural facilities; lack of proper shipping facilities and reefer space; frequent hikes in freight charges; inadequate supply of containers and packing material; poor sales promotion in the internal markets and unorganised domestic trade. In the absence of any licensing, there has been a hapazard growth of the industry all over the coastline. A number of processing units have even gone sick due to the non-availability of raw material at economic rates apart from other reasons. A stage has now come that for the healthy development of the industry, it will be desirable to introduce a system of licensing. It is also hoped that the programmes such as import of trawlers, promotion of indigenous construction of trawlers, increased flow of institutional finance, encouragement for joint collaboration, training of personnel, intensive resources survey and research activities, prospect of culture of several commercial species, the various incentives provided by the Government and the increasing interest in the development of internal market would help the industry to enlarge and expand its activity in the coming years.

Corporations

With a view to promoting integrated fisheries activities, fisheries corporations were established in the country by the end of the Third Five Year Plan. Under the scheme, a Central Fisheries Corporation was established in 1965 at Calcutta. Subsequently, all the maritime States also organised Fisheries Corporations. However, recently the Orissa Fisheries Corporation and the Maharashtra Fisheries Corporation were wound up. The activities of the Corporations include commercial fishing activities such as fishing operations, ice production, processing, storage, marketing and construction and repair of fishing vessels. The financial source of the Corporations consist of sharesissued, the loans obtained by the State Governments and the business turn over.

Co-operative sector

With a view to providing assistance to fishermen who are the actual producers, fisheries co–operative system in the country was organised. The system includes Primary Fisheries Co-operative Societies, Fisheries Federations and Apex Societies. Primary Fisheries Co–operative Societies are engaged in a variety of activities such as fishing operations, marketing, providing facilities like short-term and medium-term loans, loans for the house construction and for purchase of fishing implements. The Federations provide credit facilities and assistance to improving the organisational set up of the Primary Co–operatives.

Financial assistance to the industry

Besides the subsidies provided by the Central and State Governments on various items of fishery requisites as indicated elsewhere in this publication, credit facilities for the promotion of the industry are provided by the commercial banking institutions and other lending agencies which have been established by the Central and State Governments. These are not the same in all the States. Some of the important agencies providing credit facilities to the industry are:

1) Central Fisheries Co-operatives which buy boats at subsidised prices and sell them on long-term loans to primary fisheries co-operatives and individuals;

2) State Co-operative Banks lend to Fisheries Co-operatives and individual members (Kerala, Andhra Pradesh) and to private operators (Gujarat);

3) State Finance Corporation (Gujarat) lends mainly to private operators; and

4) State Fisheries Department (Andhra Pradesh) purchases boats and allots them on hire purchase contracts to qualified fishermen.

Much of this lending is refinanced directly by the Agricultural Refinance Corporation, a subsidy of the Reserve Bank of India established to support local lending institutions for agricultural projects including fisheries. In Gujarat, the Industrial Development Bank of India also refinances boat loans.

Ancillary Industries

Boat building yards

Besides the numerous small non-registered boat yards constructing different indigenous crafts and small boats, there are 69 registered wooden boat building yards, 16 shipyards where trawlers are constructed, and 3 yards where FRP boats are constructed. Recognition of 8 additional yards where fishing vessels are proposed to be constructed is under consideration. The country has adequate material, expertise and suitable designs for the construction of wooden and steel vessels up to 30 m long.

Marine diesel engine

Name of the firms and details of make and horse-power of the engines, and overall licenced capacity for manufacture of marine diesel engines in the country are given in Table 19.

Repair and servicing facilities

Service stations and workshops at selected centres such as Veraval, Porbander, Bulsar in Gujarat State; Satpati, Bassein, Bombay, Ratnagiri and Alibag in Maharashtra; Marmagoa in Goa; Karwar, Malpe and Mangalore in Karnataka; Cannanore, Cochin and Quilon in Kerala; Cuddalore, Nagapatinam, Colachel, Rameswaram, Mandapam and Madras in Tamil Nadu; Kakinada and Visakhapatnam in Andhra Pradesh are available. Dry dock and slipway facilities for underwater maintenance are available at Bombay, Goa, Cochin, Mandapam, Madras, Visakhapatnam and Calcutta.

Table 19. *Details of marine diesel engine makers in India*

Name of Firm	Make and Horse-power of the Engine	Total annual licensed capacity
M/s. Premier Automobiles	"Meadows" 44 to 70	3000
M/s. Ruston & Hornsby (India) Limited, Poona	"Ruston" 25 to 75	720
M/s. Kirloskar oil Engines Limited	"Kirloskar" Man/300-600	600
M/s. Kirloskar Commins Limited, Poona	Kirloskar Commins 120/372	N.A.
M/s. Garden Reach Workshop, Marine Engine Division, Ranchi	Man/800-10,000	N.A.
M/s. Lakshmi Narathan Engineering Works Limited	"Lister" 18 to 42	142
M/s. Lynx Machinery Limited, Calcutta	9 to 18	900
M/s. Veegal Engineers Limited, Calcutta	"Veegal" Outboard engines 5	N.A.
M/s. Ashok Leyland Limited, Madras	Leyland 70-130	N.A.

N. A. = Not Available

Fishing gear

Most of the indigenous fishing gears are fabricated and manufactured by fishermen themselves. There are 4 net making plants set up in the public sector with a capcity to manufacturing over 400 tonnes of twine from nylon yarn per year. Besides, there are four small units in the private sector. There are also four licenced firms for producing nylon for nets for the fishing industry.

Others

Various fishing vessel components such as reverse-reduction gear, stern gear, power-take off clutches, auxillary engines and machinery, trawl winches and other equipments such as radio-telephone, cold storage and refrigeration equipments, life saving appliances like life bouys, life rafts, required by the fishing industry are manufactured in the country.

II

socio-economics

The total fisher population of India in 1972 was 55,83,400, representing about one per cent of the total population of the country. Along the coastline live 32,81,500 fisher folk, and others on the banks of the rivers, lakes, and backwaters. About one million fishermen are actively engaged in the sea fishing. Besides fishing, fishermen also carry out other avocations such as ferrying and water transport, sea faring and salt making.

The fishermen of the country have a distinct tradition of their own. They belong to all the major religions, namely Hindu, Christian and Islam, and to several communities which differ from State to State. The principal fishermen communities of Gujarat and Maharashtra are the *Khar, Machis* and *Bhois*; of the Kanara Coast, the *Ambigas* and *Mogaveers;* of Kerala, the *Mukkavas;* of Tamil Nadu, the *Sembadavas* and *Pattanavans;* of Andhra Pradesh, the *Besta, Boya* and *Palli,* of Bengal, Bihar and eastern parts of the country, the *Mallah, Molo, Tiyar* and *Patni.* While the *Khars* have no endogamous divisions or exogamous sects, the *Ambigas* have endogamous divisions having exogamous sects. Both matrilineal and patrilineal systems are existing in the fishermen communities of *Mukkavas* of Kerala. The *Molo* and *Tiyar* communities are tribals . Thus, a great sectoral diversity exists among the fishermen communities of the country.

In the society, the fishing community occupies a low status. Majority of the fishermen belong to an economically weaker section and follow traditional methods of fishing employing indigenous crafts and gears. The percentage of fishermen who own boats varies from State to State, being 66.7 in Gujarat, 44.9 in Maharashtra, 50.0 in Karnataka, Tamil Nadu, Orissa and West Bengal, 27.8 in Kerala and 39.0 in Andhra Pradesh. Others work on hired boats or as partners or on wage basis.

The average size of a fisher family varies between 4.7 and 8.6 in different States. Although there has been considerable improvements in the living conditions of fishermen in recent years, there is very little infor-

mation on the income of family of fishermen or on the pattern of their spending. By and large, the fishermen are perennially indebted to the middle-men who advance financial help to them at times of need in return for their entire catch assessed at a low price. The middle-men also control the sale and marketing of fish.

Several factors such as low social status, poor economic conditions, illiteracy, heavy leaning on middle-men, traditional fishing equipments and methods of fishing, low production rate and income influence the socio-economic conditions of fishermen. Prior to Independence, this sector received little attention. Schemes with specific objectives to improve the socio-economic conditions of fishermen were initiated right from the beginning of the First Five Year Plan. Some of the important programmes taken up by the Government to ameliorate various problems encountered by the sector are briefly discussed below.

Housing and colonisation

The acute problem of housing facilities facing the fishermen who live in congested areas of the beach under unhygienic environment susceptible to all sorts of diseases has received priority at least from the Third Five Year Plan onwards. In the beginning, housing colonies were built in coastal areas of the States with Government funds and distributed to the needy fishermen free of cost. But because of the non-contiguous nature of the villages where houses were provided and other technical and administrative problems associated with the construction of the buildings in coastal areas coupled with high cost of construction, the programme could not be implemented very successfully in most of the States. As an alternative measure a scheme for issue of grants for construction of houses in plots owned/possessed by fishermen who have irredeemable tenancy rights over the land was started for implementation during the later part of the Fourth Five Year Plan. Under this scheme, in Kerala, grants were issued to fishermen in four stages on production of stage certificates — the first stage of grant being Rs. 375/-, second stage Rs. 1,250/-, third stage Rs. 500/- and final stage Rs. 375/-. This scheme does not give benefit to most of the fishermen who are either landless or do not have irredeemable tenancy rights over the land occupied by them. Another inherent defect in the scheme is that most of the fishermen find it difficult to complete the houses with the meagre stage payments with the result that they are forced to borrow money. An ideal scheme to mitigate the problem of housing should therefore aim at providing interest free loan with easy repayment terms. Or else the amount of grant should be enhanced to meet the increased cost of construction.

Dispensaries and community amenities

The fishermen in the coastal areas are subject to all kinds of diseases, as proper sanitation and medical facilities are not available in these areas. Schemes for providing dispensaries in coastal fishing villages have helped to solve the problem to some extent. Community amenities such as drinking water, wells, latrines, common path-ways and community halls have been provided in some of the colony sites, but majority of the coastal fishing villages are without such amenities.

Approach roads

Most of the fishing villages are inaccessible by road and the problem of transport is all the more acute. This is a major hindrance to the development of the fishing industry. Fish being a perishable commodity, quick transport is imperative to fetch good prices to the producer fishermen. Construction of link roads connecting the fish landing centres with the main road for quick transport will ensure better prices for the catches. A scheme for construction of roads was taken up for implementation during the Third Plan Period. During the Fifth Plan Period, the scheme has been included under a centrally sponsored scheme of providing infrastructural facilities in selected fishing villages. This scheme, when implemented in full, will benefit a large number of fishermen in the selected fishing villages.

Distress relief

A scheme for giving financial assistance to the dependents of fishermen who lose their life and to those who lose their fishing craft and other implements and also to those who meet with accidents while conducting fishing operations is being implemented. It is necessary to enhance the financial assistance and develop a speedy mechanism for redressal.

Education and training

Considering the low socio-economic status of fishermen, scholarships to students belonging to fishermen communities to pursue post-matric studies is under implementation in some of the States. However, due to paucity of funds only a limited number of children are benefited under this programme. In the Regional Fisheries Technical High School under the Department of Fisheries, Kerala, selected students are also given education with free boarding and lodging on a public school model with fisheries bias.

To impart training to the local fishermen in the operation and maintenance of mechanised fishing boats and in modern fishing methods, a number of Fishermen Training Centres were started in the country. These courses are essentially employment-oriented.

Subsidies

Under the Five Year Plan schemes most of the State Governments have issued some subsidy ranging upto 50% in some cases on the cost of hull/engine of mechanised boats, nylon/terylene, twine, indigenous craft, diesel oil, and so on.

Fishery co-operatives

Organised attempts to promote fishery co-operatives in the country owe their origin to the different schemes taken up for implementation in the Five Year Plans, which provided financial assistance for strengthening the fishery co-operatives. In the early years, emphasis was on the organisation of primary societies of credit type which offered loans to the members for purchase of fishery requisites and for discharging old debts. Subsequently, based on the need for marketing of the catch, marketing unions and regional marketing societies/federations were also organised in some of the States, although in most of the cases, the primary societies themselves undertook the marketing operations as well. Of late, however, apex federations of the fishery co-operatives have also been set up in quite a few States.

Though nearly 5000 co-operative societies were formed in the country exclusively for fishermen, more than two-thirds of these societies are defunct. The members on the rolls in these societies are less than 5 lakhs which clearly indicate the fact that a good percentage of the active fishermen in the country are still outside the co-operative fold. If the benefits of co-operatives are to be extended to fishermen, concerted drives have to be launched to enroll all active fishermen either by enhancing the membership in the existing societies or by organising new societies to achieve in a phased manner, cent per cent coverage.

It has been observed that a good number of members of the societies are not active fishermen and that fish traders and others owning one or two boats who are not themselves engaged in the vocation of fishing have infiltrated into these societies as well as their managements to achieve personal gains. The loan assistance, inputs, services and other facilities meant for the fishermen often do not reach genuine fishermen but are utilised by the middlemen traders and other vested interests who gain control of the societies. It is therefore necessary that such of those members, who are not actively engaged in actual fishing should be weeded out of the societies. So long as they dominate the societies there is no scope for ameliorating the miserable conditions of the fishermen.

There is scope for diversifying the activities of the primary societies. It is advisable that the primaries are affiliated directly to the State level Federation which may establish its own branches at district/regional level for efficient co-ordination of the activities of societies and for marketing of the fish. In the absence of a National level Federation of Fishery Co-operatives in the country there is an urgent need for organising one to co-ordinate the activities of the fishery co-operatives and also to act as the Chief Spokesman of the fishery Co-operative movement both at national and international levels.

The State Governments, in most of the States have been assisting the fishery co-operatives by participating in their capital base for enabling them to raise working capital from institutional finance. Government contribution at the primary level accounted for about half of the total paid up share capital while at the central and apex levels it was nearly three-fourth each. The percentage of share contribution by the State Governments varies from society to society as also for different States depending upon the require-

ments of the societies in each case and the resources available with the State Governments within the plan allocation. According to provisional estimates, Government aid to fishery co-operatives at the end of the Fourth Five Year Plan stood at Rs. 2.61 million. During the Fifth Plan, State Governments together have provided an outlay of Rs. 39.85 million for this purpose.

Though the answer to the problems of the fishermen may be the Fishery Co-operatives, much has yet to be done in the matter of actual management. Instead of thinking in terms of a small co-operative with weak financial base, it is necessary to organise multi-purpose societies under the aegis of a Co operative Federation, with a team of well-trained and adequately paid managers to attend to the day to day business transaction.

12

thirty years of progress and a challenging future

In the preceding pages an attempt is made to trace the progress, and to summarise and assess the present knowledge of the fish and fisheries of India, and the status of its industry by assembling the various components into a more unified whole. In the light of this background information, it is apparent that the Indian fisheries during the last three decades has registered an inpressive progress, though it cannot be over-emphasised. Beginning with the establishment of specialised fisheries research and other institutes, and the implementation of the development programmes formulated particularly under the National Plans, it progressed through the discovery of the commercial fishing grounds in the inshore waters, modernisation of fishing crafts and gears, improvement of fishing and processing techniques, better transportation and marketing systems. The period also witnessed the birth and growth of a modern fishing industry in the country. Above all these, it has been made possible to create a consciousness across the country, about the potentials of the fisheries, its significant role to supplementing the food requirements of the growing population and its vast scope for future development.

The overall policy of the fisheries development of the country is one of promoting growth with stability. The formulation of policies and priorities is closely related to the broad objectives of the country's development programmes. The main objectives of fisheries research and development are to collect all information relating to fishery resources and factors influencing their fluctuations in abundance and sustainability, to step up the production to maximum possible extent through capture and culture means; to monitor and recommend measures for rational exploitation of the various resources; to improve the socio-economic conditions of fishermen and to tap on an increasing scale the vast potential for foreign exchange earnings

through export of selected varieties. While formulating the programmes the main thrust is given for rural development.

Through the marine fisheries research programmes, valuable data on the fishery resources, their characteristic and dynamics as well as their environment in the inshore waters have been gathered. Intensive researches are being under taken to assess the resources in the contiguous offshore/deep-sea regions covering the extended fisheries jurisdiction of 200 miles economic zone and for their rational exploitation and conservation. The strategy of the development of marine fisheries sector is on the improvement of traditional, coastal mechanised and deep-sea fisheries. The development of traditional fishery is envisaged through improvement of designs, material and operational aspect of fishing units, fish handling, distribution and marketing and economic betterment of the fishermen community. The coastal mechanised fishery is to be further developed by introducing additional mechanised boats, by increasing their operational efficiency and reducing the operational costs, and diversification of fishing. Greater emphasis in the marine fisheries sector of the country in recent years is towards integrated development of deep-sea fishery involving fishing, processing, and marketing as well as establishment of infrastructural facilities. While there is little doubt regarding the existence or availability of resources in the seas around India and the adjacent Indian Ocean, the progress of this sector has been slow due to the limited data on economic viability of the enterprise on commercial proposition, inadequate larger fishing vessels and equipments, and expertise. However, the vessel acquisition programmes through import and indigenous construction, encouragement for joint collaboration with suitable agencies having resource and expertise, and greater awareness for the development of the sector will help to accelerate the progress of deep-sea fisheries of the country in the coming years. Besides, India with its advantageous geographical position in the Indian Ocean has bright prospects for the development of the oceanic and distant water fisheries. These opportunities together with the declaration of an exclusive economic zone of 200 miles, to explore, exploit, manage and conserve the living resources of our seas, offer a challenging future to the coastal rural population, scientists, planners, administrators and industrialists engaged in the promotion of the marine fisheries of the country.

In addition to the conventional fishery resources available for exploitation in the shelf waters,there are several non-conventional pelagic and demersal fishery resources. Important resources among them are the cuttlefishes and squids, myctophids, crabs, deepsea gastropods and echinoids and several other deepsea fishes and crustaceans. In the oceanic waters outside the continental shelf, exploitable fishery resources comprise of tunas and related species, bill fishes, pelagic sharks, oceanic squids, marine turtles and whales. These resources are at present not exploited by our country. An overall programme at the exploitation and utilisation of such resources should considerably help in the diversification of fishing and a more balanced development of the fishing industry.

Oceanic research has at present diversified into several fields and spectacular advances have been made in the field of oceanography, marine electronics, instrumentation, system designs, ships and structures, marine transportation, ocean engineering, and ocean mining. Ocean resources development programmes are becoming more significant in the national programmes of many of the affluent countries. However, in view of the huge investment required for the implementation of these programmes many of the developing countries may find it difficult to participate in these programmes on their own. Nevertheless, international co-operation and joint collaboration in the field of mutual interest would greatly benefit the participating countries.

We are developing a technology of large scale culture of selected commercial species such as marine prawns, fishes, mussels, oysters and seaweeds, and production of cultured pearls. Increased attention now given to coastal aquaculture (mariculture and brackish water fish culture) both in research and pilot projects would pave the way for an organised industry for culture fisheries of the cultiviable organisms,utilising the suitable coastal waters. Endeavours to tie up these programmes with the normal activities of the small fishermen (the concept of blending sea-brackishwater farming with the traditional capture fisheries) will have a major impact in rural development and economy.

The inland fisheries research programmes particularly relating to culture of freshwater fishes and composite fish culture have made considerable advancement and have laid the foundation for the establishment

of an extensive and intensive culture fisheries in the vast inland water ecosystems. In this context, self-sufficiency in fish seed has assumed urgency and region-wise massive efforts will have to be put in. Researches and developmental programmes towards wide application of induced breeding techniques, establishment of modern hatcheries and seed banks, increased production of fish from reservoirs and lakes, conversion of small farms into viable larger units, intensive cultivation employing composite fish culture techniques and successful implementation of Fish Farmers Development Agencies will not only enhance inland fish production but also provide gainful employment to large number of fisherman and fish farmers.

Increased exploitation and utilisation of the marine as well as inland fisheries of the country largely depend on the progress of fisheries technology evolving improved and new methods of capture, preservation and marketing. Continued efforts are being made to developing efficient fishing crafts and gears, catching and processing techniques, developing new products and to promoting profitable marketing. Similarly, a considerable amount of industrial wastes resulting from the processing of prawns and other organisms available now could be processed further for the production of useful bye-products.

There are several species of marine animals and plants which have pharmaceutical use. These are not commercially exploited at present. As the demand for these are likely to grow in the future, it is necessary to initiate researches on these organisms and develop suitable technology for their utilisation.

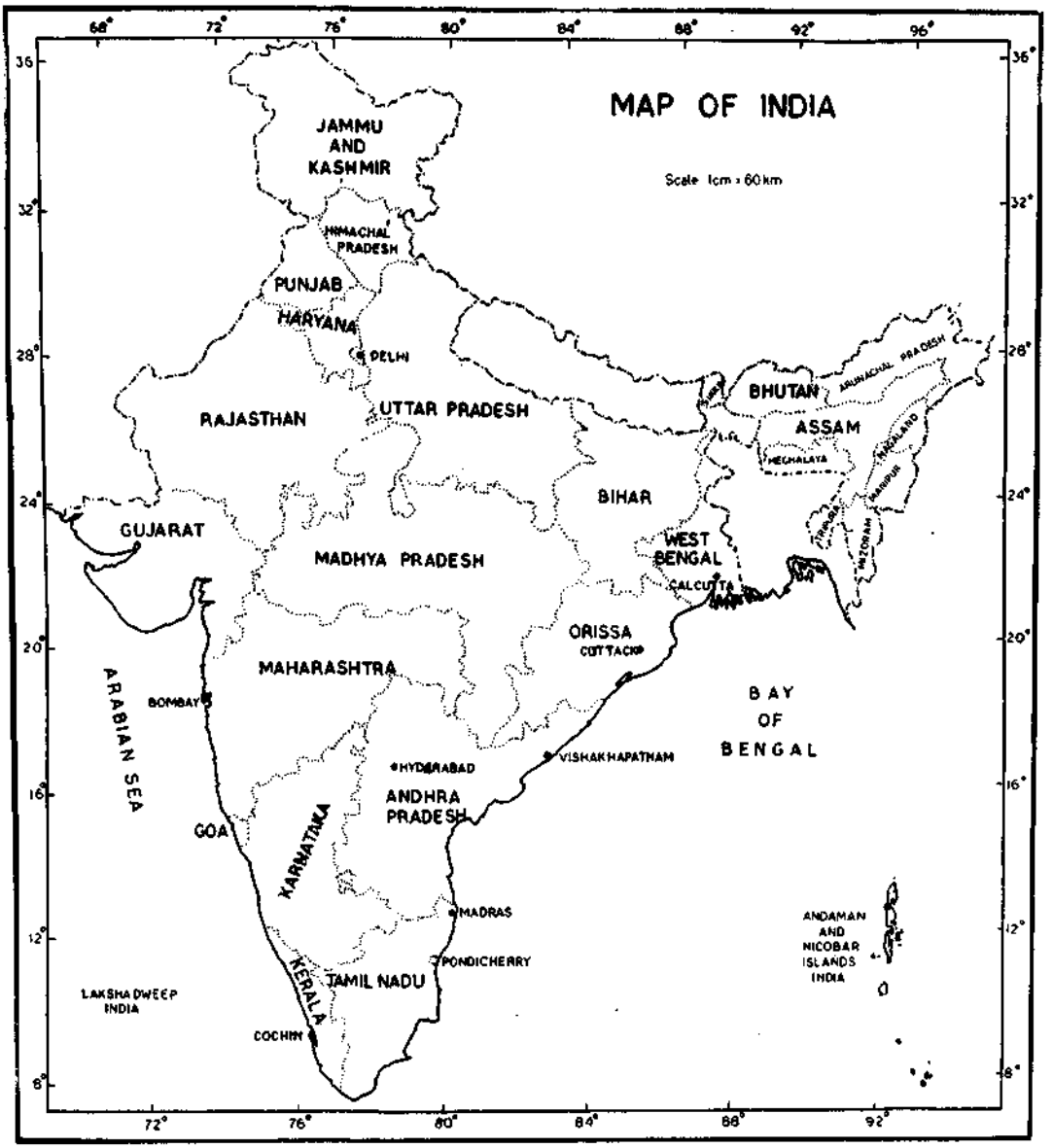
Availability of trained manpower forms an essential prerequisite for an organised development of any sector. In fisheries, necessary infrastructural facilities for education and training of various categories of essential and industry-specific personal have been established. Future planning should take into account training in management techniques at various levels, which is wanting in the present system. Increased involvement and interest of the Governments and ICAR in recent years on fisheries education and training would further strengthen the base and promote its expansion to meet the requirements of trained manpower. Simultaneously efforts are being made to transfer the technology developed in the laboratories to the field through intensive training of the actual and prospective fishermen/fish farmers and extensive extension service.

With the increasing pace of urbanisation and industrialisation of the country, pollution of the sea, and inland waters by industrial and other wastes has a hazard to local fisheries in many areas. The Central Government has passed a Water Pollution Bill in 1974 and most of the States are also having statutory regulations including Pollution Control Boards to enforce the law. However, our responsibility towards prevention of pollution and protection of our resources has considerably increased. In this context, active research on pollution problems and continuous monitoring have become imperative.

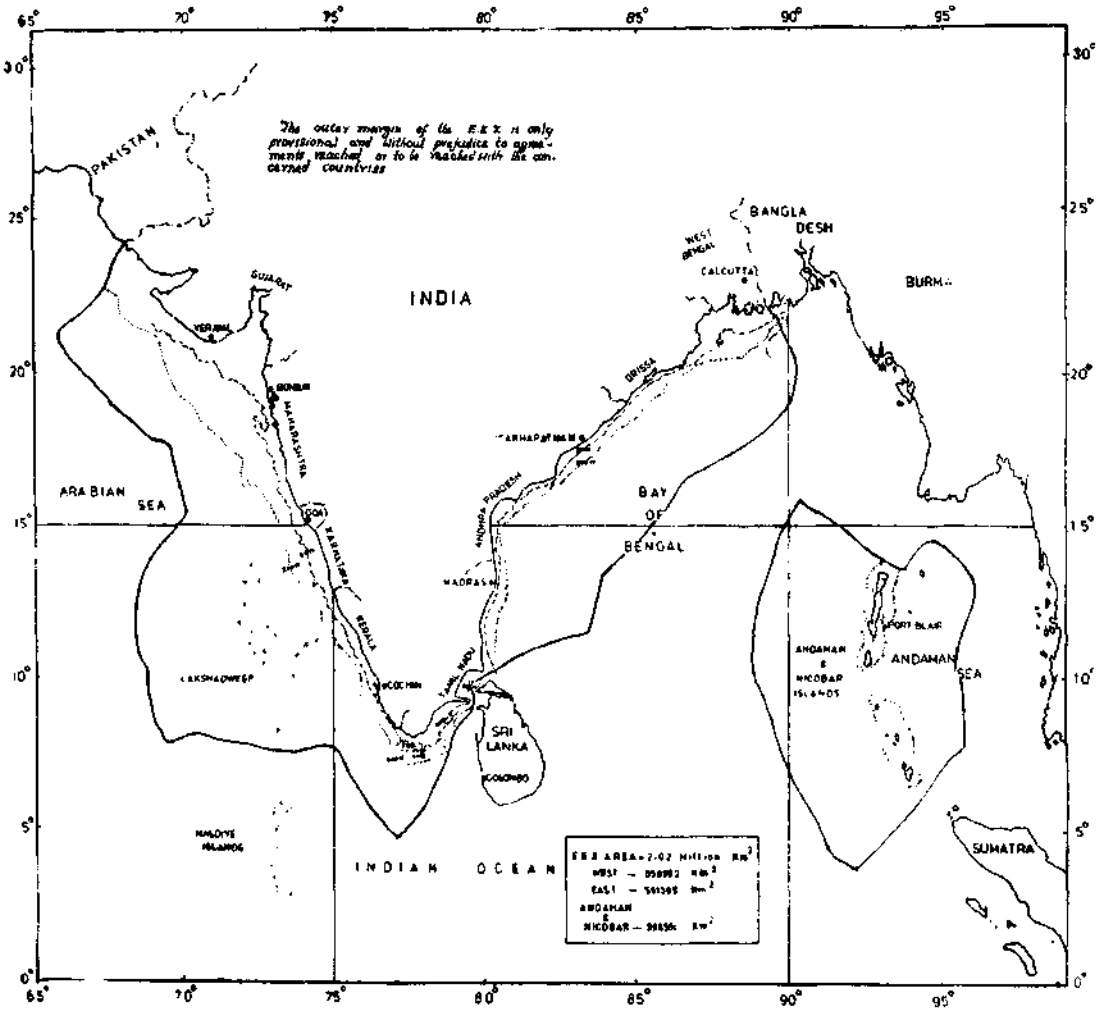
It is well known that the fishing industry of India since its inception in the early post-war period, has registered a phenomenal growth through the years. However, this pace of growth has been partial. Although the efforts and contributions of the industry towards the development and progress of the fisheries of the country are quite appreciable, its heavy dependence on the export trade has camouflaged the coherent growth of the various other sectors, particularly the domestic front. While the export sector should continue to receive due promotion and many of its problems require immediate attention, it is essential that concerted efforts are made to develop an equally strong domestic base so as to ensure an allround sustained growth of the industry.

Management and conservation of the fishery resources of the country is at present based and guided by the Indian Fisheries Act which was enacted as early as 1897, and the subsequent rules and regulations framed by the various State Governments under this Act. However, the development that have taken place in the fisheries since that time and the importance it has assumed in the national economy make it imperative to bring the various sectors of fisheries under a comprehensive Act which provides the necessary guidelines for the exploitation, mangement, conservation and optimum utilisation of not only the fishery resources, but all the living aquatic resource.

APPENDIX 1


MAP OF INDIA
Scale 1cm = 60 km
JAMMU AND KASHMIR
HIMACHAL PRADESH
PUNJAB
HARYANA
DELHI
RAJASTHAN
UTTAR PRADESH
BHUTAN
ARUNACHAL PRADESH
ASSAM
NAGALAND
MEGHALAYA
MANIPUR
TRIPURA
MIZORAM
BIHAR
GUJARAT
MADHYA PRADESH
WEST BENGAL
CALCUTTA
ORISSA
CUTTACK
MAHARASHTRA
BOMBAY
ARABIAN SEA
BAY OF BENGAL
HYDERABAD
VISHAKHAPATNAM
ANDHRA PRADESH
GOA
KARNATAKA
MADRAS
PONDICHERRY
TAMIL NADU
KERALA
COCHIN
LAKSHADWEEP INDIA
ANDAMAN AND NICOBAR ISLANDS INDIA
36°
32°
28°
24°
20°
16°
12°
8°
68°
72°
76°
80°
84°
88°
92°
96°

APPENDIX 2



Map of India showing the economic zone

APPENDIX 3

INDIA : COUNTRY DATA

1. Location

India extends between Latitudes 8°4′ and 37°6′ north and longitudes 68°7′ and 97°25′ east; adjoined in the north by China, Nepal and Bhutan; in the east by Burma and Bangladesh; in the north-west, Afghanisthan and Pakistan border on India. South of the Tropic of Cancer, the country tapers off into the Indian Ocean between the Arabian Sea on the west, and Bay of Bengal on the east. The Gulf of Mannar and the Palk Strait separate India from Sri Lanka. The Andaman and Nicobar Islands in the Bay of Bengal and Lakshadweep in the Arabian Sea are parts of the territory of India (Map in Appendix 1).

2. Area

Area:	32,87,782 km² (Provisional as on 1st July, 1971).
Coastline:	6,100 km
Continental shelf area (200m):	4,14,868 km²

3. Population

1971 (census)		
Total:		548 million
Urban:		20%
Rural:		80%
1975 (Estimated)		
Population:		597 million
Birth rate (1961–70):		41.1 per thousand
Death rate (1961–70):		18.9 per thousand
Growth rate (Decennial 1961–71):		24.80%
Density of population:		177 per km² (worked after excluding figures of Jammu & Kashmir)
Life expectancy (1961–70):	Males	47.1 years
	Females	45.6 years

4. Education

Literacy rate:	Total	29.45%
	Males	39.45%
	Females	18.69%

4.1 Enrolment at different levels of education (1973-74)

Level	Age group	Percentage of enrolment of the total population in the age group
Primary school (Classes I -V)	6-11	83.5
Middle School (Classes VI-VII)	11-14	35.6
Secondary School (Classes VIII and above)	14-17	21.2
Universities and Colleges	17-23	5.0

5. Health (1973-74)

Population per hospital bed:	2,000
Population per doctor:	4,200

6. Nutrition (1970-71)

Calorie intake in % of requirement: 77.8
Per Capita protein intake: 40-52 gm/day

7. Employement by different categories (1971)

Category	Total (in million)	Percentage of total workrers
(i) Cultivators	78.1	43.3
(ii) Agriculture labourers	47.5	26.3
(iii) Live stock, forestry, fishing, etc.	4.4	2.4
(iv) Mining, Manufacturing and Construction	20.2	11.2
(v) Trade, Commerce, Transport and Communication	14.4	8.0
(vi) Other services	15.8	8.8
Total workers	180.4	100

8. Gross and Net National Product at factor cost

(1973-74 estimates)

Total GNP (Rs. in million)	521,930
Index number of GNP with 1960–61 as base (Rs.)	372.7
Net National Product (Rs. in million)	492,900
Per capita NNP(Rs.)	849.8
Index number of NNP with 1960 as base (Rs.)	371.5
Index number of per capita NNP with 1960–61 as base (Rs.)	278.0

9. Trade

9.1 Exports of Principal commodities (1973-74)

Commodity	Percentage in total export
Cotton manufactures	9.5
Jute manufactures	9.1
Leather	6.7
Tea	5.8
Iron ore and concentration	5.3
Marine Products	4.6
Fresh fruits and meats	3.2
Tobacco unmanufactured	2.7
Iron & Steel	2.3
Crude vegetable material	2.3
Other commodities	49.5

9.2 Imports of principal commodities (1973-74)

Commodity	Percentage in total imports
Petroleum, crude & partly refined	14.8
Machinery other than electric	14.2
Wheat unmilled	11.8
Iron & Steel	9.2
Petroleum products	4.9
Electric machinery and appliances	4.2
Chemicals	3.6
Transport equipment	3.0
Raw cotton	1.7
Vegetable oils	1.9
Other commodities	30.7

9.3 Balance of Trade 1973 - 1976

in million Rs.

	1972–73	1973–74	1974–75
Imports (cif)	18,674	29,252	43,486
Exports (fob)	19,708	25,234	32,530
Balance	–1,034	–4,018	–10,956

10. Prices

10.1 Consumer price index numbers of food items* for agricultural labourers (Base 1960-61=100)

	1971–72	1972–73	1973–74	1974–75	1976 Sept.
Index	215	246	313	413	316
Annual change%	14	27	32	–23	

10.2 Annual average indices of wholesale prices of fish, food articles and all commodities(Base 1960-61=100)

Year	Fish	Food articles	All commodities
1971	343.4	207.0	186.1
1972	454.5	230.6	200.7
1973	654.0	278.9	239.3
1974	999.8	351.8	304.6
1975	1176.1	360.8	309.2

Source: Economic Adviser, Ministry of Industrial Development.

11. Union and the States

India, an Union of States, is a Sovereign Socialist Secular Democratic Republic with a parliamentary system. It is administratively divided into 22 States and 9 Union Territories as follows:

Maritime States

West coast	East coast
Gujarat	West Bengal
Maharashtra	Orissa
Karnataka	Andhra Pradesh
Kerala	Tamil Nadu

Maritime Union Territories

Goa, Daman, Diu	Andaman and Nicobar
Lakshadweep	Pondicherry

*Expenditure of rural population exists for about 80% on food items.

Inland States

Assam
Bihar
Haryana
Himachal Pradesh
Jammu and Kashmir
Madhya Pradesh
Manipur
Meghalaya
Nagaland
Punjab
Rajasthan
Sikkim
Tripura
Uttar Pradesh

Inland Union Territories

Arunachal Pradesh
Chandigargh
Dadra and Nagar Haveli
Delhi
Mizoram

APPENDIX 4

PRESENTATION OF THE FISHERIES IN DIFFERENT STATES OF INDIA

Certain basic information on fisheries of each of the States of India is given below. The information is not exhaustive. The data are collected from the information available at C.M.F.R.I., State Reports, and Statistical supplement issued during the 10th meeting of the Central Board of Fisheries, 22-23 March 1976 held at New Delhi, by the Department of Agriculture, Ministry of Agriculture and Irrigation. The data may show variation due to continuous development taking place in different sectors of fisheries.

Abbreviations used:

- Cl – Coastline in kilometers.
- Csa – Continental shelf area in sq. kilometres.
- Flc – Fish landing centres in number.
- Fv – Fishing villages in number
- Fp – Fishermen population in numbers (Active fishermen in numbers).
- Fcs – Fishermen Co-operative Societies in numbers
- Ifc – Indigenous fishing carfts in numbers.
- Mb – Mechanised boats in numbers.
- Mfp – Marine Fish production in tonnes.
- Fw – Fresh water area in million hactares.
- Ba – Brackish water area in million hactares.
- Sp – Spawn production numbers in Million.
- Ffp – Fry and fingerlings production numbers in million.
- Ifp – Inland fish production in tonnes.
- Fpo – Fifth Plan outlay in million Rupees.
- Frp – Freezing plant in numbers (capacity).
- Cp – Canning plant in numbers (capacity).
- Icp – Ice making plant in numbers (capacity).
- Cs – Cold storage in numbers (capacity).

ANDHRA PRADESH

Cl-982; Csa-39,109; Flc-229; Fv-419; Fp-136,893 (47,700); Fcs - 662; Ifc - 19,772; Mb - 586; Mfp-1,31,035; Fw - 0.3772; Ba - 0.5665; Sp - 47.00 Ffp - 46.00 Ifp - 1,00,000; Fpo - 39.50; Frp - 9 (33.00); Cp - 1 (0.25); Icp-12 (92.75); Cs - 11 (731.00).

ASSAM

Fcs - 375 ; Fw - 19.07; Sp - 185.00; Ffp - 47.00; Ifp - 42,000; Fpo - 20.00.

BIHAR

Fcs - 258; Fw - 0.4855; Sp - 280.800; Ffp - 57.50; Ifp - 68,000; Fpo - 25.00.

GUJARAT

Cl - 1663; Csa - 1,20,000; Flc - 139; Fv - 133; Fp - 82,242 (11,732); Fcs - 57; Ifc - 3,179; Mb - 3,364; Mfp-1,71,294; Fw - 0.3310; Ba 0.4189; Sp - 154.00; Ffp - 41.00; Ifp - 10,000; Fpo - 70.00; Frp - 3 (23.00); Cs - 11 (1,110).

HARYANA

Fcs - Nil; Fw - 0.3800; Sp - 3.65; Ffp - 0.70; Ifp - 1,250; Fpo - 7.50.

JAMMU & KASHMIR

Fcs - 1; Fw - 0.0894; Ifp - 7,000; Fpo - 4.0.

KERALA

Cl-560; Csa-38,673; Flc-272; Fv-249; Fp-3,33,822 (74,241); Fcs - 1,026; Ifc 20,667; Mb - 2,322; Mfp - 3,31,047; Fw - 0.0948; Ba - 0.3399; Sp - 6.00; Ffp -3.00; Ifp; -24,000; Fpo - 175.90; Frp - 99 (476.73); Cp - 40 (152.72); Icp - 47 (520. 75); Cs - 122 (9,670.00).

MADHYA PRADESH

Fw - 0.5269; Sp - 250.00; Ffp - 40.00; Ifp - 9,500; Fpo - 33.50.

TAMIL NADU

Cl - 1000; Csa - 34,820; Flc - 340; Fv - 349; Fp - 2,14,868 (56,586); Fcs - 450; Ifc - 29,661; Mb - 2,371; Mfp - 2,59,046; Fw - 0.4188; Ba - 0.1457; Ffp - 64.00; Ifp - 1,75,000; Fpo - 188.00 Frp - 40 (138.04); Cp - 3 (4.50); Icp - 30 (278.50); Cs - 56 (3,648.50).

MAHARASHTRA

Cl-720; Csa-89,096; Flc-185; Fv-348; Fp-1,03,535 (20.698); Fcs - 445; Ifc-7,894; Mb-4,718; Mfp-2,23,837; Fw - 0.2634; Ba - 0.1214; Sp - 90.00; Ffp - 65.00; Ifp - 19,300; Fpo - 45.30; Frp - 26 (183.00); Cp - 1 (2.50); Icp - 3 (190.00); Cs - 31 (4430.00).

KARNATAKA

Cl - 30; Csa - 24,999; Flc - 74; Fv - 151; Fp - 51,636 (11,732); Fcs - 129; Ifc-6,357; Mb - 2,127; Mfp -95,283; Fw - 0.7490; Ba - 0.1092; Sp - 80.00 Ffp - 27.00; Ifp - 75,000; Fpo - 55.00; Frp - 29 (116.84); Cp - 9 (38.00); Icp - 8 (115.00); Cs - 29 (2462.00).

NAGALAND

Fcs - 2; Fw - 0.0407; Sp - 0.09; Ffp - 0.85; Ifp - 160; Fpo - 4.00.

ORISSA

Cl-480; Csa-20,160; Flc-41; Fv-156; Fp - 33,630 (8,828); Fcs - 160; Ifc - 2,786; Mb - 117; Mfp - 29,823; Fw - 0.4096; Ba - 0.4128; Sp - 400.00; Ffp - 48.00; Ifp - 25,000; Fpo - 32.50; Frp - 8 (18.50); Cp - 1 (1.00); Icp - 3 (18.00); Cs - 8 (255.00).

PUNJAB

Fcs - 3; Fw - 0.4209; Sp - 6.00; Ffp - 1.20; Ifp - 2,100; Fpo - 6.00.

RAJASTHAN

Fcs - 15; Fw - 0.2023; Sp - 70.00; Ffp - 18.00; Ifp - 9,500; Fpo - 7.50.

UTTAR PRADESH

Fcs - 97; Fw - 0.8498; Sp - 191.00; Ffp - 22.00; Ifp - 26,500; Fpo - 15.0.

WEST BENGAL

Cl - 600; Csa - 17,094; Flc - 46; Fv - 182; Fp-2,311 (606); Fcs-610; Ifc - 108; Mb - 55; Mfp - 25,411; Fw - 0.5665; Ba - 0.8175; Sp - 600.00; Ffp - 120.00; Ifp - 2,60,000; Fpo - 96.50; Frp - 13 (35.00); Icp - 3 (65.00); Cs - 17 (88,600).

MANIPUR

Fcs - 44; Fw - 0.0291; Sp - 8.00; Ffp - 2.00; Ifp - 1,800; Fpo - 10.00.

DELHI

Fcs-34; Fw-0.0053; Ffp-0.61; Ifp-300; Fpo - 1.00.

MEGHALAYA

Fcs - 34; Fw - 0.001; Sp - 0.60; Ffp - 0.36; Ifp - 1,250; Fpo - 4.00.

TRIPURA

Fcs - 12; Fw - 0.0275; Sp - 90.00; Ffp - 15.20; Ifp - 4,440; Fpo - 9.30.

ARUNACHAL PRADESH

Fcs - Nil; Fw - 0.0409; Sp - 0.20; Ffp - 0.10; Ifp - 30; Fpo - 3.50.

GOA

Cl - 153; Csa - 9,809; Flc - 59; Mb - 387; Mfp - 43,155; Ifp - 1,000; Fpo - 17.50 ; Frp - 6 (23.00); Cp - 6 (41.50); Icp - 1 (10.00); Cs - 4 (145.00).

PONDICHERRY

Csa - 2,488; Flc - 40; Fv - 39; Fcs - 38; Mb - 257; Mfp - 10,123; Fw - 0.001; Sp - 0.05; Ffp - 0.40; Ifp - 640; Fpo - 20.00; Cp - 1 (1.50); Cs - 1 (1.50).

ANDAMANS

Cl - 1,500; Csa - 34,965; Flc - 26; Fv - 13; Mfp - 1,334; Fpo - 9.40.

LAKSHADWEEP

Csa - 7,770; Mb - 213; Mfp - 2,931; Fpo - 12.10; Cp - 1(1.50).

APPENDIX 5

FISHERIES ADMINISTRATION AND ORGANISATION SET UP

Administration

Under the Indian Constitution, both the Union Government and States share responsibilities for the development of fisheries. Each of the States is directly responsible for the development of fisheries within the territorial waters of the sea and of the inland waters. The Union Government is responsible for the development of fisheries beyond the territorial waters and for fisheries research although these are shared by the State Governments as well (Chart on page 92).

The Fisheries Wing in the Department of Agriculture under the Ministry of Agriculture and Irrigation, Government of India, is in overall charge of all important matters relating to policy and administration of the fisheries of the country. It is responsible for the formulation of national policies and programmes of fisheries development, fishing harbours, processing and preservation of fish, fisheries education and training, fish trade, etc., so designed as to achieve the optimum development and utilisation on modern lines of the country's fishery resources and to achieve the objective of self-reliance in this field. It is also responsible for taking all necessary steps for making available timely and adequate supply of inputs and services required; for participating in International Organisations and promoting bilateral and multilateral co-operation, collection and maintenance of relevant statistics. It assists State Governments in formulation of policy, plans and projects, setting up of fisheries corporations, and offers technical advice and guidance whenever required.

Apart from the Department of Agriculture, at the level of Union Government, the Ministry of Commerce also looks after certain functions concerning fisheries. These relate to the grant of industrial licence for the establishment of processing plants and export trade promotion.

Fisheries Education and Research are the responsibilities of the Indian Council of Agricultural Research (ICAR) which is a registered Society, and the Department of Agricultural Research and Education (DARE). The DARE is under the Ministry of Agriculture and Irrigation and provides the ICAR with the requisite linkages with Central and State Governments who are the agencies to extend the technology evolved at the Research Institutes to the field.

The fisheries administration in each of the States is carried out generally by the Department of Fisheries, under which functions a Directorate of Fisheries. The State Directorates of Fisheries are responsible for the formulation of plans for the development of fisheries of the concerned State and their implementation.

In the Union Territories, the Directorates of Fisheries administer the fisheries programmes.

ORGANISATION SET UP

Central Government

The Union Minister for Agriculture is in overall charge of fisheries of the country. He is assisted by Minister of State. The Secretary (Agriculture), who is the official head of the Department of Agriculture, assisted by the Additional Secretary (Animal Husbandry and Fisheries) holds charge of fisheries. The Joint Secretary is the head of Fisheries Wing in the Department of Agriculture. On the administrative side he is assited by a Deputy Secretary and an Under Secretary. On the technical side, Joint Commissioner is the principal adviser to the Government on all matters concerned with fisheries development. He is assisted by Deputy Commissioners and Assistant Commissioners.

DARE AND ICAR

The Department of Agricultural Research and Education (DARE), comes under the overall charge of the Union Minister of Agriculture, who is also the President of the Indian Council of Agricultural Research (ICAR). In all matters of policy and administration relating to this Department, he is assisted by a Minister of State. The Director General, ICAR, who is also Secretary to DARE, is the Principal Executive Officer

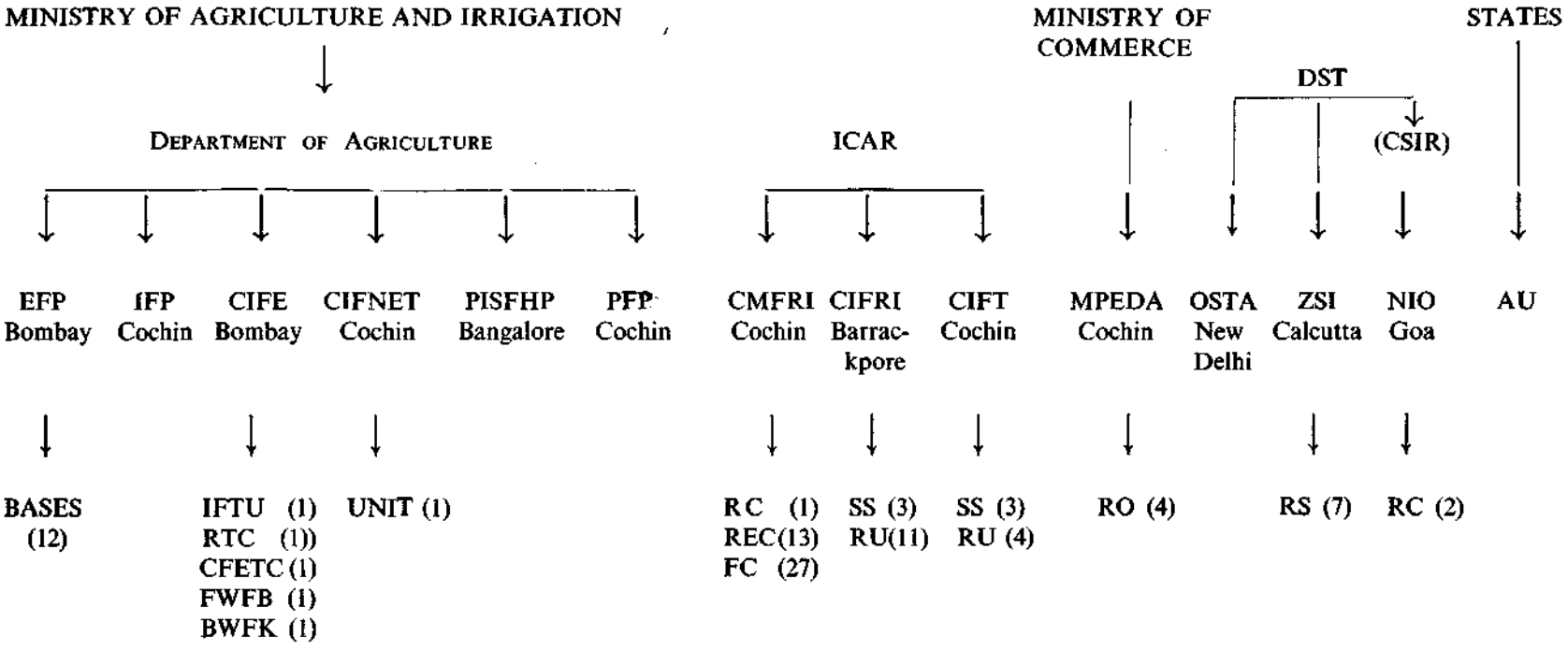
and Vice-President of ICAR. On the administrative side, he is assisted by the Secretary of the Council, who is Joint Secretary to the Government of India, and Additional Secretaries and Under Secretaries. On the technical side for Fisheries, the Director General is assisted by one of the Deputy Director Generals, dealing with Animal Sciences, one Assistant Director General (Fisheries) and one Scientist (Fisheries).

State Governments

There is considerable diversity in the organisation of Fisheries Departments in different States in India. In general, one of the Ministers of State Governments is in overall charge of Fisheries. The Secretary in charge of fisheries is the Principal Executive Officer. In the Directorates of Fisheries, Director of Fisheries is the head and responsible for planning and implementation of fisheries programmes. When the Director of Fisheries is a member of the Indian Administrative Service, he is assisted by a Joint Director on technical matters. Senior Personnel in the Directorate of Fisheries include Deputy Directors who act as zonal or regional officers, Assistant Directors or Superintendents of Fisheries, District Fishery Officers and Wardens who are in charge of each of the Districts or a particular programme. Under these District Officers, Inspectors of Fisheries and other field officers function.

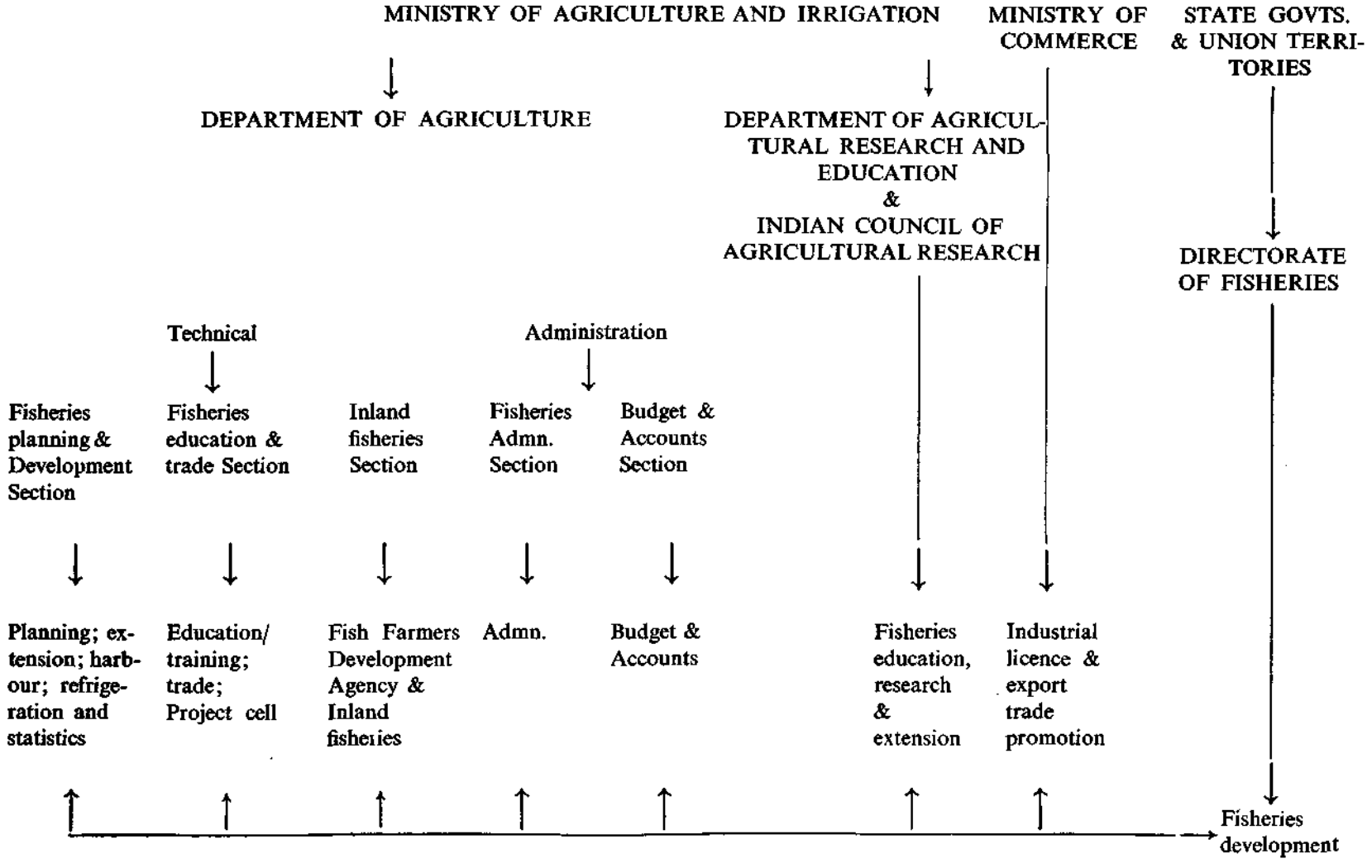
APPENDIX 6

CHART INDICATING THE NODAL ORGANISATIONS AND INSTITUTES



AU	-	Agricultural Universities
BWFK	-	Brackish water fish farm, Kakinada, Andhra Pradesh
CFETC	-	Central Fisheries Extension Training Centre, Hyderabad (Estb. 1973)
CIFE	-	Central Institute of Fisheries Education, Bombay (Estb. 1961)
CIFNET	-	Central Institute of Fisheries Nautical and Engineering Training, Cochin (Estb. 1963)
CIFRI	-	Central Inland Fisheries Research Institute, Barrackpore (Estb. 1947)
CIFT	-	Central Institute of Fisheries Technology, Cochin (Estb. 1957)
CMFRI	-	Central Marine Fisheries Research Institute, Cochin (Estb. 1947)
CSIR	-	Council of Scientific & Industrial Research
DST	-	Department of Science and Technology
EFP	-	Exploratory Fisheries Project, Bombay (Estb. 1947)
FC	-	Field Centre
FWFB	-	Fresh Water fish farm, Balabhadrapuram, Andhra Pradesh
ICAR	-	Indian Council of Agricultural Research
IFP	-	Integrated Fisheries Project, Cochin (Estb. 1952)
IFTU	-	Inland Fisheries Training Unit, Barrackpore (Estb. 1947)
MPEDA	-	Marine Products Export Development Authority, Cochin (Estb. 1972)
NIO	-	National Institute of Oceanography, Panaji, Goa (Estb. 1966)
OSTA	-	Ocean Science and Technology Agency
PFP	-	Pelagic Fishery Project (Estb. 1971)
PISFHP	-	Pre-Investment Survey of Fishing Harbours Project, Bangalore (Estb. 1968)
RC	-	Regional Centre
REC	-	Research Centre
RO	-	Regional Office
RS	-	Regional Station
RTC	-	Regional Training Centre for Inland Fishries Operatives, Agra (Estb. 1967)
RU	-	Research Unit
ZSI	-	Zoological Survey of India, Calcutta (Estb. 1916)

FISHERIES ADMINISTRATION AND ORGANISATIONAL SET UP IN THE CENTRAL AND STATE GOVERNMENTS



APPENDIX 7

IMPORTANT ASSOCIATIONS/SOCIETIES FOSTERING MARINE SCIENCE AND ALLIED SUBJECTS IN INDIA

Asiatic Society
1 Park Street, Calcutta - 700 016.

Bombay Natural History Society
The Honorary Secretary, Bombay Natural History Society, Hornbill House, Shabid Bhagat Singh Road, Bombay - 400 001 (BR).

Indian Fisheries Association
Taraporewala Aquarium, Bombay-400 002.

Inland Fisheries Society of India
c/o Central Inland Fisheries Research Institute, 24 Parganas, Barrackpore, West Bengal.

Indian Society of Ichthyologist
c/o Zoological Survey of India,
69, Santhome High Road, Madras-600 028.

Indian Meteorological Society
c/o The Director General, Indian Meteorological Department, The Observatory, Lodi Road, New Delhi-110 003.

Marine Biological Association of India
P. B. No. 1244, Cochin-682 011.

Phycological Society (India)
Indian Agricultural Research Institute,
Division of Microbiology, New Delhi-110 012.

Sea Food Exporters Association of India
The Secretary, Sea Food exporters Association of India, XII/125 (A), Jew Town Road, Cochin-682 011.

Seaweed Research and Utilisation Association of India
The Secretary, Seaweed Research and Utilisation Association of India, Mandapam Camp, Ramnad District, Tamil Nadu.

Society of Fishery Technologists
c/o Central Institute of Fisheries Technology
Willingdon Island, Matsyapuri P. O., Cochin-682 029.

Society for Clean Environment (Socleen)
Garden Resort, 606, Sion-Trombay Road, Bombay-400 071.

Zoological Society of India
c/o Zoological Survey of India,
34, Chittaranjan Avenue, Calcutta-700 012.

APPENDIX 8

IMPORTANT INDIAN PERIODICALS IN MARINE SCIENCE AND ALLIED SUBJECTS

Administration Report of the Department of Fisheries. All States, India.

Agra University Journal of Research — Science. Agra University, Agra-282 001, Uttar Pradesh.

Annual Report, Central Inland Fisheries Research Institute. Director, Central Inland Fisheries Research Institute, Barrackpore-743 101, West Bengal.

Annual Report, Central Institute of Fisheries Technology. Director, Central Institute of Fisheries Technology, Matsapuri P. O., Cochin-692 029.

Annual Report, Central Marine Fisheries Research Institute. Director, Central Marine Fisheries Research Institute, Ernakulam, Cochin-682 018.

Annual Report, Central Institute of Fisheries Natutical & Engineering Training. Director, Central Institute of Fisheries Nautical & Engineering Training, Cochin-16.

Annual Report, Integrated Fisheries Project. Director, Integrated Fisheries Project, Cochin-682 016.

Bibliography of Indian Fisheries. Director, Central Inland Fisheries Research Institute, Barrackpore-743 101, West Bengal.

Bulletin of the Department of Fisheries, Kerala. Directorate of Fisheries, Trivandrum-695 010, Kerala.

Bulletin of the Department of Marine Science, University of Cochin. The Managing Editor, Bulletin of the Department of Marine Science, Cochin-682 016.

Central Institute of Fisheries Education, News letter. Director, Central Institute of Fisheries Education, Jaipradash Road, Versova, Bombay-400 061.

Central Inland Fisheries Research Institute, News letter. Director, Central Inland Fisheries Research Institute, Barrackpore-743 101.

Central Marine Fisheries Research Institute, News letter. Director, Central Marine Fisheries Research Institute, Cochin-682 018.

Central Marine Fisheries Research Institute, Bulletin. Director, Central Marine Fisheries Research Institute, Cochin-682 018.

Current Science. The Manager, Current Science Association, Bangalore-560 006, Karnataka.

Fishery Technology. The Editor, Fishery Technology, c/o CIFT, Cochin-682 029.

Food farming and Agriculture. The Editor, 105-C, Block F. New Alipore, Calcutta-700 053.

I. C. A. R. Reporter. Under Secretary, Indian Council of Agricultural Research, New Delhi-110 001.

Indian Farming. The Business Manager, Indian Council of Agricultural Research, New Delhi-110 001.

Indian Fisheries Bulletin. Government of India, Ministry of Food & Agriculture, New Delhi.

Indian Journal of Animal Research. Agricultural Research Communication Centre, Sadar, Karnal-132 001 (Haryana).

Indian Journal of Animal Science. The Business Manager, Indian Council of Agricultural Research, New Delhi-1.

Indian Journal of Experimental Biology. C. S. I. R., Publications & Information Directorate, Hillside Road, New Delhi-110 012.

Indian Journal of Fisheries. The Director, Central Marine Fisheries Research Institute, Cochin-682018.

Indian Journal of Marine Science. C. S. I. R., Publications & Information Directorate, Hillaside Road, New Delhi -110012.

Indian Journal of Meteorology, Hydrology and Geophysics. The Editor, I J M H & G. The Observatory, Lodi Road, New Delhi-110 003.

Indian Journal of Zoology. Publication Division, Department of Zoology, Saifia College, Bhopal, M.P.

Indian Seafoods. The Director, Marine Products Export Development Authority, Cochin-682 016.

Journal of Asiatic Society. The Asiatic Society, 1 Park Street, Calcutta-16.

Journal of Bombay Natural History Society. The Honorary Secretary, Bombay Natural History Society, Hornbill House, Shahid Bhagat Singh Road, Bombay-400 001.

Journal of Aquatic Biology and Fisheries. Department of Aquatic Biology and Fisheries, University of Kerala, Sankumugham Beach, Trivandrum-695 007.

Journal of Inland Fisheries Association. Indian Fisheries Association, Taraporewala Aquarium, Bombay-2.

Journal of Inland Fisheries Society of India. Inland Fisheries Society of India, Barrackpore-743 101, West Bengal.

Journal of Madras University. University of Madras, University Centenary Building, Chepauk, Madras-5.

Journal of the Marine Biological Association of India. The Editor, The Marine Biological Association of India, P. B. No. 1244, Cochin-682 011.

Journal of Scientific & Industrial Research. Council of Scientific and Industrial Research, Publications & Information Directorate, Hillside Road, New Delhi-2.

Journal of University of Bombay. University of Bombay.

Journal of Indian Botanical Society. The Business Manager, Indian Botanical Society, School of Studies in Botany, Vikram University, Ujjain, Madhya Pradesh.

Journal of Zoological Society of India. The Zoological Society of India, c/o The Zoological Survey of India, 34 Chittaranjan Avenue, Calcutta-12.

Proceedings of the Indian Academy of Sciences. The Editor, Indian Academy of Science, Hebbal P.O., Bangalore-560 006.

Proceedings of the Indian Science Congress Association. The General Secretary, Indian Science Congress Association, 14, Dr. Biresh Guha Street, Calcutta-17.

Proceedings of the Zoological Society of Bengal. The Zoological Society of Bengal, 35 Ballygunge Circular Road, Calcutta-19.

Proceedings of the Zoological Society of India. The Zoological Society of India, c/o Zoological Survey of India, 34 Cittaranjan Avenue, Calcutta-12.

Phykos. Phycological Society (India), Indian Agricultural Research Institute, Division of Microbiology, New Delhi-110 012.

Mahasagar. National Institute of Oceanography, Dona Paula, Goa.

Matsya. c/o The Zoological Survey of India, 69, Santhome High Road, Madras-28

Madras Journal of Fisheries. Director of Fisheries, Editor, 'Madras Journal of Fisheries', Administrative office Buildings, Madras-6.

Memoirs of the Indian Museum. Zoological Survey of India, 34 C. A., Calcutta-12.

Records of the Indian Museum. Zoological Survey of India, 34 C. A., Calcutta-12.

Research & Industry. Council of Scienific & Industrial Research, Publications & Information Directorate, Hillside Road, New Delhi-110 012.

Salt Research & Industry Journal. Managing Editor, Salt Research & Industry Journal, Central Salt & Marine Chemicals Research Institute, Bhavnagar 364 002, India.

Science & Culture. Indian Science News Association, 92 Acharya Prafulla Chandra Road, Calcutta-9.

Seafood Export Journal. The Secretary, Seafood Exporters Association of India, XII/125 (A), Jew Town Road, Cochin-682 001.

Seafood Newsletter. The Marine Products Export Development Authority, P.B. No. 1708, Cochin-682 016.

Special Publications of CMFRI . The Director, Central Marine Fisheries Research Institute, Cochin-682 018.

Zoological Survey of India, Newsletter. The Zoological Survey of India, 34 Chittaranjan Avenue, Calcutta-12.

Bulletin, Central Inland Fisheries Research Institute. The Director, Central Inland Fisheries Research Institute, Barrackpore 743 101, West Bengal.

National Institute of Oceanography, Annual Report. National Institute of Oceanography, Dona Paula, Goa.

Copies of "Indian Fisheries 1947 - 1977" can be had from

THE MARINE PRODUCTS EXPORT DEVELOPMENT AUTHORITY

P. B. No. 1708, M. G. Road, Cochin-682 016